NPR-A Fisheries Monitoring Implementation Plan

Prepared for
BLM Arctic Field Office

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INTRODUCTION

Available evidence suggests that oil and gas related activities modify ecological processes in ways that impair the form, function, productivity and maintenance of habitat (National Research Council 2003). Despite decades of research in the Arctic, gaps in the state of knowledge remain, and therefore the need for activity monitoring to determine the effectiveness of current mitigation measures and management policies remains.

A primary purpose for the development of this monitoring plan was to support the U.S. Department of the Interior, Bureau of Land Management’s (BLM) national mission of sustaining the health, diversity, and productivity of the public lands while following BLM’s multiple-use management mandate. Development of appropriate monitoring for fisheries will assist in BLM Alaska’s commitment to maintain the desired ecological conditions described within its “Statewide Land Health Standards”.

The BLM was tasked with development of a Fisheries Monitoring Implementation Plan for the National Petroleum Reserve – Alaska (NPR-A). The BLM’s purpose in developing the NPR-A Fisheries Monitoring Plan is to ensure documentation of changes in fish and fish habitat conditions and to determine the cause for any observed changes. Where the cause is determined to be a result of oil and gas exploration or production activities, BLM would initiate adaptive management instituting recommended operating procedures or permit stipulations. BLM requested ENTRIX, Inc. to accomplish the following tasks:

- Prepare a literature review,
- Identify monitoring objectives,
- Critique and perhaps revise the current conceptual model,
- Critique and perhaps revise the list of indicators,
- Describe from one to three methods for measurement of each indicator, including estimated schedule and cost,
- Describe how data would be used by resource managers, and
- Submit draft and final implementation plans.

The Project Team approach to complete these tasks emphasized:

- Using existing and/or revised conceptual models describing the linkages between stressors, ecological processes and the structural and functional elements of ecosystems as a means to generate hypotheses regarding existing and future conditions, and

Designing programs to acquire field observations necessary to evaluate the manner in which these stressors alter the properties and relationships of ecosystems under consideration.

The underlying assumption to this approach was that alterations to the natural hydrologic, geomorphic and ecological processes impair ecosystem structure and function including both physiochemical and biological functions (National Research Council 1995, Simenstad et al. 2006).

This approach:

1. Provides a foundation to understand the relative importance of processes and mechanisms responsible for ecological change,
2. Can be exported to other areas on the North Slope,
3. Can be used to predict and monitor the response to avoidance, minimization, and mitigation efforts, and
4. Can be adapted to address other topic areas as they arise (e.g., mining).

While the use of conceptual models in the scientific process was a vital component of the Project Team approach, these models also provide a means to organize and convey complex concepts in a manner that is readily understandable for the general public, key decision-makers and other stakeholders (Karr 1987, Mulder et al. 1999, National Research Council 1995, Simenstad et al. 2006).

OBJECTIVES

The objectives for developing the monitoring plan were to:

- Assess the effects of oil and gas related activities on various surface resources in the NPR-A, human uses of those resources, and sociocultural systems.
- Evaluate the effectiveness of current mitigation measures and management policies, assist with answering current and future management questions, and
improve the effectiveness of future
decisions and mitigation measures (i.e.,
adaptive management).

An essential component of the NPR-A Fisheries
Monitoring Implementation Plan was to clearly
identify the objectives of fisheries monitoring.
Informal objectives were discussed by the
Project Team and were incorporated into the
monitoring recommendations.

The Project Team has worked closely with BLM
to ensure that monitoring objectives are
consistent with BLM management directives.

After initial review and discussion, the scope
and intent of the development of the NPR-A
Fisheries Monitoring Implementation Plan was
determined to be limited to fisheries resources
within freshwater, with an emphasis on
resources of primary importance to subsistence
users. For the NPR-A, broad whitefish is the
chief subsistence fish harvested from
freshwaters, although numerous other species
are also important to the fishery. While
acknowledging that coastal marine habitat is
important to many fish species (e.g. feeding
and moving between drainages), BLM’s
management authority is limited to onshore
activities. The task of providing cost estimates
for individual monitoring components was
found to be widely variable, dependent on the
contractor used, and of little added value in
development of the monitoring plan. Therefore, cost estimates were not generated
for monitoring components.
MODEL DEVELOPMENT

The Research and Monitoring Team (RMT) conceptual model (Figure 1) was used as the basis for examining the connections among key components of oil field development stressors and fisheries responses. This conceptual model identifies the stressors or model drivers that are characteristic of oil and gas exploration and development activities that were used to develop the process-based conceptual models:

- Infrastructure and Roadway Development, and
- Water Quantity.

The general framework illustrated in Figure 2 provides the basis to further develop relationships (related processes) between:

- Impacts or “stressors” (e.g. roadways),
- Physical processes (e.g. sediment dynamics),
- Structural changes (e.g. sediment composition), and
- Functional response (e.g. gravel for fish spawning).

Expanded conceptual models specific to the NPR-A were then developed to describe the physical processes through which oil and gas development stressors affect habitat structure and ecological function based on the framework illustrated in Figure 2 (adapted from Thom et al. 2005). The Project Team reviewed the initial RMT model and indicators and then discussed and revised these as appropriate into a series of process-based conceptual models (Appendix A).

These conceptual models (Figures 3 through 7) patterned after those developed by Thom et al. (2005) designed for coastal ecosystems, assume that habitat structure, habitat processes, and ultimately ecological function are driven by controlling factors, such as hydrology, sediment transport and others (Figure 2). Controlling factors are the mechanisms by which the physical properties of the habitat (habitat structure) are influenced. Oil and gas development affects fisheries by altering these controlling factors.

For direct destruction of habitats, such as by gravel fill, arrows in the NPR-A conceptual models lead directly from the physical process to the functional response - skipping the structural/physical change category (Figures 3 through 7). Although not described in the NPR-A conceptual models (Figures 3 through 7), habitat processes ultimately determine population-level responses in the fisheries which can cause socio-economic effects on local stakeholders. These process-based models are intended to facilitate a better understanding of how oil and gas industry development stressors potentially affect fish populations and ultimately fish harvest.

The RMT conceptual model (Figure 1) for each major impact or stressor (Figure 2) was expanded to create process-based conceptual NPR-A models that provide insight into the behavior of the system being studied (Figures 3 through 7). The expanded conceptual models provide a framework for compiling and organizing evidence presented in journal articles, reports, and unpublished works that supports the processes and responses identified in the models.

Process-based conceptual model critique, revision and development, serves the following purposes:

1. Refinement of the conceptual understanding of the existing conditions and effects of oil and gas related activities,
2. Identification of information gaps to be documented and addressed if practical,
3. Assessment of how well model elements explain the processes and effects,
4. Prioritization for stressors of greatest concern and determination of which indicator may serve as the more appropriate object to monitor,
5. Estimates of the temporal, spatial, and magnitude of effect from the stressors,
6. Assessment of existing monitoring approaches and protocols, and
7. Organization and presentation of complex information.
Figure 1 – RMT Conceptual Model.

Model Key
Shapes
- Primary Issue Modeled – Rectangle
- Model Response and/or Driver - Ellipse
- Model Driver and/or Response – Smoothed Rectangle

Arrows
- Direct Impact of Oil/Gas Activities
- Other Direct or Indirect Relationships

Color and Fill
- Light Gray – appropriate for measurement
- Dark Gray – currently measured in other studies
- Striped – currently measured but may be inadequate or at inappropriate scale
Figure 2 - General Framework for Linking Impacts (Stressors) to Ecological Functions (adapted from Thom et al. 2005).

- **Impact**
  - Infrastructure (Permanent)
  - Infrastructure (Temporary)
  - Water Withdrawal
  - Water Discharge / Spills
  - Fish Harvest

- **Controlling Factors**
  - Hydrology
  - Sediment Supply
  - Substrate
  - Slope/Depth (lakes)
  - Sinuosity / Channel Morphology (streams)
  - Connectivity (lakes)
  - Pollution / Nutrients

- **Habitat Structure**
  - Biomass
  - Diversity
  - Density
  - Patch Size
  - Patch Shape
  - Landscape Position

- **Habitat Processes**
  - Production
  - Sediment Flux
  - Nutrient Flux
  - Carbon Flux

- **Ecological Functions**
  - Prey Production
  - Reproduction
  - Refuge
  - Maintain Biodiversity
  - Disturbance Regulation
  - Carbon Sequestration
Figure 3 - Process-based Preliminary Conceptual Model for Permanent Infrastructure and Roadways.

Potential Constraints
- Up-Stream Water Sources
- Down-Stream Habitat
- Weather Pattern Changes
- Slope of Crossing
- Width of Crossing
- Water Quality
- Size Structure of New Sediment
- Fish Populations
- Fish Species
- Fish Timing of Use
Figure 4 - Process-based Preliminary Conceptual Model for Temporary Infrastructure.

- **Stressor**: Temporary Infrastructure (ice roads, ice bridges, off-road equipment use)
- **Physical Process**: Placement of Ice, Sheetflow, Stream Hydraulics, Water Borne Sediment Transport, Drifting Snow or Ice Build-up, Thermokarst
- **Structural/Physical Changes**: Bank Profile, Bank Stability, In-Stream Seasonal Water Volume, In-Stream Sediment Composition, Water Temperature, Water Velocities, Substrate Moisture & Temperature
- **Functional Response**: Habitat Displacement, Fish Movements, Fish Spawning, Fish Rearing & Overwintering, Water Quality Impairment, Insect Production, Vegetation Production

**Potential Constraints**
- Up-Stream Water Sources
- Down-Stream Habitat
- Weather Pattern Changes
- Width of Structure
- Depth of Structure
- Size Structure of New Sediment
- Topography
- Fish Timing of Use
Figure 5 - Process-based Preliminary Conceptual Model for Changes to Water Quantity.

- **STRESSOR**: Water Quantity (winter construction, domestic and industrial uses)
- **PROCESS**: Water Extraction, Water Recharge, Stream/Lake Hydraulics, Sediment Transport
- **FUNCTIONAL RESPONSE**: Water Quality, Fish Rearing & Overwintering, Fish Entrainment & Entrapment, Fish Movements, Insect Production, Vegetation Production
- **STRUCTURAL/PHYSICAL CHANGES**: Water Volume & Levels, Water Chemistry, Bank Stability, Shoreline Erosion, Water Velocities, Substrate Moisture & Temperature
- **Potential Constraints**: Climate Changes, Up-Stream Water Sources, Groundwater Behavior, Fish Timing of Use, Extraction amount, Extraction timing
Figure 6 - Process-based Preliminary Conceptual Model for Water Discharge and Spills.

**STRESSOR**

- Water Discharge & Spills (produced water, industrial and domestic waste and petroleum based fluids)

**PROCESS**

- Small Fuel Spills
- Water Release
- Water Recharge
- Sediment Transport
- Stream/Lake Hydraulics

**STRUCTURAL/PHYSICAL CHANGES**

- Water Chemistry
- Water Volume & Levels
- Water Temperature
- Water Velocities
- Substrate Moisture & Temperature

**FUNCTIONAL RESPONSE**

- Water Quality Impairment
- Fish Rearing & Overwintering
- Fish Movements
- Fish Entrainment & Entrapment
- Insect Production
- Vegetation Production

**Potential Constraints**

- Climate Changes
- Up-Stream Water Sources
- Groundwater Behavior
- Material Discharged
- Fish Timing of Use
- Discharge amount
- Discharge timing
Figure 7 - Process-based Preliminary Conceptual Model for Fish Harvest.

Potential Constraints:
- Population Dynamics Information
- Harvest Information
- Food Availability – Growth Relationships
- Climate Influences
MONITORING PLAN DEVELOPMENT

Use of existing and process-based conceptual models facilitated the description and understanding of linkages among stressors, ecological processes and the structural and functional elements of ecosystems. The models also were used to more clearly identify monitoring objectives (Figure 8). These models served as a means to generate hypotheses regarding existing and future conditions, evaluate the manner in which the stressors alter the properties and relationships of ecosystems under consideration, and design programs for acquiring field observations necessary to evaluate mitigation measures.

During monitoring plan development the Project Team discussed and revised the models. With a better understanding of these relationships, we identified the important physical, chemical and biological information needed. This focused our efforts on searching for and reviewing pertinent literature. Some of the identified information requirements were not met and were identified as information gaps within the monitoring plan. After reviewing the pertinent references, the Project Team evaluated which stressors and processes were most likely to be the main drivers in terms of producing effects on ecological function.

An essential component in this review was prioritizing which parameters should be monitored to understand the effectiveness of mitigation and management policies. Mitigation measures and operating procedures were screened following a process outlined in the following section. Mitigation measures or management policies that were considered appropriate for effectiveness monitoring were testable and where the effectiveness was considered uncertain were the basis of monitoring plan development.

Prioritization of mitigation measures and management policy included an examination of the relationship between human-caused change and a measurable and valuable social value.

The primary steps resulted in identification of monitoring parameters and protocols that were focused on the resources most at risk, had the greatest value to the social and cultural environment and were practical to implement based on previously developed methods.
**Figure 8 – Monitoring Plan Development**

**Initial Literature Review**

**RMT Model** → **Process-Based Preliminary Conceptual Models**

**Research Significant Stressors and Information Availability**
- Identify Further Information Needs from Conceptual Models
- Evaluate Mechanisms Responsible for Ecological Degradation
- Focused Literature Review

**Research Programmatic/Institutional Assets and Constraints**
- Prioritize Mitigation Measures and Management Policies Based on Effectiveness Monitoring Information
- Prioritize Mitigation Measures and Management Policies based on Expected Response

**Research Spatial and Temporal Overlap**
- Compile Information on Geographic Distribution of Resources at Risk
- Compile Information on Socio-Economic Importance of Resources at Risk
- Compile Information on Geographic Distribution of Stressors
- Compile Temporal Information on Resources at Risk
- Compile Temporal Information on Stressors
- Compile Information on Potential Ecological Constraints

**Characterization Program Design**
- Identify Potential Monitoring Parameters
- Identify Potential Monitoring Protocols
- Develop Experimental Design and Statistical Framework
REVIEW OF MITIGATION MEASURES AND OPERATING PROCEDURES

Oil and gas development mitigation measures and operating procedures specific to the conservation of fisheries resources described in NPR-A Integrated Activity Plans are presented in their combined and complete form in Appendix B.

Thirty mitigation measures and procedures developed to protect fisheries resources within the NPR-A organized as they relate to the stressors identified and developed in the conceptual models are listed below.

**PERMANENT INFRASTRUCTURE**
- PI1 – Pads, Roads & Pipelines
- PI2 – Roads
- PI3 – Bridges & Culverts
- PI4 – Causeways & Docks
- PI5 – Gravel Mines
- PI6 – Infrastructure Setbacks - River
- PI7 – Infrastructure Setbacks - Lakes
- PI8 – Teshekpuk Lake Exclusion and Shoreline Setback
- PI9 – Infrastructure Setbacks - Coast

**TEMPORARY INFRASTRUCTURE**
- TI1 – Exploration Drilling – Stream & River Prohibition
- TI2 – Winter Tundra Travel
- TI3 – Summer Tundra Travel
- TI4 – Snow & Ice Bridges
- TI5 – Non-Bridged River & Stream Crossings

**WATER QUANTITY**
- WW1 – River & Stream Withdrawal Prohibition
- WW2 – Lake Withdrawals

**WATER DISCHARGE & SPILLS**
- WD1 – Waste Water/Sludge
- WD2 – Hazardous Materials Plan
- WD3 – Spill Prevention & Response Plan
- WD4 – Fuel Handling
- WD5 – Produced Water Disposal
- WD6 – Reserve Pit Dewatering
- WD7 – Pipeline Operation & Maintenance

**FISH HARVEST**
- SF1 – Surface Disturbance Limitations
- SF2 – Subsistence Users Consultation & Plan
- SF3 – Environmental & Cultural Education
- SF4 – Exploration Guidelines-Dease Inlet, Admiralty Bay, Elson Lagoon
- SF5 – Coastal Development Guidelines-Dease Inlet, Admiralty Bay, Elson Lagoon
- SF6 – Kasegaluk Lagoon Deferral
- SF7 – Subsistence Food Safety

Discussion of the rationale for excluding 15 of these measures from further consideration follows.

Of these 30 measures and procedures to protect fisheries resources, 5 were eliminated from further consideration because they apply to marine and coastal fisheries (PI4, PI9, SF4, SF5, and SF6). Because the focus of this monitoring plan is freshwater resources, no further consideration was given to these measures, with the recognition that many of the fishes within the freshwaters of NPR-A use marine resources during some portion of their life-cycle.

Five additional measures and procedures were eliminated from further consideration because their relationship to fisheries and fisheries habitats is indirect (PI2, TI2, WD2, WD3, WD7, SF1, and SF3). Measure PI2 addresses the construction and use of roads, specifically the provision that roads should not prevent access of subsistence users to their resource. The provisions of this requirement are adequately addressed under SF2. Measure TI2 addresses construction and operation of snow and ice roads and winter tundra travel. While TI2 specifies protection of stream banks as an objective, we considered that measure TI4, which covers snow and ice bridge construction and operation, more directly addresses this issue.

Measure SF1 limits surface disturbance within specific lease blocks to protect subsistence resources and activities. Protections within this measure are addressed under SF2, which specifies consultation with subsistence users and monitoring of subsistence resources. SF3 provides for cultural education.

Two other procedures were eliminated from further evaluation because they are prohibitions (TI1 and WW1). Measure TI1 is a prohibition of exploratory drilling within fish-bearing streams, rivers, and lakes. However, this prohibition includes a provision for consideration on a site-specific basis. If this prohibition is waived, monitoring similar to that
recommended for temporary infrastructure would be appropriate. Measure WW1 prohibits the industrial use of water from rivers and streams during the winter. There are no provisions for exceptions to this measure.

Measures WD2, WD3, and WD7 address spill prevention and spill response planning. Because large spills and pipeline leaks would require post-spill cleanup and monitoring designed specifically for the type and extent of the spill, inclusion of these measures is considered outside of the scope of this plan. Development of a Natural Resource Damage Assessment Ephemeral Sampling Plan would be appropriate for sampling aquatic resources that would be affected by the spill based on the projected trajectory and potential contact with the spill. Measure WD4 prohibits refueling and fuel storage near water. Monitoring of the effects of small chronic spills is indirectly addressed under baseline water quality monitoring recommended for permanent and temporary infrastructure measures.

Measures WD1, WD5, and WD6 address prohibitions related to discharge of wastewater, produced water and reserve-pit fluids to waters. These prohibitions include the exception that the BLM may authorize these discharges, if an appropriate National Pollution Discharge Elimination System (NPDES) or State permit was granted. Water quality monitoring would likely be required for NPDES or State discharge permits and is considered outside of the scope of this plan. Results of discharge permit water quality monitoring would be applicable for submission to BLM to facilitate BLM’s monitoring of fisheries resources within the NPR-A.

The remaining measures and procedures were reviewed using a 5-step process to evaluate suitability for inclusion in the monitoring plan and potential effectiveness. Results of this review and evaluation is presented below and summarized in Table 1.

Of the 15 measures and procedures reviewed below, monitoring was specifically required for WW2 – Lake Withdrawals, SF2 – Subsistence Users Consultation & Plan, and SF7 – Subsistence Food Safety (Appendix B – monitoring requirements highlighted in red).

**APPROPRIATENESS FOR MONITORING**

Of the initial 30 measures and procedures designed to be protective of fisheries resources, 15 measures (listed below and in Table 1) were identified as appropriate for continued evaluation for inclusion in the monitoring plan.

**Permanent Infrastructure**

- PI1 – Pads, Roads & Pipelines
- PI3 – Bridges & Culverts
- PI5 – Gravel Mines
- PI6 – Infrastructure Setbacks – River
- PI8 – Teshekpuk Lake Exclusion and Shoreline Setback
- PI7 – Infrastructure Setbacks - Lakes

**Temporary Infrastructure**

- TI3 – Summer Tundra Travel
- TI4 – Snow & Ice Bridges
- TI5 – Non-Bridged River & Stream Crossings

**Water Quantity**

- WW2 – Lake Withdrawals

**Water Discharge & Spills**

- WD1 – Waste Water/Sludge
- WD5 – Produced Water Disposal
- WD6 – Reserve Pit Dewatering

**Fish Harvest**

- SF2 – Subsistence Users Consultation & Plan
- SF7 – Subsistence Food Safety

Next these measures were evaluated by considering the type of monitoring that was already required by outside agencies or would potentially be necessary, and considering the specificity of the measure’s testability by asking:

- Is the monitoring compliance or ecological?
- Is the wording of the mitigation measure or management policy sufficiently specific as to be testable?

Discussion of the responses to these questions for the 15 measures listed in Table 1 follows.

Permanent facilities, roads, bridges, culverts, and gravel mines covered by measures PI1, PI3, and PI5 that would cross or otherwise affect fish-bearing streams would require permitting and approval by the Alaska Department of Fish and Game (ADF&G). Permit applications provide for review of the siting and design of permanent stream crossing structures or gravel mines. However, pre-construction habitat characterization and post-construction evaluation and monitoring would not necessarily be required by ADF&G fish habitat permit stipulations. These measures specify that impacts to fish, water quality, and aquatic and riparian habitats be
minimized; that crossings allow free passage of fish and maintain natural stream flow; and that gravel mine sites within flood plains provide enhancements to fish habitat. Alteration of the physical and biotic conditions specified within these measures is testable and could be appropriately monitored using an ecologically based monitoring plan.

PI6, PI7, and PI8 specify setbacks of permanent infrastructure from specific rivers and deep-water lakes, with the exception of essential transportation corridors. Compliance with specified setbacks would be addressed during development plan reviews. Exceptions to these setbacks would be allowed if minimal impacts could be shown and if no feasible or prudent alternative exists. Permits for crossing fish-bearing rivers and streams would be necessary, as discussed for PI1 and PI3. Alteration of the physical and biotic conditions specified within the measures is testable and would be appropriately monitored using an ecologically-based monitoring plan.

Snow and ice bridges or vehicle crossings of fish-bearing streams addressed in TI4 and TI5 would require permitting through ADF&G. Both ADF&G's permits and BLM mitigation stipulate that snow and ice bridges be removed, breached or slotted prior to spring breakup. The physical changes that could occur as a result of snow or ice crossings were specified within these measures and are testable and appropriately monitored using an ecologically-based monitoring plan. Summer channel crossings, addressed in TI3, would also require permitting and would also be appropriately monitored.

WW2 specifies conditions for water withdrawal, including a potential requirement to develop a water-monitoring plan to assess draw down and water quality before, during, and after pumping water from any fish-bearing lake or lake of special concern. Water withdrawal would also require a permit from the Alaska Department of Natural Resources and ADF&G Habitat Division. The physical and chemical changes that could occur as a result of water withdrawal stipulated in measure WW2 are testable and appropriately monitored using permit compliance monitoring. Fish presence and biotic changes that could occur as a result of depleted water volumes and altered water quality would also be appropriate for monitoring.

Permitted discharge of waste water or sludge, produced water, and reserve pit fluids (WD1, WD5, and WD6) would be monitored through the NPDES process. In most instances compliance monitoring would be appropriately completed through the NPDES process. The need for additional ecologically-based monitoring programs would be dependent on the result of compliance monitoring. Because these discharges to surface waters would normally be prohibited, they are not considered further during development of this monitoring plan, although these measures are testable and would be appropriate for monitoring.

**Mitigation Effectiveness**

In some cases, the effectiveness of certain mitigation measures and management policies may have already been demonstrated and the widespread applicability of these actions is certain. In other cases, little is known about the certainty of the expected response. Because there are currently no active oil and gas facilities within the NPR-A, most information on the effectiveness of mitigation measures must come from Alaska's North Slope oil and gas developments at Prudhoe Bay and other Arctic regions. The intent of this evaluation is to focus on those actions for which the expected response is uncertain rather than allocating limited monitoring resources to the measurement of indicators for which the expected response is well understood.

A recent review of crossing structures at streams in the North Slope oilfields near Prudhoe Bay indicated that 29 percent of the crossings evaluated substantially restricted or completely blocked fish passage (Morris and Winters 2008). General problems associated with crossing structures included blockage of flow by gravel deposition, perched outlets, or inadequate conveyance of water. Much of the hydrology, especially during spring breakup, within the NPR-A is not well understood. It is likely that crossing structures designed with the best intent of providing adequate conveyance will experience similar problems as those observed in the Prudhoe Bay region. Therefore the effectiveness of measures in PI1 and PI3 are considered uncertain.

Gravel mines excavated for the construction of roads and pads within North Slope oilfields have had a history of providing fish habitat (Hemming 1992). While gravel mine excavation designs have improved, there are still uncertainties as to whether mines excavated within flood plains would continue to provide suitable fish habitat. Therefore, the...
effectiveness of measure PI5 is considered to be uncertain.

The required setbacks of infrastructure 0.5 to 3 miles from selected rivers and streams, PI6, and 0.25 miles from deep lakes, PI7 and PI8, appear to be protective of these resources. However, the adequacy of these setback distances has not been tested. These measures also provide for exceptions. Therefore the effectiveness of measures PI6, PI7, and PI8 are considered uncertain.

Although snow and ice bridges have been constructed for decades for oil and gas exploration on Alaska's North Slope, few crossings have been monitored in detail to determine whether permit provisions have afforded adequate protection to stream banks and stream-bank vegetation (McKendrick 2000). Alteration of channels and sediments during breakup due to different slotting or breaching techniques has been largely unstudied. In addition, spring fish movements across these structures have not been studied. The effect of creating repeated ice bridge crossings at the same location year after year is also uncertain. While most crossings would be considered to have a minor effect on fisheries resources, this conclusion is uncertain; therefore the effectiveness of measures TI4 and TI5 have not been demonstrated. Summer channel crossings have not been generally allowed nor evaluated, so the effectiveness of TI3 has not been demonstrated.

Lake studies for water withdrawal, WW2, have generally shown minimal or no change in conditions and adequate recharge of lakes the following spring. However, lake studies have not been completed throughout the entire NPR-A and the characteristics of ice growth, recharge, discharge, and biotic communities are unknown for many lakes that would potentially be used as water sources. It may be necessary, for example, to re-visit the assumed 7-foot ice thickness for lakes that are not in the coastal plain. Studies to date have documented the effectiveness of currently permitted withdrawal mitigation measures and operating procedures within Northeastern NPR-A, but these findings may not be applicable across the entire NPR-A because of differences in hydrologic settings and ice conditions. While there is some confidence that the protections listed in measure WW2 and those protections stipulated by water use permits have been effective in protecting fish resources within the Northeast NPR-A where these measures have been applied; monitoring is specified in this measure and the effectiveness of this measure for all lakes across the entire NPR-A remains uncertain.

The effectiveness of measure SF2 to mitigate interference with subsistence fish users and subsistence fisheries resources is to be monitored as specified in this measure. Potential contamination of subsistence foods is also to be monitored as specified in measure SF7. Because of the occurrence of natural hydrocarbon seeps within the NPR-A and the use of diesel and gasoline products within the NPR-A for purposes other than oil and gas exploration and development, identification of non-point sources for hydrocarbon contamination of subsistence fish and oil and gas industry activities may be problematic. Sampling for contamination of fish tissues is discussed further under water quality monitoring.

For the measures and policies evaluated, a substantial body of evidence does not exist to suggest that these measures or policies are consistently effective.
### Table 1 – Evaluation of NPR-A Fisheries Mitigation Measures and Operating Procedures for Monitoring.

<table>
<thead>
<tr>
<th>Measure or Policy</th>
<th>Permanent Infrastructure</th>
<th>Temporary Infrastructure</th>
<th>Water Quantity</th>
<th>Water Discharge &amp; Spills</th>
<th>Fisheries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prioritization</td>
<td>PI1 PI3 PI5 PI6 PI7 PI8</td>
<td>TI3 TI4 TI5 WW2 WD1 WD5 WD6 SF2 SF7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appropriateness for Monitoring (Y, N, or permit)</td>
<td>Y Y Y Y Y Y Y Y Y NPDES NPDES NPDES</td>
<td>Y Y Y Y Y Y Y Y Y NPDES NPDES NPDES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compliance or Ecological (C or E)</td>
<td>E E E E E E E C/E E E C/E C C C C C/E C/E</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific and Testable (Y or N)</td>
<td>Y Y Y Y Y Y Y Y Y Y Y Y Y Y Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effectiveness Demonstrated (Y or N)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spatial and Temporal Overlap of Stressor and Resource (H, M, or L)</td>
<td>M H M H L L M M M H</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecological Measures</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response specific to stressor (Y or N)</td>
<td>N Y N Y N N Y Y N Y N Y</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response significant (Y or N)</td>
<td>N Y N Y N N U Y N Y U</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response occurs to unique resource (Y or N)</td>
<td>N Y N N N N N N N Y Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Measures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resource of high value to community (Y or N)</td>
<td>Y Y Y Y Y Y Y Y Y Y Y Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resource of high value to public (Y or N)</td>
<td>N Y N Y Y Y Y N Y N N</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resource has special status (Y or N)</td>
<td>N Y N Y N N Y Y Y Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detection of Human-Caused Change (Certain or Uncertain)</td>
<td>U C C C U U U C U C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **PI1** – Pads, Roads & Pipelines
- **PI3** – Bridges & Culverts
- **PI5** – Gravel Mines
- **PI6** – Infrastructure Setbacks – River
- **PI7** – Infrastructure Setbacks – Lakes
- **PI8** – Teshekpuk Lake Exclusion and Infrastructure Setback
- **TI3** – Summer Tundra Travel
- **TI4** – Snow & Ice Bridges
- **TI5** – Non-Bridged River & Stream Crossings
- **WW2** – Lake Quantity (*Note – measure specifies water monitoring plan may be required*)
- **WD1** – Waste Water/Sludge
- **WD5** – Produced Water Disposal
- **WD6** – Reserve Pit Dewatering
- **SF2** – Subsistence Users Consultation & Plan (*Note – measure specifies development of monitoring plans for new permanent facilities*)
- **SF7** – Subsistence Food Safety (*Note – measure specifies development of monitoring plans for new permanent facilities*)
SPATIAL AND TEMPORAL OVERLAP

Data provided by the BLM were used to assist in identifying spatial and temporal components within the NPR-A including ecosystem components important for freshwater subsistence fisheries such as rivers, streams, lakes, and subsistence fisheries use areas. These resources were compared to the distribution of oil and gas leases, and likely staging areas, to evaluate potential travel corridors and co-occurrence of infrastructure and used fisheries resources. These data were spatially intersected (overlapped) to determine sensitive fisheries habitats and potential oil and gas industry development activity, based on current active leases; giving consideration to mitigation measures available for NPR-A subunits.

Spatial data were used to:

1. Establish the monitoring framework,
2. Determine current priority monitoring areas, and
3. Identify potential future monitoring priorities.

Stream segments were prioritized using four categories based on (1) location within an active lease, (2) location within a transportation corridor, (3) BLM protection and (4) reported subsistence use. Streams received scores of 1 (category applied) or 0 (category did not apply) for each category. Rankings were then computed as the sum of these four categories. Stream segments scoring 3 or 4 were ranked high, streams scoring 2 were ranked medium and streams scoring 1 or 0 were ranked low (Figure 9).

Over 50,000 mapped lakes within the NPR-A were prioritized using 6 categories: (1) subsistence use, (2) oil and gas leasing, (3) transportation corridors, (4) connection to major drainages, (5) BLM protection, and (6) depth greater than 1.6 meters. Lakes were given a score of 1 for each category if they fell within subsistence use polygons, were within oil and gas lease areas, were within 5-miles of a transportation corridor, were within 2-miles of a major drainage, had shoreline protection by BLM stipulation, and were estimated to be greater than 1.6 meters deep, based on ice cover measured by Side Looking Radar (SLR) (Mellor 1987). This estimated depth was the mean ice thickness at the surveyed lakes and includes deeper lakes with free water under the ice that may support overwintering fish. Lakes that did not fall within each of these categories were given a score of zero. Scores were then totaled for all lakes and lakes with combined totals of 4 or more for any of these 6 categories were ranked high. Lakes with combined totals of 3 were ranked medium. Lakes with combined totals of 2 or less were ranked low (Figure 10).

Map A illustrates the resulting rankings for fisheries resources (streams and lakes) showing resources which are likely to have the greatest overlap with potential oil and gas development (spatial overlap). The potential for both spatial and temporal overlap between identified stressors and fisheries resources would be greatest for PI3–Bridges and Culverts, PI6–Infrastructure Setbacks-Rivers, WW2–Water Quantity, and SF2–Subsistence Users. Although PI6 protects rivers and streams, transportation corridors across rivers and streams would be necessary for any oil and gas development within the NPR-A. Because PI1 and PI5 generally would discourage construction of oil and gas development infrastructure or gravel mines within or near fisheries resources and these activities near protected resources would largely be avoidable, spatial overlap for these measures and resources was considered medium. Since construction of oil and gas infrastructure near large lakes would also likely be avoidable, spatial overlap for this measure was considered low.

Because the extent of fish overwintering habitat within the rivers, streams, and lakes within the NPR-A is largely unknown, spatial overlap for temporary snow and ice bridges, TI4, and stream crossings, TI5, was considered medium because many small streams and rivers within the NPR-A are unlikely to provide overwintering habitat. However, considerable uncertainty remains in this assumption. Spatial overlap for summer stream crossings, TI3, was also considered medium.
Figure 9. NPR-A Fisheries Resource Prioritization - Streams

<table>
<thead>
<tr>
<th>Category</th>
<th>A to B</th>
<th>B to C</th>
<th>C to D</th>
<th>D to E</th>
<th>D to F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leases</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Transportation</td>
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<td>0</td>
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<tr>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Subsistence Use</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
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<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Ranking</td>
<td>Low</td>
<td>Medium</td>
<td>Low</td>
<td>High</td>
<td>Medium</td>
</tr>
</tbody>
</table>
Figure 10. NPR-A Fisheries Resource Prioritization - Lakes

<table>
<thead>
<tr>
<th>Category</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leases</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Transportation</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Connection</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Subsistence</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Protection</td>
<td>0</td>
<td>1</td>
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</tr>
<tr>
<td>Depth</td>
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<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Low</th>
<th>High</th>
<th>Medium</th>
</tr>
</thead>
</table>
DETECTION OF HUMAN-CAUSED CHANGE

The evaluation of certainty or uncertainty in response of fisheries resources to oil and gas development stressors was evaluated based on the developed process-based conceptual models, available literature, and professional judgment using criteria specified by the RMT. The Project Team evaluated applicable mitigation measures and management policies using the following criteria:

Ecological Measures

- Resource response to specific oil and gas stressors is likely,
- Scale of resource response is significant at the population, ecosystem, or landscape level, and
- Resource response occurs in an area that had unique qualities.

Social Measures

- Resource is of high value to the local community,
- Resource is of high value to the general public interest, and
- Resource has special status established by law or policy.

These criteria were evaluated for each measure and a “Yes” or “No” response was completed (Table 1). Discussion of the rational for responses follows.

In the evaluation of fisheries responses to oil and gas permanent infrastructure stressors, consideration was given to the type of stressor related to each mitigation measure and whether specific physical, hydrologic, chemical, or biotic responses have been documented as a result of this stressor. For measures that are generally prohibitive, such as PI1, PI5, PI7, and PI8 (i.e., these measures would generally disallow construction of permanent infrastructure within a protective distance from fisheries resources), the question of specific responses to the stressor was more difficult to address.

For this evaluation, we considered that protective measures PI1, PI5, PI7, and PI8 would limit the construction of permanent infrastructure that could potentially degrade unique fisheries resources. However, the effectiveness of these protective zones has not been demonstrated. Although infrastructure would be set-back from named streams and some lakes, the small connector drainages between protected streams and fish-bearing lakes would not necessarily be included in the protection. The radius of influence of infrastructure on aquatic habitats has not been sufficiently defined within the NPR-A to determine the effectiveness of these protective set-backs, PI1, PI5, PI7, and PI8; and in some instances, these protections may be violated as there may be no practicable alternative.

PI6 also identifies and prevents the degradation of unique fisheries resources, although it would not prevent the construction of transportation corridors across fish-bearing streams. Measures PI3 and PI6 address stream crossings by permanent infrastructure, which was considered to produce specific and potentially significant responses to fisheries resources as illustrated in the process model for permanent infrastructure (Figure 3).

In the evaluation of fisheries responses to oil and gas temporary infrastructure stressors, consideration was given to the type of stressor related to each mitigation measure and whether specific physical, hydrologic, chemical, or biotic responses have been documented as a result of the stressor. None of the temporary infrastructure measures, TI3, TI4, or TI5, prohibit stream crossings. For example, TI3 specifies that stream banks be protected, and TI4 specifies the crossing structures be removed, breached or slotted prior to spring breakup. Ice crossings may still change breakup flows and cause stream bed scour, such that even with protective conditions habitat damage and blockage of fish movements may still occur (Figure 3). TI5 specifies that there would be no additional impacts to overwintering fish or invertebrates, indicating that before a crossing could be approved the applicant must sufficiently demonstrate that the proposed crossing location is unlikely to support overwintering fish. In practice, however, neither BLM nor ADF&G require that overwintering habitat for fish and invertebrates be identified and avoided. TI5, therefore, is not considered to be protective of fisheries resources and habitats and fish overwintering habitats would remain vulnerable because these areas remain unidentified (Table 1).

In the evaluation of fisheries responses to water quantity stressors, consideration was given to this stressor and whether specific physical, hydrologic, chemical, or biotic responses have been documented as a result...
of this stressor. Winter water withdrawal from lakes for use in ice road construction has been monitored and effects of permitted water withdrawal have been measured. In general, physical, chemical and biotic responses have been insignificant due primarily to limitations on the volume of water permitted for withdrawal. However, studies have not been completed at lakes across the entire NPR-A, and unique chemical, physical, and recharge characteristics may occur at some of these lakes, which could lead to unanticipated responses. Because no lakes have been excluded from potential use as water sources, unique resources could be affected by water withdrawal.

SF2 concerns the development of a subsistence users consultation and plan to prevent conflicts between subsistence uses and oil and gas related activities. Responses of subsistence users may not be specific to the oil and gas industry stressors. Some specificity in response of subsistence users may be expected if access to fishing areas changes, or if changes in fish populations occur as a result of oil and gas development stressors. Responses to conflicts between subsistence users and oil and gas development may be significant; therefore BLM has created the provision for consultation. This measure specifies development of a subsistence monitoring plan to address the range of potential effects on resources and subsistence activities for any new permanent facilities. This measure would presumably identify and prevent effects to unique subsistence fisheries resources.

Evaluation of social measures indicates that all subsistence fisheries resources have a high value to the local communities; however, the whitefish resources within the NPR-A are remote, not easily accessible to the public, and are therefore not considered highly valued by the general public. The rivers and lakes supporting the subsistence fish populations, however, are generally highly valued by the general public, especially given the pristine qualities associated with water resources within the NPR-A. Therefore, measures which could potentially change these values for rivers and lakes, PI3, PI6, PI7, PI8, TI3, TI4, and WW2, were identified with a “Yes” for high value to the public. Streams and rivers containing anadromous and/or resident fishes are protected by state statues; therefore any measure involving an activity requiring a fish habitat permit, PI3, PI6, TI3, TI4, TI5, and WW2, has special status. Note that if gravel mining is allowed within a floodplain and the mine would be connected to the stream or river under PI5, a fish habitat permit would be required.

For each measure we considered the certainty in detection of human-caused changes to fisheries resources as a result of oil and gas development activities. Based on the previous evaluations, the process-based models, available literature, and professional judgment; we characterized the certainty of detecting oil and gas development-caused changes to the fisheries resources in the NPR-A (Table 1). Natural variability and changing climate conditions are confounding factors in associating causal relationships between changes in fisheries resources and oil and gas development activities. While we have focused on the process-based models, some uncertainty exists in the causal relationships illustrated in these models. Adequate sampling, use of unaltered reference areas, and long-term monitoring of weather patterns will all be necessary in order to accurately attribute changes that occur as a result of oil and gas development from natural processes or climate induced changes.

We considered that PI3-Bridges and Culverts, PI6-River Setbacks, TI3-Summer Crossings, TI4-Snow and Ice Crossings, WW2-Water Withdrawal, and SF2-Fisheries would all result in certain measurable changes to fisheries and subsistence use of fisheries in the NPR-A. PI1-Permanent Infrastructure 500 feet or more away from fish-bearing waters would result in uncertain changes to fisheries resources in the NPR-A as would PI7 and PI8-Permanent Infrastructure 0.25 mile away from deep lakes. PI5-Gravel Mines would produce certain changes in fisheries resources if mines are allowed to be constructed within stream or river floodplains; however, because this would generally not be allowed, this measure is considered uncertain. Because TI5 stipulates that winter crossings be demonstrated not to affect potential fish overwintering habitats, but in practice does not require that fish overwintering habitat be shown not to exist within or near crossing locations, the certainty of protection of fisheries resources for this measure is also considered uncertain.

The result of this evaluation indicates that monitoring is appropriate for measures or policies PI1, PI3, PI5, PI6, PI7, PI8, TI3, TI4, TI5, WW2, and SF2.
INSTITUTIONAL ASSETS AND CONSTRAINTS

A key element of the success of this monitoring program will be the allocation of available resources to collect representative data that enables the BLM to understand which mitigation measures and management policies provide the greatest ecological benefit (effectiveness).

The selection of monitoring protocols may be dependent on institutional assets, including personnel, equipment, budget and transportation. Consequently, a certain amount of iteration may be expected as protocols are proposed and selected and efforts are made to optimize the types of data as well as the number of samples and replicates acquired during the field effort. In general, measurements with the highest relevance to ecological function may also have the highest costs to acquire sufficient data.

In the discussion that follows on monitoring recommendations, data collection methods are cited along with data recommendations. Some of these methods were developed outside of the Arctic and sometimes outside of Alaska and may require substantial modification in order to be appropriately applied to the unique ecological setting of the Arctic environment. As the next step in the process of BLM’s monitoring implementation plan a standard procedures manual should be developed and maintained. This manual should including periodic updates as monitoring protocols are implemented, tested and refined for Arctic conditions.

The evaluation of monitoring protocols considered assets available to BLM through coordination and cooperation with state and federal management agencies. In particular, much of the information and monitoring for state fish habitat permits and federal NPDES permits are applicable for inclusion in the NPR-A Fisheries Monitoring Plan.

A constraint for any freshwater fisheries monitoring program within the NPR-A is transportation and logistics. Because there are no road systems into or within the NPR-A, summer travel to and from monitoring locations necessitates the use of aircraft, primarily helicopters. This cost constraint may be offset or reduced by sharing aircraft among various projects. Once a monitoring site has been established, repeated sampling over an extended period of time may require use of remote camps. Conditions are harsh on the North Slope during winter. Winter monitoring programs require measures to protect personnel from extreme low temperatures.

The applicability of data characterizing lower trophic level biological communities has been demonstrated in many aquatic monitoring programs. While these data can be essential to identifying subtle shifts in ecological processes, potential limitations include the cost of sample processing by specialized laboratories and the turnaround time for results.

BLM stipulated that a resource and subsistence monitoring plan be developed for each new permanent facility constructed within the NPR-A in support of oil and gas development. The purpose for the development of an overarching monitoring plan is to specify the type of monitoring and data that are key to development-specific plans. This program also guides the BLM in reviewing development specific plans, to ensure that appropriate protocols and data are used and collected. Development-specific monitoring plans are the responsibility of the developer to design and implement with oversight by the BLM and the Subsistence Advisory Panel.
REVIEW OF STRESSORS WITH MONITORING RECOMMENDATIONS

Monitoring Responsibilities

The responsibility for monitoring falls on various entities. There is a need for broad systems-level information covering the area of potential use. Baseline information on fish resources for this region should be the responsibility of the land manager and/or the agency responsible for managing fish resources, or their associated aquatic habitats. The federal land manager for NPR-A is BLM; they have responsibility for coordinating federal agencies for resource monitoring within the study area boundaries. At the state level, resource agencies responsible for specific fish population, harvest or habitat resources include ADF&G and ADNR. The North Slope Borough has permitting jurisdiction within its boundaries, and is especially concerned with activities that may interact with subsistence species and their harvest.

Maintaining compliance with all rules and regulations that are intended to limit potential impacts due to construction and operation of oil and gas industry activities is the responsibility of the project applicant. The applicant must ensure that all contractors operating under their project permit are aware of and follow all required operating procedures and guidelines. Monitoring to document compliance or non-compliance with rules and regulations is the responsibility of the agency which sets those guidelines. Similarly, those agencies are also responsible for ecological monitoring that examines the effectiveness of rules and regulations.

Ecosystems exist in a state of dynamic equilibrium. Indicators selected to characterize ecosystem level responses to oil and gas development stressors should:

- Distinguish natural or climate induced change from human disturbance, and
- Have certain statistical properties that enable detection of when and where conditions are above or below threshold values.

The NPR-A Research and Monitoring Team identified 8 indicators related to fish populations or fish habitats to be evaluated for appropriateness for monitoring (Figure 1):

- Barriers,
- Water Quantity,
- Hydro-Geomorphic Changes,
- Water Quality,
- Fish Harvest Levels and Locations,
- Harvest Area Use,
- Fish Movements, and
- Weather Patterns.

This section reviews these indicators and describes monitoring that may be appropriate for identifying impacts to fisheries resources within the NPR-A.

Barriers

Barriers posed by both permanent and temporary stream crossings were identified by the NPR-A Research and Monitoring Team as one of the most important indicators for monitoring. A conceptual model for impacts associated with permanent structures is illustrated in Figure 3, while Figure 4 provides conceptual impacts for temporary barriers.

Monitoring of barriers across North Slope floodplains has identified numerous habitat changes associated with such structures, including changes to stream hydraulics, water quality, sediment transport, thermokarst, and snow distribution. These changes in turn affect the quality and stability of a variety of habitat features, including flow depth and velocity, bank profile and stability, streambed configuration, thermal regime and sediment composition.

Inspection and monitoring of permanent stream crossings are ongoing functions within the ADF&G, Habitat Division. A recent report by Morris and Winters (2008) summarizes the state of permanent stream crossings within existing North Slope oilfields and recommends improvements where deemed necessary. The report provides information on the type and condition of each crossing, species potentially affected, and any apparent habitat modifications or passage problems resulting from the crossing. The report also recommends improvements to crossings, if needed. This level of attention is needed to ensure that fish habitat and conditions suitable for passage are maintained.
Monitoring Needs

Permanent Crossings (roads, pipelines)
Compliance monitoring of the effect of barriers to fish habitat and movements does not have to be a time-consuming and expensive set of engineering and biological studies. As demonstrated by Morris and Winters (2008), a carefully designed, structured examination of stream crossings can identify changes to fish habitat and passage efficiency and can lead to recommendations for remedial actions. Potential stream crossing problems can normally be identified during initial project review based on experience from existing infrastructure. Locations where problems may be expected are usually readily apparent based on initial crossing designs. Locating and designing cross-pad drainage structures are important steps in pre-project engineering to ensure physical integrity of the structure. During project review, adjustments to the engineering design can be recommended to accommodate fish habitat and passage needs. An important component to effective monitoring is to obtain a photographic record of each crossing location prior to and immediately after construction of the stream crossing.

Temporary Crossings (summer channel crossings)
Crossing streams or rivers may be necessary for cross-country equipment moves, gravel extraction, or access for other reasons. The physical act of driving within the stream channel can potentially affect sensitive life stages of fish. A permit from ADF&G Habitat Division is needed for any activity within an active stream channel, including stream crossings during summer.

Temporary Crossings (ice/snow road channel crossings)
Because the precise locations and extent of fish and invertebrate overwintering habitats within the NPR-A are unknown, pre-project data on potential wintering habitats should be evaluated using Synthetic Aperture Radar (SAR) images taken at the end of several winters to construct a spatial layer of potential overwintering habitats (Hirose et al. 2008; Jones et al. 2008; White et al. 2008). This would be an invaluable management tool to evaluate/adjust proposed routes and also to identify areas along the actual route that would require monitoring. For example, BLM might be able to determine that some areas of a route are of no concern regarding overwintering habitat and could then focus efforts elsewhere. This also has relevance to seismic routes/activities in that it can be used to identify overwintering areas to avoid or take precautions (Morris and Winters 2005).

Monitoring Data

Permanent Crossings (roads, pipelines)
Pre-Construction Monitoring: The Northeast NPR-A Supplemental Record of Decision specifies that operators will ensure that crossings provide for fish passage by adherence to the best management practices outlined in Stream Crossing Design Procedure for Fish Streams on the North Slope Coastal Plain (G.N. McDonald and Associates 1994), Fundamentals of Culvert Design for Passage of Weak-Swimming Fish (Behlke et al. 1991), and other generally accepted best management procedures prescribed by the Authorized Officer (BLM 2008). This ROD further specifies that “at least three years of hydrologic and fish data shall be collected by the lessee for any proposed crossing of a stream whose structure is designed to occur, wholly or partially, below the stream’s ordinary high water mark. These data shall include, but are not limited to, the range of water levels (highest and lowest) at the location of the planned crossing, and the seasonal distribution and composition of fish populations using the stream (BLM 2008).” Important information to include in this baseline evaluation is detailed mapping of streams and connected lakes upstream of the road crossing, as per Moulton et al. (2007), in order to accurately assess fish habitat upstream from the crossing. Pre-construction conditions should be documented with detailed photographs (Morris and Winters 2008). Information to allow an assessment of potential impacts to wintering areas should also be included. This information could include:

- Submission of planned routes in electronic form, and
- Geo-referenced synthetic aperture radar (SAR) imagery from late winter to identify unfrozen water beneath ice cover.

The operator would need to follow permit requirements from various agencies (Corps of Engineers, ADNR, ADF&G Habitat, and BLM). Compliance with these should provide adequate protection to fish. Site visits to document compliance are recommended.
Post Construction Monitoring: Photos, observations, measurements as per Morris and Winters (2008) will allow BLM to identify and prioritize any problems.

Important information to collect at each crossing includes:

- Location and type of crossing structure, including number and size of culverts if included in the crossing structure,
- Photographs of the stream upstream and downstream of the crossing,
- Photographs that demonstrate the condition of the inlets and outlets of the crossing,
- Photographs of bridge abutments and piers,
- Condition of any armor protection at the site,
- Physical damage to the inlets, outlets or barrels of culverts,
- Condition of the stream, including observable scour, instream gravel deposition, stream bank erosion, road prism erosion, and any condition that may restrict prevent fish from moving past the structure; and
- At locations where conditions for fish passage are questionable, quantitative investigations (e.g., water velocities, elevation of pipes at various flows, fish sampling above and below crossing) should be required by the responsible company to determine the extent of the problem.

Post-construction evaluations should include an assessment of potential effects to nearby wintering areas. The operator should provide an as-built route in electronic form, which can then be compared to appropriate SAR imagery to evaluate proximity to potential wintering areas.

Monitoring addresses measures PI1 and PI3.

Temporary Crossings (summer channel crossings)

Post Construction Monitoring: The ADF&G fish habitat permit application for stream crossings requires a detailed description of the project prior to any stream crossing. This information should also be transmitted to BLM. For post-activity determination of any impacts, the operator should report: information on the exact crossing site, how many times the channel was crossed, what types of vehicles were used, dates of crossing, and photographs showing channel conditions at the time of, and following, the crossing activity.

Temporary Crossings (ice/snow road channel crossings)

Pre-Construction Monitoring: During the permitting process, data is needed to evaluate if the crossing is near potential wintering habitat. Companies should submit a thalweg profile taken at low flow to identify water that is deeper than 7 feet. The length of the profile would vary depending on the size of the streams; for small streams (less than 20 feet across from bank to bank along a straight reach), the thalweg profile should be 200 yards both upstream and downstream from the crossing. For larger streams (more than 20 feet across from bank to bank along a straight reach), the thalweg profile should be 400 yards both upstream and downstream from the crossing. If water deeper than 7 feet is encountered, 5 cross sections should be obtained: a cross section should be taken at the deepest point, and one each near the upstream and downstream ends where the 7 feet depth is first, and last, encountered, and one half-way between the deep point and each of the end points. These measurements will provide an estimate of the volume of potential wintering habitat. Photographs of the crossings should also be supplied to BLM.

Post Construction Monitoring: Photos, locations, and observations will allow BLM to identify and prioritize crossings.

- The operator should supply BLM with an as-built route based on GPS measurements taken at the road centerline after the road or crossing has been constructed. Having in-season data will expedite the ability to identify areas potentially sensitive for fish that may need to be closely monitored.
- The operator should work with the BLM compliance program to document breaching/slotting of channel crossings at end of winter. Photographs of the ice road channel breaching/slotting should be supplied to BLM.
- Photograph should be taken of crossings during breakup to qualitatively evaluate if the breaching/slotting is effective.
Monitoring addresses measures TI3, TI4, and TI5.

**FISH DISTRIBUTION AND MOVEMENTS**

Fish species most important to subsistence users are highly migratory and use a broad range of habitats over a large area. Recent reports documenting such wide use of the region include Morris (2003), Morris et al. (2006), and Moulton et al. (2007). Broad whitefish from the Colville/Sagavanirktok region are especially mobile, moving freely from upper reaches of Judy and Fish creeks, eastward into the Sagavanirktok River and southward in the main Colville River. Another population of broad whitefish associated with Teshekpuk Lake ranges south to the upper Ikpikpuk River and west to the Chipp, Topagoruk and Meade rivers. Arctic grayling and burbot in the Fish Creek drainage also show wide-ranging movements, but not to the same extent as broad whitefish. These movements are the result of widely separated feeding, spawning and wintering areas.

**Monitoring Needs**

**NPR-A Wide**

BLM should compile all historical fish data from the NPR-A into a geodatabase and update it annually with new information. This will be necessary in order to accurately and effectively evaluate management decisions for oil and gas activities. The compilation should occur in the near future or it will become increasingly difficult to “catch up” as activities continue in the NPR-A. The historical data should include mapping of streams and connected lakes based on geo-referenced, high resolution aerial photography to identify potentially important fish habitat prior to development. These mapped drainages and connected lakes can be ground-truthed when a specific development project is identified or proposed. The spatial database should use unprojected geographic data based on either the North American Datum 1983 or the World Geodetic System Datum 1984 (these datums are compatible), such that geographic coordinates in latitude and longitude are directly related to coordinates used in Global Positioning System receivers making projection and datum conversions unnecessary.

**Proposed and Active Development Areas**

Documenting fish movements and distribution throughout a potential development area is best accomplished as part of the pre-development baseline work, normally performed by the applicant. Once a basic field design has been established, potential problem areas can be identified for focused baseline studies. Recent studies have used fyke nets, which trap and accumulate fish alive over a period of time. Fish can then be processed and released relatively unharmed. Radio-tagging of large individuals can provide detailed information on movements of individual fish, while tag and release studies can provide information on movements, harvest in area fisheries, and, potentially, abundance estimates. Baseline studies aid in final design of project facilities, such as stream crossings, and lead to monitoring as described above under Barriers. Post-development monitoring would be required by BLM to ensure that the health of regional and locally important fish stocks is maintained (BLM 2008).

**Monitoring Data**

Appropriate monitoring would include:

- Surveys to characterize community compositions (Morris 2003, Morris et al. 2006, Moulton et al. 2007),
- Radio-tagging to identify areas of use during each season,
- Mark-recapture studies to identify movement patterns, and
- Abundance estimates.

Monitoring would address measures PI1, PI3, PI5, PI6, PI7, PI8, TI3, TI4, TI5, WW2, and SF2.

**WATER QUANTITY**

Changes in water quantity caused by withdrawals during exploration are typically from lakes during winter, while water withdrawals during operations and for domestic uses would also occur during the open-water season. Winter withdrawals have the potential for damage to overwintering fish in lakes that support fish populations. Figure 5 reviews how processes associated with water withdrawal can influence fish and fish habitat. In late winter, ice thickness on the Arctic Coastal Plain can approach 7 feet, depending on the severity of the winter and snow cover. Lakes on the Coastal Plain are typically shallow, thus water volume is greatly reduced by March and April. As the ice forms, ionic concentration increases and dissolved oxygen decreases. Fish present in these conditions are stressed, and further reductions in available water could increase...
mortalities. However, ADF&G and ADNR have developed guidelines for winter water withdrawal that reduce the potential for significant impacts to fish. In lakes where fish are, or are assumed to be present, the current guideline is to allow withdrawal of up to 15 percent of the water estimated to be present under a 7 foot ice cover. If species more tolerant of low dissolved oxygen and high specific conductance, such as ninespine stickleback and Alaska blackfish, are the only fish present then withdrawal of up to 30 percent of the water under 5 feet of ice is permitted. For lakes devoid of fish, the current guideline is to allow withdrawal of up to 20 percent of the entire lake volume.

Fish can also be affected during water withdrawal by entrainment into the pump and hose or impingement on the screened intake hose. A screen with ¼-inch openings is currently required on hoses used during water withdrawal. The screen will prevent most fish from entering the intake, however, small fishes, such as young-of-the-year ninespine stickleback, are small enough to pass through the screen.

**Monitoring Needs**

Compliance monitoring of water withdrawals is a requirement of permits issued by ADF&G and ADNR. Critical monitoring needs for compliance with permitted water withdrawal include ensuring that:

1. Water is being removed from the permitted lake, and
2. Allowed volumes are not exceeded.

Identifying the permitted lake is not a simple matter because a majority of withdrawals typically occur during January through March when light levels are low and the terrain is essentially featureless snow-covered tundra.

**Monitoring Data**

**Pre-Construction Monitoring:** Appropriate baseline data are needed to ensure that the water volume removed will not unduly stress fish present in the lake. The primary data needs are:

1. An estimate of water available for removal, obtained through a bathymetric survey of the lake, and
2. Fish presence or absence (fish size, i.e., fork length).

When water from the lakes is to be used in the winter following a survey, the survey data are needed by October 1 or earlier to begin applying for water withdrawal permits; permits must be in hand for the opening of ice road construction season. A final report should be submitted to BLM by early to mid-November, when agencies are reviewing the permit applications. This report should include bathymetry data collected to calculate lake volumes, and fish sampling data (which must include sampling gear, sampling effort, number, size, and type of each fish species captured). If the lake is to be used for long-term water withdrawal that may raise concerns about lakerecharge, then it is useful to measure water surface elevation, preferably at the time of the volumetric estimate and in the fall prior to freeze-up. BLM may require development of a monitoring program including more extensive data collection and reporting on water levels and water quality for lakes of special concern. This monitoring program could include:

- Dissolved oxygen,
- Turbidity,
- Ion concentration (Ca, Mg, Na, Cl),
- Water Surface elevation, and
- Other parameters relevant to identifying changes related to water withdrawal.

**Compliance Monitoring:** Elements of a successful compliance program by an operator would include:

- Constructing an access road to the correct lake, installing an identifying sign, and then equipping the vehicle driver with a GPS to verify position,
- Documenting the location and amount of water withdrawn on a daily basis, reporting these to the operator’s compliance officer, who reports these at least weekly to BLM;
- Developing a data tracking system to ensure that withdrawals cease when the permitted limit is approached, notify BLM when a lake is no longer being used as a water source;
- Facilitate documented compliance checks by BLM personnel during winter to determine the use of appropriate screens (documentation should include lake location, date, time, observer, and
photo-documentation of screen condition; and

- Observing and documenting the effectiveness of screens attached to prevent fish from being sucked up during pumping and reporting any observations of dead fish (on screens or near the uptake hole used for pumping) within 24 hours to BLM.

If the permitted volume is exceeded, the operator needs to notify BLM within 24 hours so there can be a timely assessment of potential damage and management response.

Monitoring addresses measure WW2.

HYDRO-GEOMORPHIC CHANGES

Hydro-geomorphic changes are a sub-set of changes to stream channel hydraulics noted above under the discussion of Barriers.

WATER QUALITY

Changes in water quality can be caused by a number of factors, including construction of stream crossings, winter water withdrawals and release of contaminants (Figure 6). Habitat alterations to stream flow or changes to underlying sediments caused by stream crossings can lead to changes in water temperature, turbidity, and dissolved ion concentrations. Vehicular activity on roads can introduce contaminants from minor mechanical leaks or spills near stream crossings or while crossing lakes and wetlands during winter. Winter water withdrawal has the potential to alter dissolved ion concentrations and dissolved oxygen levels.

Monitoring Needs

Water quality monitoring depends on the type of change or contamination expected. The most likely contamination is increased turbidity and sediment load downstream from stream crossings as flowing water removes material from the gravel approaches and re-distributes it downstream from the crossing. These changes can be monitored effectively through comparisons of pre- and post-construction conditions at the site, and by upstream versus downstream comparisons of post-construction conditions. The most likely spill contaminants are petroleum products spilled as a result of vehicle accidents or minor mechanical leaks in the vicinity of a stream crossing or along an ice road during winter. The conceptual model for water discharge and spills is illustrated in Figure 6. Response organizations are in place to handle spills and their consequences.

Monitoring Data

Active Exploration Areas

Water Quality: The operator should collect baseline/single point measurements when doing fish/bathymetry work in exploration water-source lakes. Parameters measured should include: water temperature, dissolved oxygen, specific conductance, pH, and turbidity (Arar and Collins 1997; Moulton et al. 2002; Gibs et al. 2007). These parameters are useful in evaluating habitat quality and potentially identifying changes.

Water Chemistry: Additional water chemistry parameters to collect when doing fish/bathymetry work in exploration water-source lakes include: cations/anions, select metals, TDS, TSS, and nutrients (Shelton 1994; Mueller et al. 1997; USGS 2006). Baseline data can be determined using a surface grab sample since most lakes would be thoroughly mixed by wind during summer.

Development Areas

Data collection at proposed and active oil field development areas should be based on a stream ecosystem approach, which would require the highest level of monitoring intensity.

Instrumentation for continuous water quality and quantity monitoring should be deployed during breakup and continue monitoring through the open-water season (e.g. YSI 6600s, stage recorders). Appropriate parameters for continuous measurement include: water temperature, dissolved oxygen, specific conductance, pH, turbidity, and chlorophyll a (Wagner et al. 2006). Recently calibrated instruments should be used during routine monitoring site visits once the recorders are deployed to complete Quality Assurance/Quality Control (QA/QC) monitoring (Gibs et al. 2007).

Water samples should be taken at depths throughout the water column in proposed and active development areas. This protocol would be more appropriate and scientifically/legally defensible than the surface grab samples recommended for exploration area monitoring. Data to be collected should include:

- Water chemistry sampling: cations/anions, select metals, TDS, TSS,
nutrients (Shelton 1994; Mueller et al. 1997; USGS 2006),
• Lower trophic communities,
• Chlorophyll a (Arar and Collins 1997; Moulton et al. 2002),
• Depositional-area algae (fine-grained substrate) - biovolume and community structure (Barbour et al. 1999; Moulton et al. 2002; Brabets and Whitman 2002, 2004),
• Macroinvertebrates - density and community structure (Barbour et al. 1999; Moulton et al. 2002; Brabets and Whitman 2002, 2004), and
• Contaminants.

Contaminants may be sampled from the water column using semi-permeable membrane devices (SPMDs), from sediments or from fish tissue.
• Water (USGS 2006, BLM 2006b),
• Sediments (Shelton and Capel 1994; Kennedy et al. 2004), and
• Fish tissue (Crawford and Luoma 1993; Schmitt et al. 1999; Schmitt and Dethloff 2000).

SPMDs collect or accumulate petroleum contaminants that dissolve in oil, concentrating contaminants similar to aquatic organisms (USGS 2006). A pilot study for deployment of SPMDs in the Arctic was recently completed and includes recommendations on deployment, handling, and sample storage constraints (BLM 2006b).

Measures addressed include: PI1, PI3, PI6, PI7, PI8, WW2, and SF2.

FISH HARVEST LEVELS AND LOCATIONS

Both harvest levels and locations can change as a result of changes to fish populations brought on by development activities. An issue that often arises from resource users is that the fish are not as healthy as prior to the development. Changes in harvest levels can be difficult to attribute to any one factor and often require a complex set of baseline information to identify changes caused by habitat alteration. Effects to harvest levels from spilled contaminants can be easy to identify if fishing activity is disrupted or fish are killed or diverted from the harvest area. Changes to harvest location can occur if fish populations change distribution or are prevented from reaching traditional harvest areas. Alterations to harvest location are relatively easy to measure, as local knowledge of previous conditions is often available. Baseline data of existing harvest areas facilitates evaluation of temporal patterns in harvest activity (Figure 7). Changes in fish condition can be addressed if there is a sufficient baseline of length-weight information.

Monitoring Needs

Monitoring begins with an appropriate level of baseline data on pre-project harvest rates, fish population structure, and harvest locations. Some information exists for these parameters (Brower and Opie 1996, 1998; Brower et al. 2000, 2007) but additional directed data gathering is needed within the region. Fishery catch rates typically show high variability, thus extensive time-series data are desirable when attempting to separate development effects from natural variation. Harvest locations tend to be relatively stable based on historical fishing success and tradition.

Fishery issues associated with oilfield development in or near subsistence fishing areas generally fall into three issues categories:

1. Changes in abundance
There are not as many fish as there used to be (this is addressed through measures of catch rate, stratified by mesh size and in narrowly-defined fishery units, i.e. Middle Chipp, Upper Chipp, etc).

2. Changes in fish quality
The fish are thinner, not as healthy, or taste unusual. Changes in taste are difficult to address. Changes in fish length, weight and condition can be measured through analysis of length and weight of harvested fish. Otolith-based age structure of the catch is important for analyzing population status and trends.

3. Potential for contamination
Are the fish safe to eat; are they contaminated? Contamination may be addressed through pre- and post-development measures of potential contaminants in fish tissues.

Approach to Assessing a Fishery

Fishery monitoring should, at a minimum, include measurements and documentation of:
• Locations and timing of harvest,
• Type of gear used (nets, hook and line, traps, etc.),
• Sizes of nets used, including length and mesh size (gill net meshes are very selective – it is not possible to compare catch rates in the absence of mesh size information),
• Species caught, separated by gear type and mesh size,
• Length and weight information on harvested species, and
• Age structure of the harvested population.

Fishing locations are not uniformly or randomly distributed within a river system. Harvest sites are usually clumped based on known fish movement patterns or locations near traditional camps. Areas that provided decent catches in the past are often re-occupied. The area of interest should be stratified into sub-areas of identified use, and then measures of effort and catch rate should be obtained within these sub-areas.

Much of the information on fishing locations and timing can be obtained through interviews with users in the area of interest. Baseline data on harvest rates should be generated through field-based surveys in the fishing areas during the harvest season.

A fishery assessment should include the following elements:

1. Stratify the fishing area into discrete sub-areas to allow catch and population analysis at a local level.
2. Identify the timing of harvest activity within each sub-area.
3. Obtain measures of catch rate within each sub-area, the catch rate data should be identified to the lowest level of effort possible.

Since most fishing in this region is by gillnet, the catch should ideally be identified to each net if possible. At a minimum, catches should be separated by mesh size, with an estimate made of how much netting (in linear feet) was used. The parameter being measured is fish per net-day, standardized to net length and stratified by mesh size.

If hook and line, or jigging, is used, obtain information on the number of people involved in fishing and the length of time spent – the desired parameter is fish per angler-hour or angler-day.

4. Obtain length and weight data associated with the harvest.
5. Obtain otolith-based age data from the harvest.

There are currently five areas of known fishing activity for which harvest data should be obtained, ranked in order of critical data need at this time:

• Fish Creek - Ublutooch River,
• Ikpikpuk River/Teshekpuk Lake,
• Chipp River,
• Topagoruk River, and
• Meade River.

Monitoring would address measure SF2 and SF7.

**Harvest Area Use**

Changes in areas used to harvest fisheries resources can occur as a direct result of increased access created by the construction of new roads and pads. As roads are constructed into previously road less areas, access to fishing areas improves and effort is likely to increase. Conversely, development in a historically-used fishing area may cause users to shift harvest activities elsewhere. The potential for this type of impact should be easy to identify during initial project review. Major fish bearing waters within the region are known and a substantial body of information exists on current fishing areas. Consultation with subsistence users is part of the project review process and any currently unknown fishing activity near a proposed project is likely to be identified at that point.

**Monitoring Needs**

Monitoring described for evaluating fish harvest levels and locations in the previous section would be sufficient to analyze for changes in distribution caused by attraction to new areas because of increased access or avoidance of areas due to industrialization.

Monitoring would address measure SF2 and SF7.

**Weather Patterns**

Weather patterns are a natural variable that affect fish, primarily through temperature and precipitation patterns, but also through wind
strength and direction. Weather data are useful in interpreting patterns of fish growth and movement patterns, but records are often scattered or hard to find. As effects from on-going climate change become more pronounced concurrent with expanding industrial development, weather records are likely to become more important in understanding changes to all biological systems, not just fish.

**Monitoring Needs**

An array of remote automated weather stations spread through the study region could provide useful information for interpreting patterns of fish growth and habitat use, and could help track changes to fish habitat. Appropriate locations for such weather stations need to be determined by personnel associated with the data gathering effort.

**Monitoring Data**

Important weather data to monitor at appropriate scales and locations would include hourly and daily averaged data for:

- Temperature,
- Wind speed,
- Wind direction, and
- Precipitation

**REPORTING AND DATA MANAGEMENT**

Prior to the field season, a detailed procedures manual should be prepared for each project detailing all field methods, including equipment to be used and procedures for installing nets and processing fish. The procedures manual should be issued to each field person and reviewed along with the safety plans.

Reports of compliance monitoring should be submitted at the end of the first calendar quarter following completion of field work. This schedule provides timely reporting of findings and allows analysis and discussion prior to the next field season. Data files generated from the project should be submitted at the same time.
Table 2 – Summary of NPR-A Fisheries Monitoring Recommendations.

<table>
<thead>
<tr>
<th>RMT Indicator</th>
<th>Oil &amp; Gas Stressor</th>
<th>Process Model</th>
<th>Applicable Measures</th>
<th>Monitoring Data or Compliance</th>
<th>Example Protocols</th>
</tr>
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</table>
| Barriers, Hydrogeomorphic Change | Permanent Stream Crossings | Figure 3 | P11, P13 | Pre-Construction: 3 years hydrology and fish data, seasonal distribution and composition of fish populations, mapping of streams and connected lakes, photographs  
| | Temporary Stream Crossings | Figure 4 | T3, T4, T5 | Pre-Construction: Review of planned route & overwintering areas, crossing location, thalweg profiles  
| Fish Distribution & Movements | Permanent Infrastructure | Figure 3 | P11, P13, P15, P16, P17, P18, SF2 | Pre-Construction: Permit application, fish community surveys, movement studies, mark and recapture studies, abundance estimates  
| | Temporary Infrastructure | Figure 4 | T3, T4, T5, WW2 | Pre-Construction: Permit application, thalweg profile  
| Water Quantity | Water Withdrawal | Figure 5 | WW2 | Pre-Construction: Permit application, volumetric survey, fish survey  
Post-Construction: Lake withdrawal GPS location, amount withdrawn by day, tracking system, compliance monitoring, potentially surveyed water elevations | Moulton 2007b, Moulton 2006, MBJ 2007, Moulton 2007c |
| Water Quality | Permanent Infrastructure, Temporary Infrastructure, Water Withdrawal, Water Discharge & Spills | Figure 3, Figure 4, Figure 5, Figure 6 | All | Pre-Construction: Water chemistry, contaminant monitoring – water, biota, fish  
## RMT Indicator

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<tr>
<th>RMT Indicator</th>
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<td>Fish Harvest Levels &amp; Locations/Harvest Area Use</td>
<td>Fish Harvest</td>
<td>Figure 7</td>
<td>SF2, SF7</td>
<td>Pre-Construction: Location, time of harvest, gear used, net length and mesh, species caught, fish length and weight, age structure</td>
<td>Moulton and Pausanna 2007, Moulton and Seavey 2005</td>
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<td>Post-Construction: Location, time of harvest, gear used, net length and mesh, species caught, fish length and weight, age structure</td>
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<tr>
<td>Weather Patterns</td>
<td>Weather Patterns</td>
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<td>Pre-Construction: Hourly, daily average temperature, wind speed, wind direction, precipitation, others</td>
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APPENDIX A. TELECONFERENCE SUMMARY - DECEMBER 20, 2007

PARTICIPANTS
Dave Yokel (BLM)
Matt Whitman (BLM)
Stacie McIntosh (BLM)
Bill Hoffman
Steve Braund (SRBA)
Kevin Gabel (ENTRIX)
Craig George (NSB)
Larry Moulton
Greg Reub (ENTRIX)
Lynn Noel (ENTRIX)
Lynett Bontrager (ENTRIX)

AGENDA
1. Clarification of focus – freshwater systems, nearshore, anadromous species, entire NPR-A? (exclusion of the Colville River?)
2. Stressor and Mechanisms (Model Review)
3. Literature Review – where are the major data gaps, what mechanisms are well understood?
4. Mitigation – what problems are mitigated away – and therefore off the table – what works, what doesn’t, what’s missing?
5. Current Monitoring – who’s doing what, what works, what doesn’t, what’s missing?
6. What should we count or measure and why?

SUMMARY

Agenda Item 1:
Current focus on freshwater bodies and broad whitefish is correct; no change in project scope is needed. Nearshore and anadromous fish are low priority and not within the scope of this contract.

Agenda Item 2 and 3:
“Subsistence Fisheries Harvest” box on RMT Conceptual Model should be striped to show that they are currently being measured but may be inadequate or at inappropriate scale. There is a lot of data but it is scattered with several areas still unknown or the areas are too broad. The information is useful for use in the monitoring plan development.

Figure 3 – Process-based preliminary conceptual model for permanent infrastructure and roadways”-Dave Yokel w/ BLM had a concern about barriers not being explicitly mentioned. However, they are implied by the functional response in a few places.

Figure 6 – Process...for water discharge”-consider renaming stressor from “Water Discharge & Spills” to “Contaminant Spills” if wanting a more comprehensive look at all types of spills (i.e. oil spills, equipment spills, water discharge, etc.). However, categorizing spills is outside the baseline scope; why a more generalized category might be necessary. The final removal of these categories shouldn’t be done until later on in the process.

Agenda Item 4:
Institutional constraints (such as crossing structures, gray water discharge into lakes, accidental spills) shouldn’t be included because models look at stressors and ecological impacts.

There doesn’t seem to be much on human origin stressors (e.g. drums, discarded equipment, abandoned sites, ice roads, debris from airstrips, etc.) that residents of Nuiqsut have expressed previous concerns about.

Should consider including data on the fertilization of slopes to stabilize roads, which affects nearby lakes. There is some literature on the fertilization but the data is limited (only have data on one lake with current work being done on streams near Toolik).

We should also consider the effects from “unintended consequences of good intention”. Such as the fertilization of road banks and pad banks to encourage vegetative support of banks; however, this has resulted in the fertilization of lakes and streams.

Steve Braund expressed concerns related to having "Figure 7 Fish Harvest" modeled by itself and not showing how it affects the bigger picture. However, there seems to be insufficient abundance information available to quantify the order of magnitude and should be considered when monitoring.

Agenda Item 5:
Water withdrawal monitoring conducting by permittees, industry and the University appear to be working. Something that appears to be missing is data on the water level in lakes and when it becomes a problem.

Craig was going to pull together all of the NSBs resources for NPR-A fish. Currently, the NSB
monitors fish movements; lakes (trout and the Teshekpuk area); water quality; relative abundance; some hydrocarbon sediments and fish tissue; subsistence fishery information (catch rates and total harvest). Baseline information appears to be scattered and not down to CPUE level.

We should document connected lakes and identify connections with different systems.

We need more information on the seasonal habitat use of broad whitefish in order to identify habitat types.

Currently, the BLM does not monitor abandoned sites and the contaminants released.

Colville monitoring has been helpful because the area covered was much smaller. Nuiqsut monitoring included gathering a lot of data and is less helpful because it covered such a large area. To drill-down and track catch rates to help in quantifying fish harvest effects, a few locations should be focused upon.

**Agenda Item 6:**
Not covered, tabled for later discussions as work progresses on development of the monitoring plan.

Attach informational materials distributed for meeting.
APPENDIX B. CURRENT NPR-A MITIGATION MEASURES AND OPERATING PROCEDURES RELATED TO FISHERIES RESOURCES

The following listing of Recommended Operating Procedures and Mitigation Measures were compiled from the NE NPR-A Records of Decision (BLM 2006a, 2008) and the NW NPR-A Record of Decision (BLM 2004). This listing includes only those measures or parts of measures that were considered to be protective of fisheries resources. The listing has been organized to support the five processed-based conceptual models presented above (Figures 3 through 7). Specific monitoring requirements are highlighted.

STRESSOR: PERMANENT INFRASTRUCTURE (BRIDGES, CULVERTS, GRAVEL ROADS, PADS, PIPELINES)

PI1 – Pads, Roads & Pipelines
Objective (NE & NW): Protect fish-bearing water bodies, water quality, and aquatic habitats.

Requirement/Standard (NE & NW): The design and location of permanent oil and gas facilities (including roads, airstrips, and pipelines) are prohibited upon or within 500 feet as measured from the ordinary high water mark of fish-bearing waterbodies. Essential pipeline and road crossings will be permitted on a case-by-case basis. Note: Also refer to Area-Specific Lease Stipulations and ROPs for Rivers Area (Lease Stipulation K-1) and Deep Water Lakes (Lease Stipulation K-2).

Construction camps are prohibited on frozen lakes and river ice. Siting of construction camps on river sand and gravel bars is allowed and, where feasible, encourage. Where leveling of trailers or modules is required and the surface has a vegetative mat, leveling shall be accomplished through blocking rather than use of a bulldozer.

PI2 – Roads
Objective (NE & NW): Protect subsistence use and access to traditional subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish and wildlife resources.

Requirement/Standard (NE & NW): All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to traditional subsistence hunting and fishing areas. The AO will consult with appropriate Federal, state, and NSB regulatory and resources agencies prior to approving construction of roads. Subject to approval by the AO, the construction, operation, and maintenance of oil field roads is the responsibility of the lessee unless the construction, operation, and maintenance of roads are assumed by the appropriate governing entity.

PI3 – Bridges & Culverts
Objective (NE & NW): Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage.

Requirement/Standard (NE & NW): Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, maintain natural drainage, and minimize adverse effects to natural stream flow. Note: Bridges, rather than culverts, are the preferred method for crossing rivers. When necessary, culverts can be constructed on smaller streams, if they are large enough to avoid restricting fish passage or adversely affecting natural stream flow.

(NE Specific): To ensure that crossings provide for fish passage, all proposed crossing designs shall adhere to the best management practices (BMPs) outlined in “Stream Crossing Design Procedure for Fish Streams on the North Slope Coastal Plain” by G.N. McDonald and Associates (1994), “Fundamentals of Culvert Design for Passage of Weak-Swimming Fish” by Behlke et al (1991), and other generally accepted best management procedures prescribed by the AO. To adhere to these BMPs, at least three years of hydrologic and fish data shall be collected by the lessee for any proposed crossing of a stream whose structure is designed to occur, wholly or partially, below the stream’s ordinary high water mark. These data shall include, but are not limited to, the range of water levels (highest and lowest) at the location of the planned crossing, and the seasonal distribution and composition of fish populations using the stream.
PI4 – Causeways & Docks

Objective (NE & NW): Maintain free passage of marine and anadromous fish and protect subsistence use and access to traditional subsistence hunting and fishing.

Requirement/Standard (NE & NW): Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas. Causeways, docks, artificial islands, and bottom-founded structures shall be designed to ensure free passage of marine and anadromous fish and to prevent significant changes to nearshore oceanographic circulation patterns and water quality characteristics. A monitoring program, developed in consultation with appropriate federal, state, and North Slope Borough regulatory and resource agencies, may be required to address the objectives of water quality and free passage of fish.

PI5 – Gravel Mines

Objective (NE & NW): Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.

Requirement/Standard (NE & NW): Gravel mine site design and reclamation will be in accordance with a plan approved by the AO. The plan shall be developed in consultation with appropriate Federal, state, and NSB regulatory and resource agencies and consider:

   a. Locations outside the active flood plain.
   b. Design and construction of gravel mine sites within active flood plains to serve as water reservoirs for future use.
   c. Potential use of the site for enhancing fish and wildlife habitat.

PI6 – Infrastructure Setbacks - River

Objective (NE & NW): Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; the loss of spawning, rearing or over-wintering habitat for fish; the loss of cultural and paleontological resources; the loss of raptor habitat; impacts to subsistence cabins and campsites; the disruption of subsistence activities; and impacts to scenic and other resource values.

Requirement/Standard (NE Specific): Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in the streambed and adjacent to the rivers listed below at the distances identified. (Gravel mines may be located within the active flood plain consistent with ROP E-8). With the exception of the Ikpikpuk River, these setbacks are measured from the bank of the river as determined by the hydrology at the time of application. The standard setback is ½ mile from the bank’s highest high water mark and increased to a ¾ mile setback from the bank’s highest water mark where subsistence cabin and campsites are numerous. Along the Colville River and a portion of the Ikpikpuk a 1-mile setback as measured from the bank’s highest high water mark is required to protect important raptor habitat (for locations along rivers where setback distances change). On a case-by-case basis in consultation with Federal, State, and NSB regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility), essential pipeline(s) and road crossings to the main channel will be permitted through the setback areas. The above setbacks may not be practical within river deltas. In these situations, permanent facilities shall be designed to withstand a 200-year flood event.

   a) Colville River: a 1-mile setback from the boundary of NPR-A along the Colville River as determined by cadastral survey to be the highest high watermark on the left (western or northern) bank extending the length of that portion of the river located within the Planning Area. Note: The Planning Area excludes conveyed Native lands along the lower reaches of the Colville River. Development of road crossings intended to support oil and gas activities shall be consolidated with other similar projects and uses to the maximum extent possible. Note: This provision does not apply to intercommunity or other permanent roads constructed with public funds for general transportation purposes. This preserves the opportunity to plan, design, and construct public transportation systems to meet the economic, transportation, and public health and safety needs of the State of Alaska and/or communities within the National Petroleum Reserve – Alaska.
b) Ikpikpuk River: (those portions of the river within the Northeast Planning Area and east of the
river centerline)
   - A ¾-mile setback from each side of the centerline (1 ½ miles total) of the Ikpikpuk River
     extending from the mouth south to Section 19, Township 7 North, Range 11 West, U.M.
     (Umiat Meridian). Note: The setback distances only apply to the east bank where the
     Ikpikpuk River is the planning area boundary. This is to protect numerous subsistence
     cabins and campsites.
   - A 1-mile setback from the centerline is required from Section 19, Township 7 North, Range
     11 West, U.M., extending south to the northern limit of Section 4, Township 3 North,
     Range 12 West, U.M. This setback is for the purposes of protecting raptors.
   - A ½-mile setback from the centerline (1 mile total) will be required to the confluence of
     the Kigalik River and Maybe Creek.

c) Miguakiak River: A ½-mile setback from the bank’s highest high water mark.

d) Kikiakrorak and Kogosukruk Rivers: Note: The following discussion refers only to portions of
   the Kikiakrorak River downstream from Township 2 North, Range 4 West, U.M. and the
   Kogosukruk River (including the four tributaries off the southern bank) downstream from
   Township 2 North, Range 3 West, U.M. No permanent oil and gas surface facilities, except
   essential transportation crossings, will be allowed within 1 mile of the top of the bluff (or bank
   if there is no bluff) on either side of the rivers and several of the Kogosukruk tributaries.

e) Fish Creek: No permanent oil and gas surface facilities, except essential transportation
   crossings, would be allowed within 3 miles (from the bank's highest high watermark) of the
   creek downstream from the eastern edge of Section 31, Township 11 North, Range 1 East,
   U.M. or within ½ mile (from the bank’s highest high water mark) of the creek farther
   upstream. The purpose of this setback is to preclude location of permanent oil and gas surface
   facilities with the exception of essential transportation crossings.

f) Judy Creek (in the Planning Area): A ½-mile setback from the bank’s highest high water mark
   extending from the mouth to the confluence of an unnamed tributary in Section 8, Township 8
   North, Range 2 West, U.M.

g) Tingmiaksiqvik River (identified as the Ublutuoch River on USGS quadrangle maps): No
   permanent oil and gas surface facilities, except essential transportation crossings, would be
   allowed within ½ mile (from the bank’s highest high water mark) of this river from its
   headwaters within Section 13, Township 7 North, Range 1 West, U.M. downstream to its
   confluence with Fish Creek.

Requirement/Standard (NW Specific): Permanent oil and gas facilities, including gravel pads,
roads, airstrips, and pipelines, are prohibited in the stream bed and adjacent to the rivers listed below
at the distances identified. These setbacks are measured from the centerline of the river as
determined by the current hydrology at the time of application. The standard setback is ½ mile and
increased to ¾ mile where subsistence cabins and campsites are numerous. Along the Colville River
and a portion of the Ikpikpuk a 1-mile setback is required to protect important raptor habitat. (For
locations along rivers where setback distances change, see Map 20 in the Final Northwest National
Petroleum Reserve-Alaska Integrated Activity Plan/Environmental Impact Statement). On a case-by-
case basis, and in consultation with Federal, State, and North Slope Borough regulatory and resource
agencies (as appropriate, based on agency legal authority and jurisdictional responsibility), essential
pipeline and road crossings perpendicular to the main channel will be permitted (unless noted
otherwise) through setback areas. The above setbacks may not be practical within river deltas. In
these situations, permanent facilities shall be designed to withstand a 200-year flood event.

a) Colville River: a 1-mile setback from the northern bluff (or bank if there is no bluff) of the
   Colville River extending the length of that portion of the river within the Planning Area. Road
crossings intended to solely support oil and gas activities are prohibited. Note: This provision
does not apply to intercommunity or other permanent roads constructed with public funds for
general transportation purposes. This preserves the opportunity to plan, design, and construct
public transportation systems to meet the economic, transportation, and public health and
safety needs of the State of Alaska and/or communities within NPR-A.
b) Ikpikpuk River: a ¾-mile setback from the centerline of the Ikpikpuk River extending from the mouth south to Sec. 19, T7N, R11W, UM. From Sec. 19, T7N, R11W, UM to Sec. 4 T3N, R12W, UM, a 1-mile setback is required. Beginning at Sec. 4 T3N, R12W, UM, a ½-mile setback will be required to the confluence of the Kigalik River and Maybe Creek.

c) Alaktak River: a ¾-mile setback from the centerline of the Alaktak River extending from the mouth to the Ikpikpuk River.

d) Chipp River: a ¾-mile setback from the centerline of the Chipp River extending from the mouth to the Ikpikpuk River.

e) Oumalik River: a ¾-mile setback from the centerline of the Oumalik River from the mouth upstream to Sec. 5, T8N, R14W, UM, and a ½-mile setback from Sec. 5, T8N, R14W, UM, upstream to Sec. 2, T5N, R15W, UM.

f) Titaluk River: a ½-mile setback from the centerline of the Titaluk River from the confluence with the Ikpikpuk River upstream to Sec. 1, T2N, R22W, UM.

g) Kigalik River: a ½-mile setback from the centerline of the Kigalik River from the confluence with the Ikpikpuk River upstream to the Planning area boundary.

h) Maybe Creek: a ½-mile setback from the centerline of the Maybe Creek from the confluence with the Ikpikpuk River upstream to Sec. 8, T2S R6W, UM.

i) Topagoruk River: a ¾-mile setback from the centerline of the Topagoruk River from the mouth upstream to the confluence with Ishuktak Creek. A ½-mile setback from each bank upstream from the confluence with the Ishuktak to Sec. 3, T7N, R17W, UM.

j) Ishuktak Creek: a ½-mile setback from the centerline of Ishuktak Creek from the confluence with the Topagoruk River to Sec. 24, T8N, R16W, UM.

k) Meade River: a ¾-mile setback from the centerline of the Meade River upstream to Sec. 6, T6N, R21W, UM. A ½-mile setback from each bank upstream from Sec. 6, T6N, R21W, UM to the Planning area boundary.

l) Usuktuk River: a ¾-mile setback from the centerline of the Usuktuk River upstream from the confluence with the Meade River to Sec. 36, T10N, R19W, UM.

m) Pikroka Creek: a ¾-mile setback from the centerline of the Pikroka Creek upstream from the confluence with the Meade River to Sec. 11, T8N, R23W, UM.

n) Nigisakturik River: a ¾-mile setback from the centerline of the Nigisakturik River upstream from the confluence with the Meade River to Sec. 1, T11N, R25W, UM.

o) Inaru River: a ¾-mile setback from the centerline of the Inaru River from the mouth upstream to Sec. 17, T15N, R25W, UM.

p) Kucheak Creek: a ¾-mile setback from the centerline of Kucheak Creek from the confluence with the Inaru River upstream to Sec. 20, T13N, R24W, UM.

q) Avalik River: a ½-mile setback from the centerline of the Avalik River along that portion of the river within the Planning area.

r) Niklavik Creek: a ½-mile setback from the centerline of the Niklavik Creek from the confluence with the Inaru River upstream to Sec. 5, T17N, R21W, UM.

**PI7 – Infrastructure Setbacks - Lakes**

**Objective (NE & NW):** Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deep water lakes; the loss of spawning, rearing or over wintering habitat for fish; the loss of cultural and paleontological resources; impacts to subsistence cabins and campsites; and the disruption of subsistence activities. (Wording slightly different for NE – Teshekpuk Lake specific)

**Requirement/Standard (NE & NW):** Generally, permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited within ¼ mile of the ordinary high water mark of any deep lake as determined to be in lake zone III (i.e., depth greater than 13 feet [4 meters]; Mellor 1985). On a case-by-case basis in consultation with Federal, State and NSB regulatory and resource
agencies (as appropriate based on agency legal authority and jurisdictional responsibility), essential pipeline(s), road crossings, and other permanent facilities may be considered through the permitting process in these areas where the lessee can demonstrate on a site-specific basis that impacts will be minimal and if it is determined that there is no feasible or prudent alternative.

PI8 – Teshekpuk Lake Exclusion and Shoreline Protection
Note: Teshekpuk Lake and islands within the lake (approximately 219,000 acres) will not be available for oil and gas leasing.

Objective (NE Specific): Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of this large and regionally significant deep water lake; the loss of cultural and paleontological resources; impacts to subsistence cabins, campsites and associated activities; and to protect fish and wildlife habitat including important insect relief areas.

Requirement/Standard (NE Specific): Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited within ¼ mile of the ordinary high water mark of Teshekpuk Lake. In addition, no permanent oil and gas facilities, except pipelines, would be allowed in portions of Township 14-15 North, Range 9 West, and Township 15 North, Range 8 West, U.M. greater than ¼ mile of the ordinary high water mark of Teshekpuk Lake. (No alternative procedures will be approved.)

PI9 – Infrastructure Setbacks - Coast

Objective (NE Specific): Minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; to prevent contamination of marine waters; loss of important bird habitat; alteration or disturbance of shoreline marshes; and impacts to subsistence resources activities.

Requirement/Standard (NE Specific): In the Coastal Area, permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines established to support exploration and development activities shall be located at least ¾ mile inland from the coastline to the extent practicable. Where, as a result of technological limitations, economics, logistics, or other factors, a facility must be located within ¼ mile inland of the coastline, the practicality of locating the facility at previously occupied sites such as Camp Lonely, various Husky/USGS drill sites, and Distant Early Warning (DEW)-Line sites, shall be considered. Use of existing sites within ¾ mile of the coastline shall also be acceptable where it is demonstrated that use of such sites will reduce impacts to shorelines or otherwise be environmentally preferable. All lessees/permittees involved in activities in the immediate area must coordinate use of these new or existing sites with all other prospective users. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission, the Nuiqsut Whaling Captains’ Association, and the NSB to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.

STRESSOR: TEMPORARY INFRASTRUCTURE (ICE ROADS, ICE BRIDGES, OFF-ROAD EQUIPMENT USE)

TI1 – Exploration Drilling – Stream & River Prohibition

Objectives (NE & NW): Protect fish-bearing rivers, streams, and lakes from blowouts and minimize alteration of riparian habitat.

Requirement/Standard (NE & NW): Exploratory drilling is prohibited in rivers and streams, as determined by the active floodplain, and fish-bearing lakes, (NW specific) except where the lessee can demonstrate on a site-specific basis that impacts would be minimal or it is determined that there is no feasible or prudent alternative.

TI2 – Winter Tundra Travel

Objective (NE & NW): Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.

Requirement/Standard (NE & NW):

a) Ground operations shall be allowed only when frost and snow cover is at sufficient depths to protect the tundra. Ground operations shall cease when the spring snowmelt begins (approximately May 5 in the foothills area where elevations reach or exceed 500 feet and...
approximately May 15 in the northern coastal areas). The exact dates will be determined by the AO.

b) Only low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. A list of approved vehicles can be obtained from the AO. Limited use of tractors equipped with wide tracks or “shoes” will be allowed to pull trailers, sleighs, or other equipment with approved undercarriage. Note: This provision does not include the use of heavy equipment such as front-end loaders and similar equipment required during ice road construction.

c) Bulldozing of tundra mat and vegetation, trails, or seismic lines is prohibited; however, on existing trails, seismic lines or camps, clearing of drifted snow is allowed to the extent that the tundra mat is not disturbed.

d) To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips unless necessitated by serious safety or superseding environmental concern. This provision does not apply to hardened snow trails for use by low-ground-pressure vehicles such as Rolligons.

e) The location of winter ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation. Offsets may be required to avoid using the same route or track in the subsequent year.

f) (NE specific) Motorized ground-vehicle use within the CRSA associated with overland moves, seismic work, and any similar use of heavy equipment shall be minimized within the Colville Raptor, Passerine, and Moose Area from April 15 through August 5, with the exception that use will be minimized in the vicinity of gyrfalcon nests beginning March 15. Such use will remain ½ mile away from known raptor nesting sites, unless authorized by the AO.

**TI3 – Summer Tundra Travel**

**Objective (NE Specific):** Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the breakage, abrasion, compaction, or displacement of vegetation; protect cultural and paleontological resources; maintain populations of, and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and minimize impacts to subsistence activities.

**Requirement/Standard (NE Specific):** On a case-by-case basis, BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in TI2a. Permission for such use would only be granted after an applicant has:

a) Submitted studies satisfactory to the AO of the impacts on soils and vegetation of the specific low-ground-pressure vehicles to be used. These studies should reflect use of such vehicles under conditions similar to those of the route proposed for use and should demonstrate that the proposed use would have no more than minimal impacts to soils and vegetation.

b) Submitted surveys satisfactory to the AO of subsistence uses of the area as well as of the soils, vegetation, hydrology, wildlife and fish (and their habitats), paleontological and archaeological resources, and other resources as required by the AO.

c) Designed and/or modified the use proposal to minimize impacts to the AO’s satisfaction. Design steps to achieve the objectives and based upon the studies and surveys may include, but not limited to, timing restrictions (generally it is considered inadvisable to conduct tundra travel prior to August 1 to protect ground-nesting birds), shifting of work to winter, rerouting, and not proceeding when certain wildlife are present or subsistence activities are occurring. At the discretion of the AO, the plan for summer tundra vehicle access may be included as part of the spill prevention and response contingency plan required by 40 CFR 112 (Oil Pollution Act) and WD3.

**TI4 – Snow & Ice Bridges**

**Objective (NE & NW):** Maintain natural spring runoff patterns, avoid flooding, prevent streambed sedimentation, protect water quality and protect stream banks.

**Requirement/Standard (NE & NW):** Crossing of waterway courses shall be made using a low-angle approach. Snow and ice bridges shall be removed, breached, or slotted before spring breakup. Ramps
and bridges shall be substantially free of soil and debris. Except at approved crossings, operators are encouraged to travel a minimum of 100 feet from known overwintering fish streams and lakes.

**TI5 – Non-Bridged River & Stream Crossings**

**Objective (NE & NW):** Avoid additional freeze-down of deep-water pools harboring over-wintering fish and invertebrates used by fish.

**Requirement/Standard (NE & NW):** Travel up and down streambeds is prohibited unless it can be demonstrated that there will be no additional impacts from such travel to over-wintering fish or the invertebrates they rely on. Rivers and streams shall be crossed at shallow riffles from point bar to point bar whenever possible.

**STRESSOR: WATER WITHDRAWAL (WINTER CONSTRUCTION AND DOMESTIC USES)**

**WW1 – River & Stream Withdrawal Prohibition**

**Objective (NE & NW):** Maintain populations of, and adequate habitat for, fish and invertebrates.

**Requirement/Standard (NE & NW):** Water withdrawal from rivers and streams during winter is prohibited.

**WW2 – Lake Withdrawals**

**Objective (NE & NW):** Maintain natural hydrologic regimes in soils surrounding lakes and ponds. Maintain populations of, and adequate habitat for, fish and invertebrates, and waterfowl.

**Requirement/Standard (NE & NW):** Water withdrawal from lakes may be authorized on a site-specific basis depending on lake size, water volume, and depth, and fish population and species diversification. Current water withdrawal requirements specify:

a) Lakes that are $\geq 7$ ft with sensitive fish (any fish except ninespine stickleback or Alaska blackfish): water available for withdrawal is limited to 15 percent of calculated volume deeper than 7 ft. Lakes that are between 5 and 7 ft with sensitive fish: water available for withdrawal will be calculated on a case-by-case basis.

b) Lakes that are $\geq 5$ ft with only non-sensitive fish (i.e., ninespine stickleback or Alaska blackfish): water available for withdrawal is limited to 30 percent of calculated volume deeper than 5 ft.

c) Any lake with no fish present, regardless of depth: water available for withdrawal is up to 35 percent as specified within the permit.

d) A water-monitoring plan may be required to assess draw down and water quality changes before, during, and after pumping any fish-bearing lake or lake of special concern.

e) The removal of naturally grounded ice may be authorized from lakes and shallow rivers on a site specific basis depending upon its size, water volume, and depth, and fish population and species diversification.

f) Removed ice aggregate shall be included in the 15 percent or 30 percent withdrawal limits-whichever is the appropriate case-unless otherwise approved.

g) Any water intake structures in fish bearing or non-fish bearing waters shall be designed, operated, and maintained to prevent fish entrapment, entrainment, or injury. Note: All water withdrawal equipment must be equipped and must utilize fish screening devices approved by the Alaska Department of Natural Resources (ADNR).

h) Compaction of snow cover or snow removal from fish-bearing water bodies shall be prohibited except at approved ice road crossings, water pumping stations on lakes, or areas of grounded ice.
STRESSOR: WATER DISCHARGE & SPILLS (PRODUCED WATER, INDUSTRIAL WASTE, AND DOMESTIC USES)

WD1 – Waste Water/Sludge

Objective (NE & NW): Minimize impacts on the environment from non-hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil field workers and the general public. Avoid human-caused changes in predator populations.

Requirement/Standard (NE & NW): Lessees/permittees shall prepare and implement a comprehensive waste management plan for all phases of exploration and development, including seismic activities. The plan shall be submitted to the AO for approval, in consultation with Federal, State, and NSB regulatory and resource agencies, as appropriate (based on agency legal authority and jurisdictional responsibility), as part of a plan of operations or other similar permit application. Management decisions affecting waste generation shall be addressed in the following order of priority:

1. Prevention and reduction,
2. Recycling,
3. Treatment, and
4. Disposal.

The plan shall consider and take into account the following requirements:

a) Disposal of pumpable waste products. Except as specifically provided, the BLM requires that all pumpable solid, liquid, and sludge waste be disposed of by injection in accordance with USEPA, ADEC, and the Alaska Oil and Gas Conservation Commission (AOGCC) regulations and procedures. On-pad temporary mud and cuttings storage, as approved by ADEC, will be allowed as necessary to facilitate annular injection and/or backhaul operations.

b) Disposal of wastewater and domestic wastewater. The BLM prohibits wastewater discharges or disposal of domestic wastewater into bodies of fresh, estuarine, and marine water, including wetlands, unless authorized by the National Pollution Discharge Eliminations System (NPDES) or State permit.

WD2 – Hazardous Materials Plan

Objective (NE & NW): Minimize pollution through effective hazardous-materials contingency planning.

Requirement/Standard (NE & NW): For oil and gas-related activities, a Hazardous Materials Emergency Contingency Plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances. The plan shall include a set of procedures to ensure prompt response, notification, and cleanup in the event of a hazardous substance spill or threat of a release. Procedures applicable to fuel and hazardous substances handling (associated with transportation vehicles) may consist of Best Management Practices if approved by the AO. The plan shall include a list of resources available for response (e.g., heavy-equipment operators, spill-cleanup materials or companies), and names and phone numbers of Federal, State, and NSB contacts. Other Federal and State regulations may apply and require additional planning requirements. All staff shall be instructed regarding these procedures.

In addition, contingency plans related to facilities developed for oil production shall include requirements to:

a) Provide refresher spill-response training to NSB and local community spill-response teams on a yearly basis.

b) Plan and conduct a major spill-response field deployment drill annually.

c) Prior to production and as required by law, develop spill prevention and response contingency plans and participate in development and maintenance of the North Slope Subarea Contingency Plan for Oil and Hazardous Substances Discharges/Releases for the National Petroleum Reserve-Alaska operating area. Planning shall include development and funding of detailed (e.g., 1:26,000 scale) environmentally sensitivity index maps for the lessee’s operating area and areas outside the lessee’s operating area that could be affected by their activities. (The specific area to be mapped shall be defined in the lease agreement and
approved by the AO in consultation with appropriate resource agencies). Maps shall be completed in paper copy and geographic information system format in conformance with the latest version of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration’s Environmental Sensitivity Index Guidelines. Draft and final products shall be peer reviewed and approved by the AO in consultation with appropriate Federal, state, and NSB resource and regulatory agencies.

**WD3 – Spill Prevention & Response Plan**

**Objective (NE & NW):** Minimize the impact of contaminants on fish, wildlife and the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.

**Requirement/Standard (NE & NW):** Before initiating any oil and gas or related activity or operation, including field research/surveys and/or seismic operations, lessees/permittees shall develop a comprehensive spill prevention and response contingency plan per 40 CFR § 112 (Oil Pollution Act). The plan shall consider and take into account the following requirements:

a) **On-site Clean-up Materials.** Sufficient oil-spill-cleanup materials (absorbents, containment devices, etc.) shall be stored at all fueling points and vehicle-maintenance areas and shall be carried by field crews on all overland moves, seismic work trains, and similar overland moves by heavy equipment.

b) **Storage Containers.** Fuel and other petroleum products and other liquid chemicals shall be stored in proper containers at approved locations. Except during overland moves and seismic operations, fuel, other petroleum products, and other liquid chemicals designated by the AO in excess of 1,320 gallons in storage capacity shall be stored within an impermeable lined and diked area or within approved alternate storage containers such as over packs, capable of containing 110 percent of the stored volume. In areas within 500 feet of water bodies, fuel containers are to be stored within appropriate containment.

c) **Liner Materials.** Liner material shall be compatible with the stored product and capable of remaining impermeable during typical weather extremes expected throughout the storage period.

d) **Permanent Fueling Stations.** Permanent fueling stations shall be lined or have impermeable protection to prevent fuel migration to the environment from overfills and spills.

e) **Proper Identification of Containers.** All fuel containers, including barrels and propane tanks, shall be marked with the responsible party's name, product type, and year filled or purchased.

f) **Notice of Reportable Spills.** Notice of any reportable spill (as required by 40 CFR 300.125 and 18 AAC [Alaska Administrative Code] 75.300) shall be given to the AO as soon as possible, but no later than 24 hours after occurrence.

g) **Identification of Oil Pans ("duck ponds").** All oil pans shall be marked with the responsible party's name.

**WD4 – Fuel Handling**

**Objective (NE & NW):** Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.

**Requirement/Standard (NE & NW):** Refueling of equipment within 500 feet of the active flood plain of any water body is prohibited. Fuel storage stations shall be located at least 500 feet from any water body with the exception of small caches (up to 210 gallons) for motorboats, float planes, ski planes, and small equipment, e.g. portable generators and water pumps, will be permitted. The AO may allow storage and operations at areas closer than the stated distances if properly designed to account for local hydrologic conditions.

**WD5 – Produced Water Disposal**

**Objective (NE & NW):** Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.

**Requirement/Standard (NE Specific):** Discharge of produced water in upland areas and marine waters is prohibited.
Requirement/Standard (NW Specific): Procedures for the disposal of produced fluids shall meet the following requirements:

a) In upland areas, including wetlands, disposal will be by subsurface-disposal techniques. The AO may permit alternate disposal methods if the lessee demonstrates that subsurface disposal is not feasible or prudent and the alternative method will not result in adverse environmental effects.

b) In marine waters, approval of discharges by the AO will be based on a case-by-case review of environmental factors and consistency with the conditions of an NPDES permit. Discharge of produced fluids will be prohibited at locations where currents and water depths, in combination with other conditions, are not adequate to prevent impacts to known biologically sensitive areas. Alternate disposal methods will require an NPDES permit certified by the State.

**WD6 – Reserve Pit Dewatering**

**Objective (NE & NW):** Minimize the impact on fish, wildlife, and the environment from contaminants associated with the exploratory drilling process.

**Requirement/Standard (NE & NW):** Surface discharge of reserve-pit fluids is prohibited.

**WD7 – Pipeline Operation & Maintenance**

**Objective (NW):** Minimize the potential for pipeline leaks, the resulting environmental damage and industrial accidents.

**Requirement/Standard (NW):** All pipelines shall be designed, constructed, and operated under an AO-approved Quality Assurance/Quality Control plan that is specific to the product transported and shall be constructed to accommodate the best available technology for detecting and preventing corrosion or mechanical defects during routine structural integrity inspections.

**STRESSOR: FISH HARVEST (SUBSISTENCE, COMMERCIAL, AND SPORT)**

**SF1 – Surface Disturbance Limitations**

**Objective (NE Specific):** To protect key surface resources and subsistence resources/activities resulting from permanent oil and gas development and associated activities.

**Requirement/Standard (NE Specific):** Permanent surface disturbance resulting from oil and gas activities is limited to 300 acres within the following described lease tracts; this does not include surface disturbance activities from pipeline construction. Existing gravel pads within these tracts would not count against the 300-acre limit. A pipeline will be considered after a workshop is convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to Federal, State, and NSB representatives. (No alternative procedures will be approved).

(Acreages are based on GIS calculations and are approximate):

a) Total Acreage: 52,700:
   - 26,500 acres = RSO for Permanent Oil and Gas facilities excluding pipelines (the 23,350 acres includes 5,605 acres of overlap with the Coastal area restrictions).
   - 26,200 acres = Area open to development subject to general and site specific lease stipulations and required operating procedures.
   
   The total new development footprint cannot exceed 300 acres (0.6 percent of total acreage).

b) Total Acreage: 55,000:
   - 38,200 acres = RSO for Permanent Oil and Gas facilities, excluding pipelines (the 33,478 acres includes 5,131 acres of overlap with the Coastal area restrictions).
   - 16,800 acres = Area open to development subject to general and site specific lease stipulations and required operating procedures.
   
   The total new development footprint cannot exceed 300 acres (0.5 percent of total acreage).

c) Total Acreage: 46,100:

Appendix B. Current NPR-A Measures and Procedures
• 32,500 acres = RSO for Permanent Oil and Gas facilities, excluding pipelines.
• 13,600 acres = Area open to development subject to general and site specific lease stipulations and required operating procedures.

The total new development footprint cannot exceed 300 acres (0.7 percent of total acreage).

d) Total Acreage: 54,500:
• 46,900 acres = RSO for Permanent Oil and Gas facilities excluding pipelines.
• 7,700 acres = Area open to development subject to general and site specific lease stipulations and required operating procedures.

The total new development footprint cannot exceed 300 acres (0.6 percent of total acreage).

e) Total Acreage: 56,500:
• 32,200 acres = RSO for Permanent Oil and Gas facilities, excluding pipelines.
• 24,300 acres = Area open to development subject to general and site specific lease stipulations and required operating procedures.

The total new development footprint cannot exceed 300 acres (0.5 percent of total acreage).

f) Total Acreage: 57,100:
• 43,200 acres = RSO for Permanent Oil and Gas facilities, excluding pipelines.
• 4,900 acres = Restricted area open to development subject to the results of 3 year study requirement to determine appropriate placement of permanent facility(s).
• 9,000 acres = Area open to development subject to general and site specific lease stipulations and required operating procedures.

The total new development footprint cannot exceed 300 acres (0.5 percent of total acreage).

g) Total Acreage: 56,800:
• 48,700 acres = RSO for Permanent Oil and Gas facilities excluding pipelines.
• 300 acres = Restricted area open to development subject to the results of 3 year study requirement to determine appropriate placement of permanent facility(s).
• 7,800 acres = Area open to development subject to general and site specific lease stipulations and required operating procedures.

The total development footprint cannot exceed 300 acres (0.5 percent of total acreage).

SF2 – Subsistence Users Consultation & Plan

**Objective (NE & NW):** Provide opportunities for participation in planning and decision making to prevent unreasonable conflicts between subsistence uses and oil and gas and related activities.

**Requirement/Standard (NE & NW):** Operational activities will be prohibited within a minimum distance of 1 mile around cabins and campsites (as identified by the NSB’s official inventory) without alternate agreement between the operator and the cabin/campsite users/owners. Lessee/permittee shall consult directly with affected users/communities using the following guidelines:

a) Before submitting an application to the BLM, the applicant shall consult with directly affected subsistence users/communities, the NSB, and the National Petroleum Reserve-Alaska Subsistence Advisory Panel to discuss the siting, timing, and methods of their proposed operations to help discover local traditional and scientific knowledge, resulting in measure that minimize impacts to subsistence uses. Through this consultation, the applicant shall make every reasonable effort, including such mechanisms as conflict avoidance agreements and mitigating measures, to ensure that proposed activities will not result in unreasonable interference with subsistence activities.

b) The applicant shall submit documentation of consultation efforts as part of its operations plan. Applicants should submit the proposed plan of operations to provide an adequate time for review and comment by the National Petroleum Reserve-Alaska Subsistence Advisory Panel.
and to allow time for formal Government-to-Government consultation with Native Tribal governments. The applicant shall submit documentation of its consultation efforts and a written plan that shows how its activities, in combination with other activities in the area, will be scheduled and located to prevent unreasonable conflicts with subsistence activities. Operations plans must include a discussion of the potential effects of the proposed operation, and the proposed operation in combination with other existing or reasonably foreseeable operations.

c) A subsistence plan addressing the following items must be submitted:

1) A detailed description of the activity(s) to take place (including the use of aircraft).

2) A description of how the lessee/permittee will minimize and/or deal with any potential impacts identified by the AO during the consultation process.

3) A detailed description of the monitoring effort to take place, including process, procedures, personnel involved, and points of contact both at the work site and in the local community.

4) Communication elements to provide information on how the applicant will keep potentially affected individuals and communities up-to-date on the progress of the activities and locations of possible, short-term conflicts (if any) with subsistence activities. Communication methods could include holding community meetings, open house meetings, workshops, newsletters, radio and television announcements, etc.

5) Procedures necessary to facilitate access by subsistence users to conduct their activities.

In the event that no agreement is reached between the parties, the AO shall consult with the directly involved parties and determine which activities will occur, including the timeframes. During development, monitoring plans must be established for new permanent facilities, including pipelines, to assess an appropriate range of potential effects on resources and subsistence as determined on a case-by-case basis given the nature and location of the facilities. The scope, intensity, and duration of such plans will be established in consultation with the AO and Subsistence Advisory Panel. Permittees that propose barging facilities, equipment, supplies, or other materials to NPR-A in support of oil and gas activities in the planning area shall notify, confer, and coordinate with the Alaska Eskimo Whaling Commission, the appropriate local community whaling captains’ associations, and the NSB to minimize impacts from the proposed barging on subsistence whaling activities.

**SF3 – Environmental & Cultural Education**

**Objective (NE & NW):** Minimize cultural and resource conflicts.

**Requirement/Standard (NE & NW):** All personnel involved in oil and gas and related activities shall be provided information concerning applicable lease stipulations, ROPs, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region. The lessee/permittee shall ensure that all personnel involved in permitted activities shall attend an orientation program at least once a year. The proposed orientation program shall be submitted to the AO for review and approval and should:

a) Provide sufficient detail to notify personnel of applicable lease stipulations and ROPs and inform individuals working on the project of specific types of environmental, social, traditional, and cultural concerns that relate to the region.

b) Address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals, and provide guidance on how to avoid disturbance.

c) Include guidance on the preparation, production, and distribution of information cards on endangered and/or threatened species.

d) Be designed to increase sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which personnel will be operating.

e) Include information concerning avoidance of conflicts with subsistence and commercial fishing activities, and any pertinent mitigation.
f) Include information for aircraft personnel concerning subsistence activities and areas/seasons that are particularly sensitive to disturbance by low-flying aircraft. Of special concern is aircraft use near traditional subsistence cabins and campsites, flights during spring goose hunting and fall caribou and moose hunting seasons, and flights near North Slope communities.

g) Provide that individual training is transferable from one facility to another except for elements of the training specific to a particular site.

h) Include on-site records of all personnel who attend the program for so long as the site is active, though not to exceed the 5 most recent years of operations. This record shall include the name and dates(s) of attendance of each attendee.

i) Include a module discussing bear interaction plans to minimize conflicts between bears and humans.

j) Provide a copy of 43 CFR 3163 regarding Non-Compliance Assessment and Penalties to on-site personnel.

SF4 – Exploration Guidelines-Dease Inlet, Admiralty Bay, Elson Lagoon

**Objective (NW Specific):** Protect fish and wildlife habitat, preserve air and water quality, and minimize impacts to traditional subsistence activities and historic travel routes on Dease Inlet, Admiralty Bay, and Elson Lagoon.

**Requirement/Standard (Exploration-NW Specific):** Oil and gas exploration operations (e.g., drilling, seismic exploration, and testing) are not allowed on Dease Inlet, Admiralty Bay, and Elson Lagoon (including natural and barrier islands), between May 15 and October 15 of each season. Requests for approval of any activities must be submitted in advance and must be accompanied by evidence and documentation that demonstrates to the satisfaction of the Authorized Office that the actions or activities meet all of the following criteria:

a) Exploration activities will not unreasonably conflict with traditional subsistence uses or significantly impact seasonally concentrated fish and wildlife resources.

b) There is adequate spill response capability to effectively respond during periods of broken ice and/or open water, or the availability of alternative methods to prevent well blowouts during periods when adequate response capability cannot be demonstrated. Such alternative methods may include improvements in blowout prevention technology, equipment and/or changes in operational procedures and "top-setting" of hydrocarbon-bearing zones.

c) Reasonable efforts will be made to avoid or minimize impacts related to oil spill response activities, including vessel, aircraft, and pedestrian traffic will be conducted to minimize additional impacts or further compounding of "direct spill" related impacts on area resources and subsistence uses.

d) The location of exploration and related activities shall be sited so as to not pose a hazard to navigation by the public using high-use traditional subsistence-related travel routes into and through Dease Inlet, Admiralty Bay and Elson Lagoon, as identified by the North Slope Borough, recognizing that marine and nearshore travel routes change over time, subject to shifting environmental conditions.

e) Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission and the North Slope Borough to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.

SF5 – Coastal Development Guidelines- Dease Inlet, Admiralty Bay, Elson Lagoon

**Objective (NW Specific):** Protect fish and wildlife habitat, preserve air and water quality, and minimize impacts to traditional subsistence activities and historic travel routes on Dease Inlet, Admiralty Bay, and Elson Lagoon.

**Requirement/Standard (Development-NW Specific):** With the exception of linear features such as pipelines, no permanent oil and gas facilities are permitted on or under the water within ¾ mile seaward of the shoreline (as measured from mean high tide) of Dease Inlet, Admiralty Bay, and Elson Lagoon or the natural islands (excluding Barrier Islands). Elsewhere, permanent facilities within Dease
Inlet, Admiralty Bay, and Elson Lagoon will only be permitted on or under the water if they can meet all the following criteria:

- **a)** Design and construction of facilities shall minimize impacts to traditional subsistence uses, travel corridors, seasonally concentrated fish and wildlife resources.

- **b)** Daily operational activities, including use of support vehicles, watercraft, and aircraft traffic, alone or in combination with other past, present, and reasonably foreseeable activities, shall be conducted to minimize impacts to traditional subsistence uses, travel corridors, and seasonally concentrated fish and wildlife resources.

- **c)** The location of oil and gas facilities, including artificial islands, platforms, associated pipelines, ice or other roads, bridges or causeways, shall be sited and constructed so as to not pose a hazard to navigation by the public using traditional high-use subsistence-related travel routes into and through Dease Inlet, Admiralty Bay and Elson Lagoon as identified by the North Slope Borough.

- **d)** Demonstrated year-round oil spill response capability, including the capability of adequate response during periods of broken ice or open water, or the availability of alternative methods to prevent well blowouts during periods when adequate response capability cannot be demonstrated. Such alternative methods may include seasonal drilling restrictions, improvements in blowout prevention technology, equipment and/or changes in operational procedures, and "top-setting" of hydrocarbon-bearing zones.

- **e)** Reasonable efforts will be made to avoid or minimize impacts related to oil spill response activities, including vessel, aircraft, and pedestrian traffic that add to impacts or further compound "direct spill" related impacts on area resources and subsistence uses.

- **f)** Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission and the North Slope Borough to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.

**SF6 – Kasegaluk Lagoon Deferral**

**Objective (NW Specific):** Protect the habitat of the fish, waterfowl, and terrestrial and marine wildlife resources of Kasegaluk Lagoon, and protect traditional subsistence uses and public access to and through Kasegaluk Lagoon for current and future generations of North Slope residents.

**Requirement/Standard (NW Specific):** Within the Kasegaluk Lagoon Special Area, oil and gas leasing is approved subject to the decision to defer the implementation of oil and gas leasing in the "Leasing Deferral Area." When leasing is implemented, no permanent oil and gas facilities are permitted within the boundary of the Special Area. Geophysical (seismic) exploration is authorized subject to the terms and conditions provided in other applicable ROP's. No restrictions are imposed on traditional subsistence activities and access for subsistence purposes.

**SF7 – Subsistence Food Safety**

**Objective (NE Specific):** Ensure that permitted activities do not create human health risks through contamination of subsistence foods.

**Requirement/Standard (NE Specific):** A lessee proposing a permanent oil and gas development shall design and implement a monitoring study of contaminants in locally-used subsistence foods. The monitoring study shall examine subsistence foods for all contaminants that could be associated with the proposed development. The study shall identify the level of contaminants in subsistence foods prior to the proposed permanent oil and gas development and monitor the level of these contaminants throughout the operation and abandonment phases of the development. If ongoing monitoring detects a measurable and persistent increase in a contaminant in subsistence foods, the lessee shall design and implement a study to determine how much, if any, of the increase in the contaminant in subsistence foods originates from the lessee’s activities. If the study determines that a portion of the increase in contamination in subsistence foods is caused by the lessee's activities, the AO may require changes in the lessee's processes to reduce or eliminate emissions of the contaminant. The design of the study/studies must meet the approval of the AO. The AO may consult with appropriate Federal, state, and NSB agencies prior to approving the study/studies design. The AO may require/authorize changes in the design of the studies throughout the operations and abandonment period, or terminate or suspend studies if results warrant.
APPENDIX C. NORTH SLOPE DATA REFERENCES

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APPENDIX D. ANNOTATED BIBLIOGRAPHY

INTRODUCTION

An annotated bibliography was developed during the literature review and search process which was initiated with literature known to the authors and added to during focused literature searches using online databases and on holdings of the Alaska Resources Library and Information Services, Anchorage, Alaska. A total of 306 references were identified and included in the database which provides a link to a digital copy of most references. Database records are presented below organized as they relate to oil and gas industry stressors and background information. A notation describing how each reference was used during development of the monitoring plan is also included, with pertinent topics underlined.

INFRASTRUCTURE

1. Alaska Department of Fish and Game (ADF). 1986. Alaska habitat management guide Arctic Region. Alaska Department of Fish and Game Habitat Division, Juneau, Alaska.
   Ref ID: 153
   Reprint: In File
   Keywords: Monitoring/Alaska/Habitat/Arctic/Arctic Region/Land use/Planning/Water
   Abstract: This project presents the best available information on selected fish and wildlife species: mapping and discussing their geographical distribution; assessing their relative abundance; describing their life functions and habitat requirements; identifying the human uses made of them, including harvest patterns of rural communities; and describing their role in the state's economy. This last kind of information, because of the variety of values humans place upon fish and wildlife, is not easily derived. There are, however, several methods to estimate some of the economic values associated with these resources, and such estimates have become particularly important in land use planning because many potentially conflicting uses must be evaluated in economic terms. Essential to assessing what might happen to fish and wildlife if their habitats are altered is information about what effects or impacts are typically associated with particular kinds of developmental activities. The habitat management guides therefore also provide summaries of these known effects. This information, in conjunction with compiled life history information, will allow those concerned to estimate how sensitive a given species might be to a specific proposed activity - whether or not, and to what degree, the fish and wildlife are liable to be impacted. The guidance offered (a compilation of existing options for habitat management) is not site-specific. Rather, it is general information available to those who seek to avoid adverse impacts without placing undue restraints upon other land and water uses. The completed guides coverage of fish and wildlife resources encompasses the Fish and Game Resource Management Regions established by the Joint Board of Fisheries and Game. These regions provide the most inclusive and consistent format for presenting information about fish and wildlife resources and relating it to management activities and data collection efforts within the department.
   Notes: Use in monitoring plan development:
   Not Used
   Baseline Data
   Model Development
   Stressor
   Physical Process
   Structural or Physical Changes
   Functional Response
   Method

   Ref ID: 184
   Reprint: In File
   Keywords: Land use/Monitoring/bioassessment/Habitat/Streams
   Abstract: Local habitat and biological diversity of streams and rivers are strongly influenced by landform and land use within the surrounding valley at multiple scales. However, empirical associations between land use and stream response only varyingly succeed in implicating pathways of influence. This is the case for a number of reasons, including (a) covariation of anthropogenic and natural gradients in the landscape; (b) the existence of multiple, scale-dependent mechanisms; (c) nonlinear responses; and (d) the difficulties of separating present-day from historical influences. Further research is needed that examines responses to land use under different management strategies and that employs response variables that have greater diagnostic value than many of the aggregated measures in current use.
   Notes: Use in monitoring plan development:
   Not Used
   Baseline Data
   Model Development
   Stressor
   Physical Process
   Structural or Physical Changes
   Functional Response
   Method
Ref ID: 183
Reprint: In File
Keywords: Land use/Monitoring/bioassessment/Habitat
Abstract: The development of bioassessment methods for lotic ecosystems, combined with advances in geographic information systems and spatial analysis, has resulted in a rapidly expanding literature linking land use to river condition. Such studies provide evidence that declines in forested land and increases in agricultural and urban land frequently are predictors of a degraded state of the habitat and biota. However, further research should address a number of challenges to our current knowledge. Both linear and non-linear relationships have been described, and it will be useful to know when to expect non-linear or threshold responses. Legacy effects, where historical impacts may be stronger than present-day impacts, may be common but can be difficult to recognize. There is ample evidence that landscape factors influence lotic ecosystems across a wide range of spatial scales, but the roles of near-stream vs. larger spatial scales can be difficult to separate. This is part of the larger issue that multiple, interacting factors link landscape change to stream response, and the pathways or mechanisms are rarely identified. Natural and anthropogenic gradients often co-vary, because human activities are most intense in certain landscape settings, making it difficult to determine how much of the variation in stream condition should be attributed to human actions. Finally, because bioassessment methods are intended to detect impairment rather than diagnose cause, it is important to establish mechanisms that more precisely link land-use activities to stream condition, in order to prescribe appropriate restoration action. Future research that combines landscape-stream condition analyses with a basic understanding of the pathways whereby human alteration of landscapes influences river condition can serve the dual function of advancing both the management and the understanding of lotic ecosystems.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 185
Reprint: In File
Keywords: Humpback Whitefish/Whitefish/Alaska/Monitoring/Streams/Lakes/Water/River/Subsistence
Abstract: Modal gill raker counts of Coregonus pidschian from various areas of Alaska ranged from 21 to 26, with populations of coastal streams having lower counts. Humpback whitefish are mainly distributed north of the Alaska Range and are found in lakes, streams, and brackish water. Feeding migrations into lake and slough areas of many Alaskan waters occur soon after ice breakup, with an outmigration occurring during freeze-up. Many spawning populations migrate upstream during summer and fall and spawn in upper reaches of rivers. Spawning generally occurs during late September and October over gravel bottoms. Humpback whitefish studied reached 540 mm fork length and age XIV. Populations from interior Alaska waters grow faster than coastal populations, with Chatankika River fish reaching 442 mm at age VIII. First maturity is usually reached between ages V and VII. Main utilization of the humpback whitefish in Alaska is for subsistence but small commercial and sport fisheries exist in interior Alaska.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 248
Reprint: In File
Keywords: Monitoring/Environmental assessments/Environmental Assessment
Abstract: Roads are pervasive in modern landscapes and adversely affect many aquatic ecosystems. Conventional environmental assessments of roads focus on construction impacts but ignore subsequent impacts. A comprehensive framework for considering all impacts of roads would enable scientists and managers to develop assessment tools that more accurately inform stakeholders and policymakers about the biological consequences of road building. We developed a two-dimensional framework to organize impacts of roads on aquatic biota. One dimension recognizes three phases of road development, each with distinctive ranges of spatial and temporal scales. The second dimension recognizes five classes of environmental impacts associated with road development. The framework is useful in evaluating the completeness of assessments in identifying gaps in scientific knowledge. We applied the framework to a draft environmental impact statement (DEIS) for a proposed interstate highway to illustrate which road impacts are typically ignored in such assessments and how our framework can be used to enhance assessments. The DEIS largely omitted long-term, large-scale impacts from consideration. Such omissions preclude fair assessments of the desirability of roads and bias landscape-
management decisions in favor or road building. Additional scientific input and changes in agency ideology are needed to reduce bias in assessments of the biological impacts of roads.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 261
Reprint: In File
Keywords: Fish Passage/Monitoring
Abstract: This report is intended to review, summarize, and update current information on fish passage through culverts. The scope of the report is limited to highway drainage structures, not including bridges. This distinction was made in an effort to concentrate on those road drainage structures that are most commonly used in fish passage situations. The publication is primarily issued for fish biologists, engineers, and hydrologists who will be designing the projects and making current decisions on fish passage at drainage structures.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 188
Reprint: In File
Keywords: salmonids/Monitoring/Streams/Habitat/Transportation/Water/Composition
Abstract: Human activities in Northwestern watersheds, including logging, grazing, agriculture, mining, road building, urbanization, and commercial construction contribute to periodic pulses or chronic levels of suspended sediment in streams. Suspended sediment is associated with negative effects on spawning, growth, and reproduction of salmonids. Effects on salmonids will differ based on their developmental stage. Suspended sediments may affect salmonids by altering their physiology, behavior, and habitat, all of which may lead to physiological stress and reduced survival rates. A sizable body of data (laboratory and field-based) has been gathered in North America focusing on the relationship between turbidity, total suspended sediments, and salmonid health. The controlled environment of laboratory studies tends to give clearer results than field studies. Understanding the relationship between turbidity measurements, suspended sediments, and their effects on salmonids at various life stages will assist agencies implementing transportation projects to devise techniques to reduce temporary and chronic erosion and sedimentation in the water column is measured: turbidity, total suspended solids, and water clarity. While these measures are frequently correlated with one another, the strength of correlation may vary widely between samples from different monitoring sites and between different watersheds. Turbidity is currently in widespread use by resource managers, partially due to the ease of taking turbidity measurements. In addition, current state regulations addressing suspended sediment are usually NTU-based. The disadvantage of turbidity is that it is only an indicator of suspended sediment effects, rather than a direct measure, and may not accurately reflect the effect on salmonids. Protection of Washington State's salmonids requires that transportation officials consider the effect of suspended sediments released into streams during transportation projects. Many state and provincial criteria are based on a threshold of exceedance for background levels of turbidity. However, determining natural background levels of turbidity is a difficult endeavor. Turbidity measures may be affected by 1) differing physical processes between watersheds including geologic, hydrologic, and hydraulic conditions; 2) legacy issues (activities historically conducted in the watershed); and 3) problems with instrumentation and repeatability of turbidity measurements. Altered systems may not provide accurate baseline conditions. The inconsistent correlation between turbidity measurements and mass of suspended solids, as well as the difficulty in achieving repeatability using turbidimeters contributes to concerns that turbidity may not be a consistent and reliable tool in determining the effects of suspended solids on salmonids. Other factors, such as life stage, time of year, size and angularity of sediment, availability of off-channel and tributary habitat, and composition of sediment may be more telling in determining the effect of sediment on salmonids in Northwestern rivers. Although salmonids are found in naturally turbid river systems in the Northwest, this does not necessarily mean that salmonids in general can tolerate increases over time of suspended sediments. An understanding of sediment size, shape, and composition, salmonid species and life history stages, cumulative and synergistic stressor effects, and overall habitat complexity and availability in a watershed is required. For short-term construction projects, operators will need to measure background turbidities on a case by case basis to determine if they are exceeding regulations. However, transportation projects may also produce long-term, chronic effects. Short-term pulses will presumably have a different effect on salmonids than chronic exposure. To adequately protect salmonids during their
freshwater residence, TSS data on physiological, behavioral, and habitat effects should be viewed in a layer context incorporating both the spatial geometry of suitable habitat and the temporal changes associated with life history, year class, and climate variability. Spatial and temporal considerations provide the foundation to decipher legacy effects as well as cumulative and synergistic effects on salmonid protection and recovery.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method

   Ref ID: 190
   Reprint: In File
   Keywords: Habitat/Monitoring/Water/Plants/Planning
   Abstract: This study examined juvenile salmonid use and habitat changes associated with stream bank protection at the site level in the mainstem Skagit River. Natural and hydromodified banks were paired by location over an eighty mile river length. Bank habitat was defined as either "natural" or "hydromodified" based on the presence of riprap or other human induced bank modification and distinguished from mid-channel units (e.g., riffle, glide, and pool) by differences in water current velocity. Natural banks had a higher percentages of their area in wood, cobble, boulder, aquatic plants, undercut bank, and no cover types when compared to hydromodified banks. While no riprap or rubble was found in natural banks, wood cover was common in some hydromodified banks. Wood cover in hydromodified banks increases with increasing time after hydromodification. We found no significant difference in water surface velocity between natural and hydromodified banks. Riprap/rubble and wood cover were not correlated with water surface velocity. However, the gradient of the bank unit and the streamflow discharge were correlated with water surface velocity. The findings of this study reveal some consistent trends in fish use across sampled reaches. For juvenile chinook and coho in bank habitat, fish abundance has a significant positive correlation with the amount of wood cover. Wood cover in hydromodified banks explained 82% of the variation in chinook abundance. For juvenile coho at the end of summer rearing, wood cover in both bank types explained 62% of the variation in fish abundance. There is evidence of preference for riprap (but not rubble) and some specific types of wood cover by rainbow suggesting that rainbow may not be adversely impacted at the site level by bank hydromodification if rock particles are large. While wood cover is the most common natural bank cover, fish abundance within wood cover types is not uniform. Fish abundance is greater in rootwad cover than single logs for all species and life stages examined, except sub-yearling chum. Sub-yearling chum prefer aquatic plants and cobble, two other cover types more common in natural banks. The findings also suggest that the use of natural cover types along with bank protection may mitigate some site (but not reach) level impacts of hydromodification. Results presented can form the basis for estimating restoration project benefits, planning mitigation, or assessing the impacts of habitat loss.
   Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method

   Ref ID: 262
   Reprint: In File
   Keywords: Monitoring/Water
   Abstract: Properly designed culverts do not produce water velocities that exceed fish swimming abilities. Fish have two different musculature systems for swimming. A white muscle system generates power for short, vigorous swimming. A red muscle system furnishes power for long, sustained swimming. The culvert design must account for both swimming modes. Therefore, the engineer must know the hydraulic conditions where the fish swims. These conditions change throughout the culvert. The engineer determines acceptable hydraulic conditions for fish by matching known fish swimming power and energy capacities. Subcritical flow is necessary to pass weak-swimming, upstream-migrating fish. Therefore, this requirement precludes the use of inlet control. The engineer may use artificial roughness to create areas of slower water velocities within culverts. Examples of these are depressed inverts, weir baffles, and deep culvert corrugations. This manual presents design procedures to pass upstream-migrating, weak-swimming fish. The manual also displays criteria for retrofitting existing culverts. This paper does not present cost-effective criteria for strong-swimming fish.
   Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
Ref ID: 249
Reprint: In File
Keywords: Monitoring/Water/Fish Passage
Abstract: Combinations of water velocity and passage length in highway culverts were evaluated to determine conditions that enabled or prevented the passage of nonanadromous rainbow trout *Oncorhynchus mykiss*, brown trout *Salmo trutta*, cutthroat trout *O. clarki*, and brook trout *Salvelinus fontinalis*. Fish passage through six culverts 45-93 m long was determined by trapping and electrofishing. Water velocities were measured 5 cm above the bottom (bottom velocity) and at 0.6 of the water depth at intervals between rest sites throughout the lengths of the culverts. Nonlinear regression lines specific to species and state of sexual maturity were fit to the combinations of mean bottom velocity and passage length representing the most strenuous passage conditions that allowed the upstream passage of trout. Because of the similarity of the strenuous passage relations among species, the spawning rainbow trout relation could be used as the general criterion for passage of the trout studied. This relation indicated that fish could swim distances of 10, 30, 50, 70, and 90 m with mean bottom velocities up to 0.96, 0.80, 0.74, 0.70, and 0.67 m/s, respectively.
Notes: Use in monitoring plan development:
- Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 141
Reprint: In File
Keywords: Habitat/Monitoring/Water/Composition/benthic macroinvertebrates
Abstract: A field study was conducted to investigate the physical and biological effects of pipeline watercourse crossings on fish habitat, in two streams in southwestern Alberta. The effects of the crossing were assessed using selected variables that are standard measures of fish habitat quality: water temperature, flow rates, water depth, substrate composition, benthic macroinvertebrates, and fish cover. The effects of the crossing include a substantial reduction in available fish cover, a reduction in the diversity of cover types, and the lack of specific cover types, such as deep pools and undercut banks; an alteration in the substrate composition in the right-of-way and the subsequent loss of structural heterogeneity in the physical habitat; channelization of the stream; and an alteration in the community structure of benthic macroinvertebrates. These findings will be of particular interest to individuals responsible for the assessment or regulation of pipeline crossings under legislation such as the Canada Fisheries Act, which requires a determination whether a river crossing will cause "Harmful Alteration, Disruption or Destruction of fish habitat" (HADD).
Notes: Use in monitoring plan development:
- Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 192
Reprint: In File
Keywords: Monitoring/Alaska/River
Abstract: Field studies of forest gravel-bed rivers in northwestern Washington and southeastern Alaska demonstrate that bed-surface grain size is responsive to hydraulic roughness caused by bank irregularities, bars, and wood debris. We evaluate textural response by comparing reach-average median grain size (D50) to that predicted from the total bank-full boundary shear stress (tbf), representing a hypothetical reference condition of low hydraulic roughness. For a given tbf, channels with progressively greater hydraulic roughness have systematically finer bed surfaces, presumably due to reduced bed shear stress, resulting in lower channel competence and diminished bed load transport capacity, both of which promote
textural fining. In channels with significant hydraulic roughness, observed values of $D_{50}$ can be up to 90% smaller than those predicted from $t_{0bf}$. We find that wood debris plays an important role at our study sites, not only providing hydraulic roughness but also influencing pool spacing, frequency of textural patches, and the amplitude and wavelength of bank and bar topography and their consequent roughness. Our observations also have biological implications. We find that textural fining due to hydraulic roughness can create usable salmonid spawning gravels in channels that otherwise would be too coarse.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 14
Reprint: In File
Keywords: Alaska/Environmental aspects/Gas well drilling/National Petroleum Reserve/Oil well drilling/Petroleum/Monitoring
Abstract: The EA is written as a stand-alone document, but incorporates segments of other related documents by reference. The scope of the EA includes analysis of effects of the proposed exploration activity and alternatives, including the No Action Alternative. The EA also addresses the impacts of hypothetical oil and gas field development if an economic discovery were made during this activity. The project consists of a proposed overland trail and ice road, with up to 24 exploration wells in up to eight areas in the Trailblazer Prospect in the Northeastern NPR-A, identified in the case file. Proposed action and alternatives -- Affected environment -- Environmental impacts -- Consultation and coordination -- Appendix A. Stipulations from the 1998 Record of Decision (ROD) -- Appendix B. BPXA plan of operations.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 33
Reprint: In File
Keywords: Alaska/Environmental aspects/Gas well drilling/Lakes/National Petroleum Reserve/National Petroleum Reserve (Alaska)/Oil well drilling/Petroleum/Water/Monitoring
Abstract: The EA is written as a stand-alone document, but is tiered to, and incorporates segments of other related documents by reference. The scope of the EA includes analysis of effects of the proposed exploration activity and alternatives, including the no-action alternative. The project includes proposed overland travel and ice road systems, with up to 19 exploration wells (total) in up to 10 locations on PAI leases in the Northeastern NPR-A, identified in the case file. Proposed action and alternatives -- Affected environment -- Environmental impacts -- Consultation and coordination -- Appendix A. Proposed project facility locations -- Appendix B. Selected information on water supply/ice aggregate lakes
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 30
Reprint: In File
Keywords: Alaska/Environmental aspects/Gas well drilling/Habitat/Lakes/National Petroleum Reserve/National Petroleum Reserve (Alaska)/Oil well drilling/Petroleum/Water/Monitoring
Abstract: Analyzes effects of the proposed exploration activity and alternatives and addresses the impacts of hypothetical oil and gas field development if an economic discovery is made during exploration. Applicant: Phillips Alaska, Inc. Proposed action and alternatives -- Affected environment -- Environmental impacts -- Consultation and coordination -- Appendix A. Threatened and endangered species consultation -- Appendix B. Essential fish habitat evaluation -- Appendix C. Selected information on water supply/ice aggregate lakes.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 31
Reprint: In File
Keywords: Alaska/Environmental aspects/Lakes/National Petroleum Reserve/Oil well drilling/Petroleum/Petroleum industry and trade/Planning/Prospecting/Transportation/Water/Water-supply/Monitoring/Arctic/Environmental Assessment
Abstract: Report focuses on Anadarko's proposed project, which includes up to 11 miles of new routing from the existing approved access route via ice road or overland trail to two new drill site locations and five water supply lakes. The drilling program will include up to two reservoir penetrations (one well and one sidetrack) at each pad location ... This [Environmental Assessment] considers combined use of approved access route, new routings, new ice pad locations, and new water supply lakes." Proposed action and alternatives -- Affected environment -- Environmental impacts -- Consultation and coordination.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 263
Reprint: In File
Keywords: Habitat/Monitoring/lake trout
Abstract: A habitat classification system was used to describe aquatic habitat and evaluate habitat degradation in Lake Ontario. Primary consideration was given to physical loss or disruption of habitat availability; because habitat availability was treated as a functional entity, disruptions or stresses caused by chemical or biological sources were included. Data on biological, chemical, and physical anthropogenic changes were scattered, patchy, and disjointed. Therefore, the Delphi technique was used to evaluate the degree of functional habitat impairment for 29 habitats. The criteria for the impairments were the severity of the ecological impact (shift in trophic transfer efficiency) and its permanence (short > decades > permanent). The amounts of functional degradation were averages by habitat categories (N = 88) for each habitat and multiplied by the estimated areal proportion of that habitat in the ecosystem. We estimated that during 1970-1990, Lake Ontario's ecosystem health was degraded by 58%. Impairments were caused almost equally by anthropogenic stresses from biological (loss of indigenous and introduction of exotic species), chemical (persistent toxins), and physical (dredge-fill, damming, and water-level regulations) sources. Our finding is consistent with a late 1980s study that used lake trout (Salvelinus namaycush) as an indicator of ecosystem health.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method
Ref ID: 264  
Reprint: In File  
Keywords: Monitoring/Fish Passage  
Abstract: Statistical techniques commonly used in fish passage research fail to adequately quantify delays incurred at obstacles, or the effects of modifications to those obstacles on passage rates. Analyses of telemetry data describing these effects can be misleading, particularly when passage route of some individuals is not established (e.g., because of mortality, tag failure, passage through unmonitored or alternate routes, etc.). Here, we demonstrate how event-time analysis, better known as survival analysis, can be used to quantify passage rates for any study that allows tracking of individuals through time, even when some individuals fail to pass the route or obstacle in question. We review two of the primary methods of event-time analysis (parametric and Cox's proportional hazards regression analyses) and use them in combination with logistic regression to provide unbiased estimates of delay incurred at a hydroelectric facility, as well as insights on factors affecting both rates of passage and route selection. Passage rate increased with increased depth of a surface bypass sluice gate and, among fish that passed through the turbines, with turbine flow. The data further indicate that risk of turbine passage increased with both delay and turbine flow.  
Notes: Use in monitoring plan development:  
Not Used  
Baseline Data  
Model Development  
Stressor  
Physical Process  
Structural or Physical Changes  
Functional Response  
Method

Ref ID: 257  
Reprint: In File  
Keywords: biological indicators/Monitoring/Fishes/Fish populations/Habitat  
Abstract: This chapter evaluates some of the main methodologies for physical habitat assessment that have been used to indirectly assess effects of environmental stressors on fish populations, focusing on methodologies that apply at the landscape level. These methods include the long-established instream-flow method and habitat quality index methods. This chapter also describes a recent methodology that is being applied to the Everglades hydroscape, which represents the wetland hydroscape as a spatially explicit grid of pixels and calculates a suitability index for each spatial pixel. These suitability indices are then used to help evaluate the effects of stressors on fish populations.  
Notes: Use in monitoring plan development:  
Not Used  
Baseline Data  
Model Development  
Stressor  
Physical Process  
Structural or Physical Changes  
Functional Response  
Method

Ref ID: 78  
Reprint: In File  
Keywords: Alaska/Ecology/Arctic/Monitoring  
Abstract: Studies conducted from the early 1980s to the mid-1990s show that anadromous Dolly Varden Salvelinus malma in the Kotzebue Sound and Chukchi Sea drainages of Alaska exhibit complex movement patterns. Movements are framed within the context of annual seaward feeding migrations and fall migrations into freshwater for overwintering. Dolly Varden home for spawning but do not demonstrate fidelity to overwintering rivers. Movements associated with spawning differ from the annual migrations exhibited by nonspawners. The existence of summer and fall spawning groups further complicates the pattern. Summer spawners remain in freshwater during the year in which they spawn. If they overwintered in their home river, they move upstream to spawning areas during June or early July, remain on spawning grounds until early September, then descend to lower river areas where they join nonspawners to overwinter, remaining in freshwater for 20 months during the spawning cycle. If fish have overwintered in a river other than their natal river, they move to sea with nonspawners in June, travel directly to their home river, and move upstream in early July to join other summer spawners already on spawning grounds. Postspawning movements are similar to those of other summer spawners. Fall spawners feed at sea during summer, enter rivers in August, and travel directly to spring areas in headwater streams where they spawn and remain throughout the winter. Unlike summer spawners, fall spawners make annual migrations to sea. Stocks are mixed in major overwintering areas. A hypothesis based on ocean currents and life history patterns of Dolly Varden may explain the observed movements and mixing of stocks.  
Notes: Use in monitoring plan development:  
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 267
Reprint: In File
Keywords: Monitoring/Hydrology/Fish Passage/Water/River/Pike/Broad Whitefish/Whitefish/Habitat
Abstract: The impact of improper culvert design and effects on the hydrology and fish biology of Frog Creek, N.W.T. are discussed. Fish migration discharge design, as required by Fisheries and Marine Service, Environment Canada for northern highway culverts, is defined. At this or lower discharges, flow conditions within the culvert must allow for the upstream passage of fish. Fish migration discharge for Frog Creek, N.W.T. is calculated as 22.4 m³/s (800 cfs). If the culvert at Frog Creek had been designed to allow fish passage at this discharge, the delay to fish migrations would have been only 3 to 4 days. Water velocities in the Frog Creek culvert during 1973 exceeded the maximum allowable velocity of 1.5 m/s (5 fps) for 40 days from May 26 to July 5. Bank erosion downstream from the culvert caused retreat of the river bank at a rate of 15 cm (6 inches) per day. Siltation of the stream resulting from construction was evident, but appeared to be insignificant. During the peak discharge period, extensive ponding occurred upstream of the culvert. Ice buildup inside the culvert occurred primarily during early spring as a result of over-ice flow. High water velocities within the culvert blocked the spawning migration of approximately 600 northern pike *Esox lucius* (Linnaeus) and appeared to block movements of some broad whitefish *Coregonus nasus* (Pallas). Fish passage did not become generally possible until July 5, when water velocities of less than 1.5 m/s (5 fps) were attained. After passage became possible, both pike and broad whitefish dispersed equally in upstream and downstream directions. It was estimated that only a small proportion of the total pike population of the Frog Creek drainage was blocked by the culvert. No physiological effects of culvert delay on ripe pike were evident. Feeding habitats of northern pike and broad whitefish are described in relation to available food organisms, as indicated by drift and artificial substrate samples. Age and growth and length frequency distributions for pike and broad whitefish are described. Maximum ages recorded in Frog Creek were 8 years for pike and 6 years for broad whitefish.
Notes: Use in monitoring plan development:
Not Used

Ref ID: 268
Reprint: In File
Keywords: Streams/Monitoring/stream habitat/Habitat
Abstract: We examined the influence of logging and road construction on substrate and standing stocks of trout (*Salvelinus* and *Salmo*) in 28 stream reaches in the Medicine Bow National Forest, Wyoming. The extent to which roads crossed watercourses (culvert density) within a drainage and the proportion of the drainage that was logged were positively correlated to both the amount of fine substrate and embeddedness. Trout standing stocks had a negative relation with the density of culverts. Erosion of soil from road surfaces, ditches, and disturbed areas adjacent to roads that subsequently is deposited in stream channels seems to be an important mechanism by which logging has affected stream habitat.
Notes: Use in monitoring plan development:
Not Used

Ref ID: 82
Reprint: In File
Keywords: Alaska/Water/Habitat/Ecology/Arctic/Monitoring
Abstract: Dolly Varden Salvelinus malma spawn, rear, and overwinter in freshwater tributaries to the Beaufort Sea and migrate to coastal waters to feed. Oil and gas development activities that alter the freshwater or marine environments could affect char populations and the local fisheries they support. The purpose of this study was to describe the genetic relationships among Dolly Varden populations from Beaufort Sea tributaries. Allozyme electrophoresis was used to analyze variation at 49 loci (21 were polymorphic) in 27 collections made from 11 river drainages. Average heterozygosity observed was 0.038 (range: 0.016-0.052). Average percent of loci that were polymorphic was 19%. Overall heterogeneity G-tests indicated highly significant differences among collections (P < 0.001). Cluster analysis of Nei's genetic distance sometimes formed groups of geographically proximate collections; however, correspondence between genetic and geographic distances was weak in hierarchical groupings. Differences among collections within and between river systems were observed. On average, 91% of the genetic variation occurred among individuals within collections, whereas 8% was attributable to differences among river systems and 1% to differences within systems. Resident char from Sadlerochit Spring were genetically distinct from char in other collections due to low variability rather than to the presence of unique alleles. Genetic data indicated that multiple populations of char occur along the arctic coast of Alaska and Canada, often organized by major river system, and that more than one population may occur within river systems. Human activities that affect critical habitats, such as areas used for spawning or overwintering, must be considered with respect to the effects on individual populations rather than on a generalized char "population" that uses the Beaufort Sea.

Notes: Use in monitoring plan development:
- Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 168
Reprint: On Request 03/20/08
Keywords: Alaska/Monitoring/Subsistence/Nuiqsut
Abstract: Chapter XXII of this report addresses subsistence in Nuiqsut. Full report available at ARLIS.
Notes: Use in monitoring plan development:
- Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref Type: Journal (Full)
Ref ID: 229
Keywords: Alaska/Arctic/Arctic cisco/Ecology/Fishes/Habitat/Least Cisco/Monitoring/North Slope/Water/Prudhoe Bay
Reprint: In File
Abstract: This paper assesses the short-term movements and distribution of two species of ciscoes (Coregonus autumnalis and C. sardinella) in relation to a solid-fill causeway (West Dock) based upon results of studies conducted in Prudhoe Bay from 1981 through 1985. When winds blow from the east, West Dock modifies nearshore hydrographic and circulation regimes to such an extent that the eastward dispersals of ciscoes are delayed or blocked. Under the reversed situation (westerly winds confronting westward-dispersing ciscoes), the effects of West Dock are less clear-cut. Local conditions largely determine whether one of these man-constructed intrusions may seriously affect a delicate, fragile environment, or may be insignificant quirks to populations that have survived millennia of such adversities.
Notes: Use in monitoring plan development:
- Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Appendix D. Annotated Bibliography

Ref ID: 269
Reprint: In File
Keywords: Arctic/Arctic grayling/Monitoring/River/Alaska/Habitat/Recruitment
Abstract: The effects of delays on the spawning run of Arctic grayling in Fish Creek, a tributary of the Jack River, near Cantwell, Alaska were examined. Tagged grayling were delayed for 3, 6, or 12 days, and then released; control fish were released within 12 hours of capture. During the delays, a high proportion of females became ripe; most males were ripe before the delays and remained ripe over a longer period than females. Delayed and control fish were monitored by the recapture of tagged fish in upstream traps. Females released in a "running-ripe" condition migrated at higher rates, but failed to reach upstream areas in similar proportions as those of "less ripe" females. Reduction in distances traveled by grayling as a result of longer delays may lead to use of non-preferred spawning habitats, underuse of spawning areas upstream, and decreases in recruitment. I recommend that spawning delays for Arctic grayling not exceed 3 days.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 85
Reprint: In File
Keywords: North Slope/Monitoring
Abstract: Design consideration/requirements for constructing stream crossings on the North Slope.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref Type: Journal (Full)
Ref ID: 232
Keywords: Alaska/Anadromous/Arctic/Arctic cisco/Colville River/Colville River Delta/Fish populations/River/Fishery management/impact assessment/Monitoring
Reprint: In File
Abstract: The model developed for Colville River arctic cisco was used to predict catches for 1982-1985. Results consistently overestimated actual catch-per-unit-effort but mimicked relative change in 3 out of 4 years. New blind predictions were made that suggest an impending decline in the fisheries over the next 5 years followed by a period of marked increases. Independent information concerning year class strengths in recent years suggests that the model predictions may be reasonably correct. If the model predictions are proven to be correct over the next 10 years, then the model's value is that, despite some obvious flaws, it will have illustrated that the information contained in historical fishery catch trends can be directly used for fishery management and impact assessment purposes. Marked changes in key parameter estimates may signal impacts from development or overharvest.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 271
Reprint: In File
Keywords: Fish Passage/Habitat/Monitoring/Stream Crossings/Streams
Abstract: In the light of declines in Atlantic salmon (Salmo salar) stocks, we sought to determine the extent to which stream
crossings along a newly constructed section of the Trans Labrador Highway (TLH Phase II) in southern Labrador accorded
with government regulations for fish habitat protection. We surveyed crossings of permanent streams over a 210 km road
segment, containing 4 bridges and 47 culverts. Fifty-three percent of culverts posed problems to fish passage, due to poor
design or poor installation. We conjecture that cost and inadequate environmental oversight in the field explain the weak
compliance with the relevant fisheries guidelines. Our research has prompted the federal regulator to instigate remediation
of problems with the Phase II part of the highway. In addition many of the planned stream crossings for Phase III of the TLH
were re-designed, and a commitment to careful monitoring of the installations has been made by the federal regulator in
cooperation with the indigenous inhabitants.

Notes: Use in monitoring plan development:
- Not Used

Baseline Data
Model Development

Stressor

Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 356
Reprint: In File
Keywords: Hydrology/Monitoring/River/salmonids/Stream Crossings/stream habitat/Ecology/Water/Water quality/Habitat
Abstract: One of the main purposes in writing the first edition of this book in 1992 was to help improve communication
between the disciplines of stream ecology and river engineering and to foster a sense of co-operation in these
interdisciplinary efforts. The field of river research and management has been evolving so rapidly that it was difficult for us
to decide when was an appropriate time to update the book. Many countries have implemented new river laws that require
managers to at least maintain the current levels of stream health and be highly accountable for their actions. the ecosystem
concept, which originated in ecology as a research paradigm, has now been transferred to the realm of public policy:
physico-chemical characteristics are still important, but we now speak of "stream health" and measure it in terms of water
quality, habitat availability and suitability, energy sources, hydrology, and the biota themselves. Chapters include: 1
Introducing the Medium, 2 How to Study a Stream, 3 Potential sources of Data (How to Avoid Reinventing the Weir), 4
Getting to Know Your Stream, 5 How to Have a Field Day and Still Collect Some Useful Information, 6 Water at Rest and in
Motion, 7 It's Sedimentary, Watson!, 8 Dissecting Data with a Statistical Scope, 9 "Putting It All Together": Assessing Stream
Health, Stream Classification, Environmental Flows and Rehabilitation.
Notes: Use in monitoring plan development:
- Not Used

Baseline Data
Model Development

Stressor

Physical Process
Structural or Physical Changes
Functional Response
Method

directional drilling and traditional construction techniques for wetland and riparian area crossings in natural gas pipeline
Ref ID: 142
Reprint: In File
Keywords: Habitat/Monitoring/Water/Composition/benthic macroinvertebrates
Abstract: Horizontal Directional Drilling (HDD) is increasingly advocated as the preferred, and often required, construction
method (as opposed to traditional trenching) for natural gas transmission line crossings of ecologically-sensitive areas
including wetlands and riparian areas. As a result, a closer look at the technical rationale, environmental and cost
implications, and construction procedures in these areas is required to determine the benefits and drawbacks of these
crossing techniques. The focus of this evaluation was to examine crossing techniques such as the traditional open-cut
trenching and HDD in the context of the above-mentioned criteria. Variables common to both crossing technologies which
were evaluated included assessing physical elements such as landform and subsurface conditions and limitations;
operational components such as workspace requirements, staging area locations, and equipment mobilization; engineering
design; manpower requirements; and ecological restoration. Representative cost comparisons were developed and
correlated with matrices of potential environmental concerns. This comparative analysis can be used as a template to assist
planners, designers and permitting specialists in decision-making relative to application and implementation of these
construction techniques.
Notes: Use in monitoring plan development:
- Not Used

Ref ID: 143
Reprint: In File
Keywords: Habitat/Monitoring/Water/Composition/benthic macroinvertebrates/Water quality
Abstract: State water quality agencies typically impose turbidity standards on pipeline construction across waterbodies primarily because it is a widely used water quality measurement, is easy to determine in the field, and provides instantaneous feedback to regulatory personnel. Often, regulatory personnel will use turbidity data to infer fishery impacts. Turbidity, however, has a lesser biological effect on fish than does its often-related measurement, suspended sediment.

Portland Natural Gas Transmission System (PNGTS)/Northern Ecological Associates, Inc. (NEA) used established engineering models and grain size analysis to conduct a detailed study of turbidity and suspended sediment dynamics caused by pipeline construction across streams. To predict total suspended sediment (TSS) distribution and transport, PNGTS/NEA developed scenarios for typical waterbody crossings by assuming representative stream characteristics including: width, cross-sectional area, bed composition, mean velocity, estimated transport distances, material lost during excavation, and the increases in suspended solids expected downstream of the crossing. PNGTS/NEA used sediment grain size analyses that were collected from representative stream crossings as input parameters in the model. PNGTS/NEA’s estimates were then input into Trow's 1996 model to estimate sediment dispersion for three stream types: low, medium, and high energy. Predicted suspended sediment values were then used to determine lethal and sublethal fishery impacts using Newcombe and Jensen’s mathematical model which assigns a Severity of Ill Effect (SEV) value for fish species guilds based on does (TSS/ml) and duration (hours) of exposure. The results of this analysis were used in negotiations with state regulatory personnel to help describe potential realistic fishery impacts, rather than hypothetical effects that may be caused by elevated turbidity values.

Notes: Use in monitoring plan development: Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method


Ref ID: 88
Reprint: In File
Keywords: North Slope/Composition/Prudhoe Bay/Habitat/Kuparuk/Monitoring
Abstract: As part of an ongoing program to monitor the use of flood mine sites by fish, we continued and expanded fyke net and gill net sampling in 1989. This annual progress report on the gravel mine site project presents information on the species composition and length-frequency distribution of fish captured at six flooded gravel mine sites in the Prudhoe Bay and Kuparuk oilfield development areas. Earlier progress reports, present background information on the other four sites. The objective of the fish sampling program is to provide information on the seasonal use of several different habitat types resulting from North Slope gravel extraction activities.

Notes: Use in monitoring plan development: Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method


Ref ID: 89
Reprint: In File
Keywords: North Slope/Composition/Prudhoe Bay/Habitat/Fish populations/Alaska/Lakes/Water/Broad Whitefish/Whitefish/Least Cisco/Kuparuk/stream habitat/monitoring/Overwintering Habitat/River/Colville River
Abstract: Fish populations in the mid-Beaufort Region of Alaska’s North Slope are limited by the availability of suitable overwintering habitat. Overwintering habitats on the North Slope are confined to a few scattered deep lakes, spring areas, and river pools that do not freeze solid. In the mid-Beaufort coastal plain area (Colville River to the Sag River), known fish overwintering habitat is limited to several deep isolated pools in the lower Sag and Kuparuk rivers and more extensive areas...
in the Colville River. Flooded gravel mine sites excavated to provide construction material for oil and gas development projects provide habitat suitable for overwintering fish. These man-made lakes are deep enough to retain a large volume of under-ice water with dissolved oxygen concentrations that are at or near saturation during the ice covered season. To determine whether grayling would use the gravel mine site and tundra stream system in a similar manner as do other grayling populations found in tundra stream and deep lake systems, we conducted an experimental fish transplant. In late June 1989, we transplanted 210 large juvenile and adult grayling to Aanaaliq Lakes. Transplant and fish sampling conducted in 1989 are reported in Technical Reports 90-2 and 90-4. In 1990 we sampled Aanaaliq Lakes and East Creek to evaluate the survival, growth, and reproductive success of the transplanted grayling. If we assume that all the grayling captured in 1990 were from the 1989 transplant, then we recaptured 17.1% of the transplanted population. This represents a minimum survival rate for the first year. We found no evidence of grayling reproductive success in 1990 as our fyke net sampling in East Creek and Aanaaliq Lakes failed to capture young-of-the-year grayling. The apparent lack of reproductive success could result from the large population of ninespine stickleback found in Aanaaliq Lake and East Creek. The reduced catch rate in late summer and fall may be due to reduced activity levels during periods with lower water temperatures. It is also possible that as water temperatures decrease, grayling use deeper areas in the lakes and are not effectively sampled with fyke net gear that is not effective in water depths greater than 1.2 m (4.0 ft). Juvenile broad whitefish were found at all fyke net sites fished in June. In August, broad whitefish were captured in East Creek upstream of the lakes, at the inlet, and in the lakes. These data indicate that the lakes and stream habitats near the lakes are used as summer rearing areas for juvenile broad whitefish. These data also indicate that East Creek and Aanaaliq Lakes provide summer rearing habitat for least cisco. These data indicate that downstream movement of ninespine stickleback was occurring in late September as ice was forming on East Creek.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
  - Stressor
  - Physical Process
  - Structural or Physical Changes
  - Functional Response
- Method

Ref ID: 90
Reprint: In File
Keywords: North Slope/Composition/Prudhoe Bay/Habitat/Fish populations/Alaska/Lakes/Water/Broad Whitefish/Whitefish/Least Cisco/Water quality/Monitoring/Arctic cisco/Kuparuk/fish communities/Arctic
Abstract: This progress report summarizes results of tundra stream fish sampling in the Prudhoe and Kuparuk Units on the North Slope oilfields and water quality investigations at the Put 27 Mine Site and Kuparuk Mine Site B and D. Data presented in this report can be used to predict changes in fish community structure that may occur following construction of the proposed projects. The results of water quality monitoring indicate that tundra stream systems in the North Slope oilfield area are suitable for fish production. Fish sampling conducted with fyke net gear in 1991 and 1992 indicates that relatively few fish species use tundra streams in the North Slope oilfield area and fish abundance is low in relation to the amount of rearing habitat available. Ninespine stickleback are the numerically dominant fish species in tundra stream systems. Grayling were found in small tundra streams that are tributary to a large river system (Kuparuk River) with wintering habitat and in similar streams that drain directly to the Beaufort Sea but are located in close proximity to a large river. Anadromous fish that are known to occur in nearshore areas of the Beaufort Sea during the open water season also use small tundra stream systems. Least cisco, broad whitefish, Arctic cisco, and Dolly Varden were captured in small tundra stream systems sampled in this study. The Kuparuk Mine Site B experimental grayling transplant demonstrates that if wintering habitat is available in a small tundra stream system it is possible to introduce freshwater fish common to the area but not found in the drainage.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
  - Stressor
  - Physical Process
  - Structural or Physical Changes
  - Functional Response
- Method

Ref ID: 87
Reprint: In File
Keywords: Prudhoe Bay/Monitoring/Alaska/Habitat/North Slope
Abstract: In 1986, the Alaska Department of Fish and Game (ADF&G) Habitat Division (now Habitat and Restoration Division), initiated a multi-year investigation of flooded gravel sites within the North Slope oilfields. This project developed from a common interest of the oil industry and ADF&G in the potential of abandoned gravel extraction sites as wintering habitat for fish. This report summarizes the results of field investigations conducted in 1993.

Ref ID: 350
Reprint: In File
Keywords: Streams/Monitoring/Habitat
Abstract: It is difficult to quantify in-stream physical attributes of salmonid habitats, yet quantification is necessary if conditions are to be compared within or between streams over time or space. This paper presents an objective method based on hydraulic geometry to quantify hydraulic characteristics of fish habitat. Two small streams in coastal British Columbia provide examples. Morphological mapping and streamflow measurements were used to generate the bivariate distributions of mean depth and mean velocity at cross sections within the study reaches at various discharges. The distributions are used to generate measures of potentially useable area within the streams. Survey criteria and numerical adjustments are presented to improve comparability between channels. The streams respond similarly to a change in discharge. The main hydraulic difference is a decrease in area usefu; in coho salmon (Oncorhynchus kisutch) for rearing at higher discharges in Bonanza Creek (logged) compared with Hangover Creek (unlogged). The example indicates that quantitative comparisons can be made, at comparable flows, between reaches and between streams, or over time.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
  - Stressor
  - Physical Process
  - Structural or Physical Changes
  - Functional Response
  - Method


Ref ID: 195
Reprint: In File
Keywords: Habitat/Lakes/Monitoring/Land use
Abstract: To evaluate effects of habitat modification at different spatial scales, we assessed species richness and tolerance of fish assemblages in littoral zones of 17 Wisconsin lakes with extensive residential and recreational development, and compared fish associations among site specific and lakewide conditions. Samples consisted of combined DC electrofishing and seineing. Stations were randomly selected within strata defined by type of shoreline erosion control structure, including retaining walls, rock riprap, and no structure. Habitat characteristics differed among the site types. Species richness at the site level was greatest in complex habitat (riprap) regardless of fish assemblage structure. However, more effort was required to achieve complete sampling of fish species present in sites without erosion control structures. This result may be related to homogeneity of habitat among sites altered by manmade structures. We used an analysis of covariance (ANCOVA) to compare site level habitat effects with basin scale impacts as indexed by total phosphorus, which is affected by land use in the riparian zone and surrounding watershed. Although species richness is positively correlated with local habitat complexity across the range of lakes sampled, assemblage structure, assessed as proportion of intolerant or tolerant species, shifted in response to cumulative effects. Habitat management programs, such as shore land zoning and permitting, should consider the cumulative effects of small habitat modifications in addition to local effects.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
  - Stressor
  - Physical Process
  - Structural or Physical Changes
  - Functional Response
  - Method


Ref ID: 113
Reprint: In File
Keywords: Petroleum/Monitoring/Water

Abstract: Oil exploration in the northeastern portion of the National Petroleum Reserve-Alaska (NPRA) has been extending farther west and away from existing facilities, which has created challenges for mobilizing equipment to distant exploratory well sites. In this study, we used a two-phase approach to assess the impacts of heavy winter rolligon use on federal lands in the NPRA. Representative photographs of the most common vegetation types with various levels of disturbance are provided in Figures 2 and 3. We attribute the wide range of mean disturbance levels among the vegetation types to differences in topography, plant growth form, and soil conditions. Disturbances in Wet Sedge Meadow Tundra and Moist Sedge-Shrub Tundra were mostly low-level, because these vegetation types occurred on flat to gently sloping topography, were dominated by herbaceous vegetation, and generally had water at or near the soil surface. Consequently, the traffic created only "green" trails caused by the compaction of dead plant material. Moderate-level disturbances were more common in Tussock Tundra, which occurred on upland areas with steeper slopes and considerable micro-relief associated with the tussocks. Thus, rolligon traffic in this vegetation type tended to result in crushed tussocks and some removal of vegetation, creating somewhat more visible "brown" trails. High-level disturbances occurred only in shrub-dominated vegetation types. Moderate- and high-level disturbances in Dwarf Shrub Tundra were highly visible because of the black-grey color of the trails.

Notes: Use in monitoring plan development:
Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 198
Reprint: In File
Keywords: Monitoring/Transportation/Fish Passage/salmonids/Fish populations

Abstract: An outcome of the Washington State Department of Transportation's Juvenile Fish Passage Workshop on September 24, 1997, was agreement that a literature review was necessary to determine the state of knowledge about juvenile salmonid movement and passage through culverts at road crossings. This report summarizes the findings of the literature review. The conclusion of this literature review is that stream dwelling salmonids are often highly mobile. Upstream movement was observed in nearly all studies that were designed to detect it, and in all species, age classes, and seasons. There are variations in the movement patterns of fish populations both between and within river systems. The role of turbulence in affecting the ability of fish to pass through culverts is poorly understood and deserves further investigation. Countersunk culverts have proved to be better for fish passage than culverts with or without other modifications for fish passage.

Notes: Use in monitoring plan development:
Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 140
Reprint: In File
Keywords: Alaska/Monitoring

Abstract: Culverts are a very simple hydraulic structure. However, because the engineer must design for peak flows passing through the culvert while fish are trying to move upstream serious problems arise. Almost all culvert installations in interior and northern Alaska were casually examined, with approximately 100 examined in detail where hydraulic problems existed that may retard fish passage. Data from the field program are included in an appendix to this report. The two major hydraulic problems in regard to fish passage were high velocities and perching; inlet drops caused by deposited sediment, aufeis, alignment of culvert with stream, and non-uniform culvert slopes are some of the other fish passage deterrents that were observed. Also, all known baffled structures were evaluated. Numerous recommendations were made that should improve the hydraulic conditions that exist at a culvert relative to fish passage. Also, it is recommended that further studies be carried out to evaluated the swimming performance of the native fish. Present design criteria are based on very limited studies. Lastly, it is recommended that the concept of the velocity in the occupied zone (area in culvert where fish swim) be considered as the culvert design velocity for fish passage in place of the presently used average cross-sectional velocity.

Notes: Use in monitoring plan development:
Not Used

Abstract: A two year study of fish passage through the Fish Creek culvert, located at Mile 132.2 of the Denali Highway, was carried out by an interdisciplinary task force. The purposes of this study were multifaceted: study the behavior of spawning Arctic grayling (Thymallus arcticus) in this drainage, monitor the interaction of the spawning Arctic grayling and the existing culvert, and document variables of watershed hydrology (primarily runoff) and hydraulic behavior of the culvert that may impact fish passage. Weirs were placed across the stream to determine the temporal distribution of fish movement, to measure both fish length and weight, and to capture fish for tagging. Measurements of water temperature, water chemistry and discharge were made. Numerous velocity measurements at various cross-sections within the culvert and water surface slopes upstream, through the culvert and downstream were also made. The performance of fish passing through the culvert was visually observed at the inlet and outlet of the culvert in 1987 and at the inlet, outlet and through the barrel in 1988. Experimentation with radio-tagged fish was carried out both years. In summary, Arctic grayling (for the two years of the study) encountered minimal difficulty in passing upstream through the culvert. The major areas of difficulty for the fish were entering the slightly perched culvert and exiting where nonuniform flow existed. The peak runoff events were below the mean annual flood. Because the snowmelt floods were low, researchers were able to construct scaffolding in the culvert to visually evaluate fish performance. Rates of movement through the culvert barrel varies from less than a minute to over 80 minutes. Generally, larger fish moved through more rapidly than smaller fish. In any case, all fish stayed as close to the boundary of the culvert as possible, and they orientated themselves normal to this boundary; meaning that they were not always swimming in a vertical position. The radio tagged experiment was only minimally successful the first year. During the second year, much better results were obtained.

Notes: Not Used


Abstract: We assessed fine-scale behavioral responses of the smolts of four Pacific salmonid species to open and constricted channels in a flume. Natural migrants encountered two geometrically similar parallel channels with different hydraulic conditions representing constricted and open treatments. Observation of route selection under alternate discharge scenarios provided evidence of behavioral choice by smolts. As expected, the majority of smolts passed through the open channel in a ratio consistent with flow. After controlling for the influence of flow, both initial channel selection and subsequent channel rejection was higher for the constricted channel; rejection was probably due to fish detecting an area of rapidly accelerating flow. The majority of smolts traveled downstream headfirst and faster than the mean midcolumn water velocity. Those that faced the flow passed at a slower rate and tended to select the open treatment. The few yearling Chinook salmon Oncorhynchus tshawytscha and coho salmon O. kisutch smolts that did not pass through the treatment channels, but held position within the flume, were larger than their conspecifics that passed downstream. Large steelhead (anadromous rainbow trout O. mykiss) smolts and subyearling Chinook salmon were more likely to pass the constricted channel than smaller fish. These results suggest that efforts to effectively guide fish with diversion structures will require understanding how the structures alter the local hydraulic environment and, thus, influence fish behavior.

Notes: Not Used
Ref ID: 200
Reprint: In File
Keywords: Monitoring/Ecology/Transportation
Abstract: Sediment is mechanically removed from river channels in Washington State for a variety of reasons: to improve navigation, agricultural drainage, flood control, channel stability, and production of construction aggregate. In this white paper we review the scientific information regarding the effects of these activities.
Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method

Ref ID: 46
Reprint: In File
Keywords: Alaska/gravel sources/National Petroleum Reserve (Alaska)/Monitoring/North Slope/Natural resources/Transportation/Arctic/Arctic regions/Arctic Region
Abstract: This appendix describes alternatives to gravel for construction of embankments in the North Slope of Alaska, particularly in NPR-A in a brief technical paper, prepared simultaneously with the EA. In order to achieve full development of the natural resources of NPR-A, construction of extensive surface transportation facilities, drill pads, work pads, and similar structures must be considered a reality. Historically, in the NPR-A, surface facilities have primarily included temporary and experimental installation; however, these facilities are only the beginning of the development networks required to market the energy resources of the NPR-A. It is the intent of this paper to discuss current aspects of alternatives for the above mentioned structures that are associated with the full development of this area. Broadly speaking, these alternative include: 1) Sands and silts with synthetic fabric and membrane insulating materials, and chemical binders; 2) Light weight aggregate (LWA products); 3) Mats (aluminum, plastic, fiberglass, and steel, and treated and fiberglass coated plywood); 4) Winter roads, (winter trails, snow roads, and ice roads); 5) Quarries, and; 6) Piles. The present experimental and exploratory embankment and similar structural designs and construction in NPR-A recognizes the perennially frozen subsoil characteristics, commonly referred to as permafrost. This paper includes a review of analysis of some of the gravel alternatives for design and construction of structures over permafrost and active frost layers and the problems resulting from the thaw of the permafrost within the active layer of unstable soil materials as often observed on the Arctic regions in NPR-A. This paper presents, in general terms, the consideration for embankment design, construction and maintenance and focuses in detail on certain special topics and techniques resulting from the writer's and others experiences in these Arctic regions. It is not an engineer's design manual, but a presentation of available materials and techniques as considered from an engineering point of view that may be used and have been used in the NPR-A region of the Arctic.
Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method

Ref ID: 221
Reprint: In File
Keywords: impact assessment/Monitoring/Habitat/Streams/Water/Water quality/Composition/River
Abstract: Pipeline crossing construction alters river and stream channels, hence may have detrimental effects on aquatic ecosystems. This review examines the effects of crossing construction on fish and fish habitat in rivers and streams, and recommends an approach to monitoring and assessment of impacts associated with these activities. Pipeline crossing construction is shown to not only compromise the integrity of the physical and chemical nature of fish habitat, but also to affect biological habitat (e.g., benthic invertebrates and invertebrate drift), and fish behavior and physiology. Indicators of effect include: water quality (total suspended solids TSS), physical habitat (substrate particle size, channel morphology), benthic invertebrate community structure and drift (abundance, species composition, diversity, standing crop), and fish behavior and physiology (hierarchy, feeding, respiration rate, loss of equilibrium, blood hematocrit and leukocrit levels, heart rate and stroke volume). The Before-After-Control-Impact (BACI) approach, which is often applied in Environmental Effects Monitoring (EEM), is recommended as a basis for impact assessment, as is consideration of site specific sensitivities, assessment of significance, and cumulative effects.

Appendix D. Annotated Bibliography 73
Reprint: In File
Keywords: Monitoring/Water
Abstract: Natural gravel bed channels commonly contain a fine mode of sand and fine gravel that fills voids of the bed framework of coarser gravel. If the supply of fine bed material exceeds the storage capacity of framework voids, excess fine material forms surficial patches, which can be voluminous in pools during low flow. Data collected in 34 natural channels in northern California and southern Oregon indicate the following. (1) Fine material on the bed surface can be readily winnowed and transported at high particle velocities, much of it in intermittent suspension. Fine material can dominate the bed material load in gravel bed channels, but its abundance on the bed surface is limited by its increasing mobility as hiding places among prominent particles are filled. (2) Fine material in pools is typically replaced many times per year. (3) The proportion \( V^* \) of residual pool volume filled with fine bed material correlates with annual sediment yield in channels whose parent material produces abundant sandy sediment. (4) Temporal and spatial changes in \( V^* \) appear to correspond to variations in the balance between sediment inputs and water discharge. These results suggest that \( V^* \) can be used to monitor and evaluate the supply of excess fine material in gravel bed channels and that samples of fine material in pools can characterize the fine, mobile mode of bed material load.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Reprint: In File
Keywords: Turbidity/Habitat/Water/Water quality/Monitoring/Alaska
Abstract: There currently exists some disagreement about the value of turbidity as a water quality criterion and standard (Pickering 1976, Wilber 1983). However, to date there has not been a detailed interpretation of available information regarding the specific effects associated with turbidity in aquatic systems. The purpose of this paper is to review and interpret recent information on turbidity as it relates to freshwater aquatic habitats in Alaska, and to provide guidance for establishing reasonable water quality standards to protect aquatic habitats from potentially adverse effects of human-induced turbidity. Largely at issue is whether or not turbidity should be retained as a simple and effective indicator of light penetration and suspended sediment concentration, to be used a statewide water quality standard in regulating the discharge of wastewater to freshwater aquatic habitats.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Reprint: In File
Keywords: Turbidity/Water/Water quality/Habitat/Alaska/Monitoring
Abstract: Evidence both of trophic level changes induced by reduction in light penetration and of more direct effects of sediment and turbidity on aquatic life indicates that turbidity constitutes a valid and useful water quality standard that can be used to protect aquatic habitats from sediment pollution. A review of studies conducted in Alaska and elsewhere indicated that water quality standards allowing increases of 25 or 5 nephelometric turbidity units above ambient turbidity in clear
coldwater habitats provide moderate and relatively high protection, respectively, for salmonid fish resources in Alaska. Even stricter limits may be warranted to protect extremely clear waters, but such stringent limits apparently are not necessary to protect naturally turbid systems.

Notes: Use in monitoring plan development: Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 276
Reprint: In File
Keywords: Turbidity/Water/Alaska/Monitoring/Lakes/Streams/Arctic/Arctic grayling/Water quality/Habitat
Abstract: Turbidity results from the scattering of light in water by organic and inorganic particles; however, high turbidities usually are caused by suspended inorganic particles, particularly sediment. For several Alaskan lakes, we found that the depth to which 1% of subsurface light penetrated had a strong inverse correlation with sediment-induced turbidity. We also developed a model that describes the decrease in primary production in shallow interior Alaskan streams caused by sediment-induced turbidity. Euphotic volume in lakes correlated strongly with production of juvenile sockeye salmon (*Oncorhynchus nerka*). We also observed reduced abundance of zooplankton, macroinvertebrates, and Arctic grayling (*Thymallus arcticus*) in naturally and artificially turbid aquatic systems. Turbidity measurements correlated less consistently with measures of suspended sediment concentration (total nonfilterable residue), but provided an adequate estimator for use as a water quality standard to protect aquatic habitats.

Notes: Use in monitoring plan development: Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 211
Reprint: In File
Keywords: Biological Assessment/Fish Passage/Habitat/Monitoring/Turbidity
Abstract: Enclosed is a biological opinion prepared by the National Marine Fisheries Service (NOAA Fisheries) pursuant to Section 7 of the Endangered Species Act (ESA) for the Commercial Street Weir and Fish Ladder Reconstruction on Pringle Creek in Salem, Oregon. NOAA Fisheries concludes that the proposed action is not likely to jeopardize Upper Willamette River chinook salmon or steelhead. Pursuant to Section 7 of the ESA, NOAA Fisheries has included reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to minimize the potential for incidental take associated with this project. Included in the ESA biological opinion is a consultation on the effects of the proposed action on Essential Fish Habitat, pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act and its implementing regulations (50 CFR Part 600).

Notes: Use in monitoring plan development: Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 101
Reprint: In File
Keywords: Monitoring/Plants/Stream Crossings/River
Abstract: At the end of the year 2000 growing season, the vegetation at the Ublutuoch River crossing appeared much as it did prior to the construction of the ice road. The majority of the willow plants within the path of the ice road appeared quite
normal. The few effects from the ice road on the tall willow plants included: 1) Breaking a few twigs at the tops of plants in select portions of the stand; 2) Within the ice road path, crushing about 12 to 16% of clumps on the east side of the river and 2 to 2.4% of the clumps on the west side of the river. These crushed plants were all confined to the outer margin of their respective communities, i.e. near the edge where the ice road encountered the stands. 3) Out of an estimated population of 650 to 800 plants encountered by the ice road, two plants were killed on the east side of the river. None on the west side of the river were killed. 4) Spring leaf out and flowering was delayed 3-4 weeks for will plants at the margins of the stands, the same locations where willows were broken and a few killed. The only other effects to vegetation were two scrapes on the bank of the river. These were insignificant, because plants survived within the scrapes. Peat near the valley brink on the east side of the crossing was also scraped to a minor extent. It is believed that all these effects will recover naturally, and no vegetation actions are warranted. How the ecosystem will respond to fill the openings where the two willow plants died remains unclear. Tall willow may reoccupy those niches. Perhaps other plant species will invade. It would be instructive to mark the locations where the two plants died and then for a few years annually examine and record the vegetation responses. A suggestion of how to better photographically record ice road damages on tall willow in the future is offered.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 105
Reprint: In File
Keywords: North Slope/Monitoring/Alaska/Petroleum/Prudhoe Bay/Water/Broad Whitefish/Whitefish/Least Cisco/Habitat
Abstract: Alaska's North Slope was opened to petroleum development after the 1968 oil discovery at Prudhoe Bay. With development came a substantial demand for construction gravel for exploration and development pads, roads, and general infrastructure. Gravel extraction is one component of the surface impacts resulting from oil and gas development on the North Slope. Gravel mine sites created to provide construction material for oil and gas development are likely to become deep-lake features at the end of their useful lives as gravel material sources. These mine sites typically are deeper and larger than many of the known over wintering sites for anadromous and freshwater resident fish. Recognizing the enhancement potential of flooded gravel mine sites, the ADF&G initiated a multi-year investigation of North Slope oilfield flooded gravel mine sites in 1986. The ADF&G's four-year field study found that flooded gravel mine site were colonized by two or more fish species. The greatest species diversity and relative abundance occurred in sites located within the floodplains of large river systems. Mine sites associated with small tundra streams draining directly into the Beaufort Sea were colonized by nininespine stickleback (Pungitius puntitius) and anadromous fish species such as broad whitefish (Coregonus nasus) or least cisco (Coregonus sardinella) that occur in the nearshore Beaufort Sea and were affected by time. Older sites tended toward greater species diversity than younger sites. The studies found most of the mine site basins lacked littoral habitat, an important factor for benthic community development and warmer water temperatures preferentially used by rearing fish such as Arctic grayling. The ADF&G's preliminary conclusion is that smaller sites that can be reclaimed as part of a single project during a shorter time frame may offer a greater and more immediate enhancement benefit to fish and wildlife than multi-user, long-term sites that may not be reclaimed for 20 to 30 years. Concurrent with other investigators, the ADF&G has concluded that, with proper design, positive impacts that are beneficial to wildlife can be obtained from the reuse of fill material.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 106
Reprint: In File
Keywords: benthic macroinvertebrates/bioassessment/Biological monitoring/Habitat/pebble counts/salmonids/sculpins/stream habitat/Water quality/Monitoring
Abstract: The purpose of this article is to report on the testing of responses of multimetric macroinvertebrate and habitat indices to common disturbances to streams: stream habitat alteration, excessive sediment, and elevated metals concentrations. Seven macroinvertebrate community metrics were combined into a macroinvertebrate biotic index (MBI), and 11 channel morphology, riparian, and substrate features were combined into a habitat index. Indices were evaluated by comparing the habitat results to fish population surveys and comparing the macroinvertebrate results to habitat ratings, percent fine sediments measured by Wolman pebble counts, and copper concentrations. Macroinvertebrate scores decreased with increasing percentages of fine sediments measured either across the bankfull or instream channel widths.
Macroinvertebrate scores decreased with increasing copper. One metric, richness of Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa, was more responsive to both copper and sediment than was the multimetric MBI. Habitat scores corresponded well with the age class structure of salmonids, but not with that of benthic sculpins. Both salmonid and sculpin age classes declined with increasing percentages of fine sediments. The decline was graded with the sculpin age classes, whether fine sediments were measured across the instream or bankfull channel, whereas salmonids consistently responded only to the instream fine sediments.

Notes: Use in monitoring plan development:
- Not Used

Baseline Data

Model Development

Stressor

Physical Process

Structural or Physical Changes

Functional Response

Method

Ref ID: 220
Reprint: In File
Keywords: Alaska/Environmental Assessment/Monitoring/National Petroleum Reserve/Petroleum
Abstract: The following information is submitted in an effort to assist the U.S. Geological Survey (USGS) in producing Environmental Assessment Reports (EAR's) and The Annual Plan of Operations (PO) for the National Petroleum Reserve in Alaska (NPR-A). An effort has been made to condense information and to provide data pertinent to EAR/PO preparation. Additional environmental information and methods for data collection are available from Bureau of Land Management (BLM) NPR-A offices in Fairbanks. The Draft Annual Plan of Operations (DPO) for the 1978-79 season has been used as the guideline for summer assessment studies for the preparation of the assessment information and comments provided herein. Additional guidance from USGS Anchorage has been helpful in setting priorities for assessment detail needed for specific sites being excluded from the PO or for which there are particular problems.
Notes: Use in monitoring plan development:
- Not Used

Baseline Data

Model Development

Stressor

Physical Process

Structural or Physical Changes

Functional Response

Method

Ref ID: 37
Reprint: In File
Keywords: Alaska/Habitat (Ecology)/Land use/National Petroleum Reserve/National Petroleum Reserve (Alaska)/Petroleum/Planning/Subsistence economy/Traditional ecological knowledge/Wildlife management/Monitoring
Abstract: This symposium brings together leading experts on the land's resources and their uses by Natives and newcomers. Because some special-interest groups, the public in general, and State and Federal agencies have concerns regarding oil and gas exploration and development in the NPR-A, which is a possible result of the IAP/EIS, the symposium will focus special attention on oil and gas activities and their potential impacts on resources.
Notes: Use in monitoring plan development:
- Not Used

Baseline Data

Model Development

Stressor

Physical Process

Structural or Physical Changes

Functional Response

Method

Ref ID: 204
Reprint: In File
Keywords: Monitoring/Streams
Abstract: Bed scour, egg pocket depths, and alteration of stream-bed surfaces by spawning chum salmon (Onchorhynchus
keta) were measured in two Pacific Northwest gravel-bedded streams. Close correspondence between egg burial depths and scour depths during the incubation period suggests an adaptation to typical depths of bed scour and indicates that even minor increases in the depth of scour could significantly reduce embryo survival. Where egg burial depths are known, expressing scour depth in terms of bed-load transport rate provides a means for predicting embryo mortality resulting from changes in watershed processes that alter shear stress or sediment supply. Stream-bed alteration caused by mass spawning also may influence embryo survival. Theoretical calculations indicate that spawning related bed surface coarsening, sorting, and form drag reduce grain mobility and lessen the probability of stream-bed scour and excavation of buried salmon embryos. This potential feedback between salmon spawning and bed mobility implies that it could become increasingly difficult to reverse declines in mass spawning populations because decreased spawning activity would increase the potential for bed scour, favoring higher embryo mortality. Further analysis of this effect is warranted, however, as the degree to which spawning-related bed loosening counteracts reduced grain mobility caused by surface coarsening, sorting, and reed form drag remains uncertain.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 108
Reprint: In File
Keywords: Alaska/Broad Whitefish/Ecology/Habitat/Humpback Whitefish/Lakes/Monitoring/National Petroleum Reserve/National Petroleum Reserve (Alaska)/Natural resources/North Slope/Petroleum/Planning/Whitefish/Wildlife management/Arctic/Arctic grayling
Abstract: In 2001, a collaborative effort among the North Slope Borough Wildlife Management Department, MJM Research, LLC., ConocoPhillips Alaska, Inc., and the Alaska Department of Natural Resources, Office of Habitat Management and Permitting (OHMP) (at the time Habitat Division, Alaska Department of Fish and Game) initiated a project to identify the seasonal movement patterns of fish and their use of specific habitats for wintering, spawning, and rearing within the eastern portion of the northeast planning area of the National Petroleum Reserve-Alaska (NPR-A). Three species of fish, broad whitefish (Coregonus nasus), Arctic grayling (Thymallus arcticus), and burbot (Lota lota) were identified as the focus of this research effort. To accomplish the goals set forth for this project, we determined that radio-telemetry techniques would be most effective. Using relocation surveys and data from individual radio-tagged fish, it would be possible to sample large areas and many habitat types in a relatively short period of time. Use of tundra lakes and small tundra drainages was significant for all species investigated. Relocation results reflected the relative productivity of each system and offered insight into the role each system and respective habitat type plays in the annual ecology of fish in the region. The Ublutuoch River is used by all species for wintering, feeding, and likely for spawning by burbot and broad whitefish. Broad whitefish exhibited the most complex movement patterns of the species radio-tagged in this study. Main channel habitats within Fish and Judy creeks are used most heavily as migration routes to lakes and small tundra drainages by broad whitefish and Arctic grayling, and as migration routes to and from wintering and spawning areas.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 83
Reprint: In File
Keywords: Alaska/Fish Passage/Prudhoe Bay/Streams/Monitoring
Abstract: Fyke nets were set throughout Fawn Creek during summer 2004 to investigate the effectiveness of crossing structures for fish passage. In July, nets were fished upstream and downstream from the four lowest stream crossings of Fawn Creek and upstream from the upstream-most crossing. During August, only 3 crossings were sampled. We also fished a net in D Pad Lake at the head-waters of the Fawn Creek system in August. During July we expended over 1000 net-hours of effort and over 325 net-hours were fished in August. Fish were captured above and below most crossings; however, catch rates were highest in the lower portion of the system and generally highest downstream from crossings. Only one, exceptionally large, fish was captured above the Spine Road crossing and no fish were captured above the fifth (upstream most) crossing or in D Pad Lake. The stream crossings of Fawn Creek appear to be reducing the upstream extent of use in
the system by fish, but the Spine Road crossing presents the most complete blockage to fish passage. Additional sampling and a system wide effort evaluating the potential for rehabilitation of the five crossings is recommended with emphasis on the Spine Road and upstream-most crossings.

Notes: Use in monitoring plan development: Not Used

Baseline Data
Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method


Reprint: In File

Keywords: Prudhoe Bay/Alaska/Lakes/Habitat/Natural resources/Water/North Slope/Broad Whitefish/Whitefish/lake trout/Monitoring

Abstract: With the shift in seismic exploration techniques from use of explosives to the use of air gun arrays and vibroseis vehicles as the primary energy sources for seismic exploration in northern Alaska, risk to fish from seismic exploration has been greatly reduced. However, there have been concerns that these techniques may be harmful to fish and aquatic mammals. In consultation with the Bureau of Land Management, North Slope Borough, individuals from the communities of Barrow and Nuiqsut, and WesternGeco, the Office of Habitat Management and Permitting (OHMP) developed a two part study to directly address the potential impacts to fish from vibroseis. Results from the experimental tests provide little evidence that energy imparted to water bodies by vibroseis equipment will harm fish. Our results found no indication that vibroseis cause acute mortality in fish or causes injury to fish that would later cause mortality. The behavioral response of wintering fish, primarily broad whitefish, to vibroseis noise is extreme but short in duration and appears to reduce in intensity with multiple exposures over a short period of time. However, the magnitude and vigor of the flight response observed suggests that multiple exposures over a winter season to vibroseis noise could have significant energetic consequences to wintering fish. Managers can safely authorize seismic programs on fish wintering areas but should require that exposure be limited to work that can be conducted within one or two hours from initial sweep of the vibroseis rigs. It is still advisable to avoid wintering areas where possible; however, by limiting exposure, managers can be confident that they are being conservative and decreasing the likelihood of fish winter mortality. Lakes containing especially sensitive fish at risk during winter, such as lake trout, probably should be avoided in general, but clearly should not receive long duration vibroseis activity during winter.

Notes: Use in monitoring plan development: Not Used

Baseline Data
Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method


Reprint: In File

Keywords: Habitat/Broad Whitefish/Whitefish/Petroleum/Monitoring/Alaska/Lakes/Humpback Whitefish/Wildlife management/Natural resources/North Slope/Streams/River/Subsistence/Barrow/Aqtasuk/Arctic/Arctic graying

Abstract: Teshekpuk Lake is located within the National Petroleum Reserve-Alaska in the northwestern portion of the North Slope of Alaska. This region of lakes and streams connected to Teshekpuk Lake via the Mayoriak River and the Ikiapkuk River has been and remains an area of substantial subsistence fishing for residents of Barrow and Aqtasuk. Arctic graying (Thymallus arcticus), burbot (Salvelinus namaycush), humpback whitefish (Coregonus pidschian), pink salmon (Oncorhynchus gorbuscha), chum salmon (Oncorhynchus keta), and less frequently, sockeye (Oncorhynchus nerka) and Chinook (Oncorhynchus tshawytscha) salmon are captured throughout the summer fishing season which extends from ice-out through early freeze-up. However, broad whitefish (Coregonus nasus) are harvested most significantly by subsistence users. Radio tracking of broad whitefish in the Teshekpuk Region from 2003 to 2005 has lead to a clearer picture of the species use of the area and has also contributed information as to how the species can be harvested at reasonably high levels from the drainages around Teshekpuk Lake with no apparent detriment to the population. Based on these data, it is apparent that the population of broad whitefish is so widely dispersed at any given time that significant portions of the population are not available for harvest during any one year, and therefore, over harvest is unlikely. Broad whitefish distribute widely throughout area drainages and use virtually all habitats available during some period of the year.
Reprint: In File
Keywords: North Slope/Monitoring/Streams/Stream Crossings/Kuparuk/Water
Abstract: Since 1988, new culverts and bridges have been installed as oilfield infrastructure expanded, culvert installations have been repaired or replaced, and bridges have been modified in light changing stream conditions. As a result of these additions and changes to the inventory of stream crossing structures in the oilfields, along with additional information regarding fish distribution within oilfield streams, we resurveyed, beginning in summer 2004, the stream crossings of the original survey, along with structures installed since 1988 and some that were not surveyed in 1988. The report is organized on a geographic basis within the oilfields from Endicott in the east to Meltwater in the western Kuparuk area. Crossing structures in the Badami or Alpine fields were not examined. Breaches in the Endicott and West Dock causeways also were not examined in the field review. Culverts used exclusively for cross drainage that did not involve fish-bearing or suspected fish bearing waters were also not examined.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref Type: Journal (Full)
Ref ID: 230
Reprint: In File
Keywords: Alaska/Arctic/Arctic cisco/Ecology/Fishes/Habitat/Monitoring/Nearshore Habitat/Recruitment/Water/Beaufort Sea Coast/River/Prudhoe Bay/Colville River/Sagavanirktok
Abstract: In 1985, westward movement along the Beaufort Sea coast between Kay Point, Yukon Territory, and the Colville River, Alaska, was documented for young-of-the-year arctic cisco. The observed movement pattern closely paralleled the recruitment pattern previously hypothesized. The westward movement and recruitment into the Colville Delta was facilitated by persistent easterly winds in the early and middle parts of the open-water season. Larger-bodied members of the age group arrived at the deltas of the Colville and Sagavanirktok Rivers first, with smaller fish arriving later. In 1986, recaptures at Kay Point of eight adult arctic cisco previously tagged near Prudhoe Bay provided further direct evidence of the exchange of this species between Prudhoe Bay and the Mackenzie River region.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Reprint: In File
Keywords: Monitoring/Arctic/Arctic cisco/Least Cisco/Bering cisco/Prudhoe Bay
Abstract: The objectives of the 1997 study were to 1) continue obtaining estimates of effort and catch for the commercial gill net fishery in the delta, which targets arctic cisco, 2) evaluate harvest predictions made prior to the fishing season, and 3) evaluate methods for improving harvest predictions. Similar to previous years, a daily count was made of fish caught in each net fished during the season, which ran from October 13 to November 14. The 1997 fishery was characterized by a relatively high catch rate on arctic cisco throughout the season, with the average unadjusted catch rate (62.8 fish per day) being 14% above the recent 10-year average. This catch rate, however, is a decrease from 1996, which produced 120.2 fish per day. The least cisco catch was the highest since 1990. Effort was up 39% from that recorded in 1996, however, the lower catch...
rate resulted in an arctic cisco catch 22% lower than the previous year. Bering cisco, which had been unusually abundant in 1990, remained at an incidental level in 1997. The effort-adjusted catch rate of arctic cisco between 300-340 mm (76-mm mesh only) was 61 fish per day compared to a pre-season prediction of 55 fish per day. It was expected that the catch would be composed of the 1990 and 1992 year classes. These year class contributed approximately 84% of the catch, with the 1991 year class contributing an additional 12%. The prediction for 1998 is for a slight increase in the arctic cisco CPUE, to about 67 fish per 45-m net day. This prediction is based on the correlation of commercial catch rate with Prudhoe Bay fyke net catches, the observed 1997 fyke net catch of fish between 260-300 mm, and the likelihood that a substantial number of 1992 year class fish will recruit into the fishery as age 6 fish.

Notes: Use in monitoring plan development:
- Not Used

Baseline Data
- Model Development
  - Stressor
    - Physical Process
    - Structural or Physical Changes
  - Functional Response
- Method


Ref ID: 109
Reprint: In File
Keywords: Freshwater fishes/Fishes/Alaska/Arctic/Habitat/Oil fields/Water/Ecology/Lakes/Fish populations/Monitoring

Abstract: Oil development currently poses little risk to freshwater fish species because (1) freshwater habitat capable of supporting fish year-round is in limited supply in the oil fields compared to other nearby regions and (2) the design and placement of facilities, such as bridges and culverts or water withdrawal facilities, have incorporated features to minimize impacts to those populations that are present. The major freshwater systems, such as the Sagavanirktok, Colville, and Canning river systems, lie outside or adjacent to the oil-field region. As the oil-field region grows with the development of new fields, additional information on freshwater fishes will be needed to ensure that development continues to proceed with minimal impact to the populations. Oil-field expansion currently is planned westward and southward of existing oil fields into areas more heavily used by freshwater species. Information on fish species present and the annual pattern of habitat use by the populations encountered will likely be needed on a project-specific basis to adequately plan for oil-field development.

The routes and timing of migration and dispersal into different habitats are of particular importance. Although considerable information has been collected on overwintering requirements of freshwater fish, this subject still remains one of the least understood aspects of arctic fish ecology. Both development programs and fish need fresh water in winter, and these needs are usually in conflict. A better understanding of winter habitat requirements of freshwater fishes, particularly in shallow coastal plain lakes, would assist in designing water withdrawals that do not adversely affect fish populations.

Notes: Use in monitoring plan development:
- Not Used

Baseline Data
- Model Development
  - Stressor
    - Physical Process
    - Structural or Physical Changes
  - Functional Response
- Method


Ref ID: 9
Reprint: In File
Keywords: Fishes/Habitat/Alaska/National Petroleum Reserve/Fish surveys/Petroleum/Fish populations/Monitoring/River/Streams/Nuiqsut/North Slope/Water/Lakes/Arctic/Arctic grayling/Humpback Whitefish/Whitefish/Broad Whitefish/Least Cisco

Abstract: The present study was the first detailed examination of fish populations in the drainages of eastern NPR-A. The study was designed to provide details of fish populations in eastern NPR-A (Figure 1), and the habitats used by those populations, so that oilfield facilities can be sited, designed and constructed in a manner that will avoid or minimize impacts. Specific objectives of the 2001 fish survey were to conduct studies on the Fish Creek and Ublutuoch River drainage systems to: a) describe the fish populations and habitat use patterns within the streams, b) obtain information on fish movements within the drainages, and c) document the recovery of tagged fish in both study nets and the Nuiqsut fishery from different release locations. The study included cooperative efforts among PHILLIPS Alaska, the North Slope Borough (NSB) and Alaska Department of Fish and Game (ADF&G). An additional objective was to provide fish for radio-tagging by ADF&G.

The sampling in eastern NPR-A during 2001 indicated that the main river channels of Fish and Judy Creek are sparsely used by fish during the summer and likely serve primarily as migration corridors for fish moving between various other habitats, such as clear water streams, tapped lakes and perched lakes. The unstable channels of Fish and Judy creeks likely limit productivity, and the prey is probably limited compared to other habitats. The Ublutuoch River, in contrast to Fish and Judy creeks, is heavily used by arctic grayling, humpback whitefish and broad whitefish, with round whitefish and least cisco also present during summer. A high percentage of the fish in the Ublutuoch River were large fish. It is likely that this high density of large fish reduces the value of the drainage as a rearing area as predation is likely to be intense. Arctic
graying, round whitefish and least cisco, in particular, are known to be opportunistic feeders that prey heavily on young fishes. Lakes connected to the rivers also provide important fish habitat, as evidenced by the heavy use of the tapped lake MC7916, and the perched lakes M9909 and M9910. The value of the lake increases as predictability of access increases. Access to lake M9911 was apparently less frequent than that for the other two perched lakes as few fish were caught. Inadequate access is likely the cause for the low fish densities because the lake has a maximum depth of 15.3 feet, which should be adequate to overwinter fish that gain access.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Reprint: In File
Keywords: Fishes/Habitat/Alaska/National Petroleum Reserve/Fish surveys/Lakes/Petroleum/Fish populations/Water/Monitoring
Abstract: ConocoPhillips Alaska Inc. (CPAI) has been exploring for oil within the eastern portion of the National Petroleum Reserve–Alaska (NPR-A) since the winter of 1999/2000. Significant oil reserves have been located in the region, and the feasibility of developing a producing field in the area is being investigated. Part of the evaluation process includes assessing the potential environmental impacts. The inventory of fish and fish habitat provides information for assisting permitting decisions regarding road and pipeline routing. In addition, streams in the area may be crossed by ice roads, so an understanding of potential overwintering areas is also desirable. A key element of the study is identifying movements and distribution of fish utilizing the stream systems. The present study was the first detailed examination of fish populations in the drainages of eastern NPR-A. The study was designed to provide details of fish populations in eastern NPR-A and the habitats used by those populations, so that oilfield facilities can be sited, designed and constructed in a manner that will avoid or minimize impacts. Specific objectives of the 2001-2002 fish survey were to conduct studies on the Uvlutuq (Fish Creek) and Tingmiagsiugvik (Ublutoock) River drainage systems: a) describe the fish populations and habitat use patterns within streams and lakes of eastern NPR-A, b) obtain information on fish movements within the drainages, c) document the recovery of tagged fish in both study nets and the Nuiqsut fishery from different release locations, and d) estimate available water in lakes in or near potential development areas. The study included cooperative efforts among ConocoPhillips Alaska, the North Slope Borough (NSB) and Alaska Department of Fish and Game (ADF&G). An additional objective was to provide fish for radio-tagging by ADF&G.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Reprint: In File
Keywords: Fishes/Habitat/Alaska/National Petroleum Reserve/Fish surveys/Petroleum/Water/Lakes/Monitoring/River/Streams/Arctic/Arctic grayling/Humpback Whitefish/Whitefish/Broad Whitefish/Least Cisco
Abstract: Sampling in eastern NPR-A during 2001-2003 indicated that the main river channels of Uvlutuq (Fish Creek) and Iqaliiqiq (Judy Creek) are sparsely used by fish during the summer and likely serve primarily as migration corridors for fish moving between various other habitats, such as clear water streams, tapped lakes and perched lakes. The unstable channels of Fish and Judy creeks likely limit productivity, and the prey is probably limited compared to other habitats. The Tingmiagsiugvik (Ublutoock River), in contrast to Uvlutuq (Fish Creek) and Iqaliiqiq (Judy Creek), is heavily used by Arctic grayling, humpback whitefish and broad whitefish, with round whitefish and least cisco also present during summer. A high percentage of the fish in the Tingmiagsiugvik (Ublutoock River) were large fish. Clear water tributaries to Fish Creek and the Ublutoock River supported high densities of juvenile Arctic grayling. Lakes connected to the rivers also provide important fish habitat. The value of the lake increases as predictability of access increases. Lakes remote from stream systems also supported low densities of juvenile Arctic grayling. The importance of connected lakes as fish habitat was illustrated by the results of the cooperative radio-tag study with ADF&G. Many of the broad whitefish, Arctic grayling and burbot that were radio-tagged by ADF&G in 2001 moved into connected lakes in various portions of the Uvlutuq (Fish Creek)/Iqaliiqiq (Judy Creek)/Tingmiagsiugvik (Ublutoock River) drainage system.
Notes: Use in monitoring plan development:
Not Used
Reprint: In File
Keywords: Fishes/Habitat/Alaska/National Petroleum Reserve/Fish surveys/Lakes/Petroleum/monitoring/Water/Water chemistry/River/Arctic/Arctic grayling/Broad Whitefish/Whitefish/Least Cisco/Streams
Abstract: As part of an effort to determine environmental impacts of oil exploration and development in the eastern National Petroleum Reserve, an inventory of fish and fish habitats was conducted in summer 2004. Twenty-eight lakes were sampled as possible water-source lakes; water chemistry was analyzed and water volume was estimated. Biological sampling by fyke net was done in 19 lakes. Wintering areas in the Tingmiaqsiugvik (Ublutoch River) was performed by bathymetric survey. Sampling in eastern NPR-A during 2004 indicated, as in previous years, that the Tingmiaqsiugvik (Ublutoch River) is heavily used by Arctic grayling and broad whitefish, with round whitefish and least cisco also present during summer. Clearwater tributaries to the Tingmiaqsiugvik (Ublutoch River) that have strong connections to lakes supported high densities of juvenile Arctic grayling, as well as a variety of other species, indicating the importance of these small connected streams as summer feeding areas. Adult Arctic grayling also ascended these small tundra drainages to feed, resulting in some tag recaptures. A substantial portion of the lower Tingmiaqsiugvik (Ublutoch River) contains water deep enough to support wintering fish, with over 10.7 million cubic feet of potential wintering habitat. Use of this reach as a wintering area has been previously documented. Lakes connected to the rivers also provide important fish habitat, as evidenced by the heavy use of connected lakes and associated streams, and results from radio-tagged broad whitefish, Arctic grayling, and burbot. The value of a lake increases as predictability of access increases. Lakes remote from stream systems supported ninespine stickleback, while lakes with seasonal connections to stream systems also supported Alaska blackfish and low densities of juvenile Arctic grayling.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 226
Reprint: In File
Keywords: Habitat/Planning/Lakes/Freshwater fishes/Fishes/Land use/Monitoring
Abstract: Investigations in eastern NPRA have established that lakes connected to stream systems are important as feeding and rearing areas for a variety of freshwater fishes (Morris 2003, Moulton 2005). These studies found that fish frequently ascend even small ephemeral creeks to access lakes during spring and early summer, then leave the lakes to move towards wintering areas in the late summer and fall. The goal of this mapping effort is to identify lakes that have potential to function as fish habitat so that the information will be available 1) for future land use decisions and 2) to aid in the design of fish studies in the region.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 236
Reprint: In File
Keywords: Habitat/Monitoring/Broad Whitefish/Whitefish/Least Cisco/Arctic/Arctic grayling/Water/climate change/Pike/River/Lakes

Abstract: Fish habitats and populations in and around Teshekpuk Lake were investigated during summers 2003 to 2005. Sampling was primarily by fyke net, supplemented by gill net. The area of focused study was selected after obtaining traditional local knowledge and reviewing fishing patterns in the region. While broad whitefish was the primary species of interest, data were obtained on all captured species. Length, weight, age, sex, maturity and stomach samples were obtained for the three dominant species, broad whitefish, least cisco and Arctic grayling. Broad whitefish and Arctic grayling were tagged with T-bar anchor tags. Radio transmitters were implanted in 94 selected broad whitefish. Water depth was measured throughout the study area to identify potential wintering areas. Invertebrate prey species were sampled by Petite Ponar, plankton net and sweep net. Over 200 m² of habitat deeper than 7 feet are present in the main basin of Teshekpuk Lake, while large relict lake basins that form the outlet of the lake provide an additional 21.5 m² of potential wintering habitat. Results from radio-tagged broad whitefish confirmed that the outlet region of Teshekpuk Lake is the most heavily used wintering area within the system, with few radio-tagged broad whitefish using the main basins of Teshekpuk Lake for wintering. There were substantial differences in growth of broad whitefish and least cisco sampled in 2003-2005 when compared to the growth in 1990-1992. The differences were likely a result of the different habitats being sampled in the two time periods. Arctic grayling growth rates between the two periods did not show any difference. At this time, there is no evidence for detectable changes in fish growth or condition that can be attributed to climate change. Heat has historically been a scarce resource in the arctic and fish will, up to a point, seek out warmer habitats to feed and grow, especially when fish are dispersing from wintering areas to begin feeding after the long period of winter fasting. Warmer habitats will have higher primary productivity, which can lead to abundant prey populations. In the Teshekpuk Lake study area, water temperatures at the tributary stations were higher than those at the outlet stream stations during June of both 2003 and 2004. Fish appeared to congregate in these warmer lateral habitats, leading to high catch rates of feeding broad whitefish, least cisco and Arctic grayling. These high concentrations of fish apparently attracted northern pike and burbot. The warm, lateral habitats typified by the tributary mouths contained extensive vegetation beds that support high densities of chironomids and snails, in contrast to the main outlet channel, which contained mostly amphipods. Chironomids and snails proved to be the predominant prey for broad whitefish. Another factor that appears to increase the value of specific tributaries is the extent of connected lake habitat. Radio-tagged broad whitefish moved widely within the Teshekpuk Lake/Ikpikpuk River system. Fish moving into the upper Ikpikpuk region tended to be fish heading for spawning areas, while fish remaining in the outlet region tended to be non-spawning fish. Fish moving into the upper Ikpikpuk overwintered in deep pools near spawning habitats or dispersed to downstream riverine habitats or lakes.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Reprint: In File
Keywords: Fish populations/Monitoring/Alaska/Colville River Delta/Ublutuoch River Region/Fishes/Habitat/Water chemistry/Fish surveys/National Petroleum Reserve (Alaska)/Petroleum/Lakes
Abstract: Sampling in eastern NPR-A during 2006 indicated, as in previous years, that the Timgniaqsugvik (Ublutuoch River) drainage system is heavily used by Arctic grayling and broad whitefish, with humpback whitefish, least cisco and round whitefish also present during summer. Clearwater tributaries to the Timgniaqsugvik (Ublutuoch River) that have strong connections to lakes supported high densities of juvenile Arctic grayling, as well as a variety of other species, indicating the importance of these small connected streams as summer feeding areas. Larger Arctic grayling (in excess of 180 mm) also ascended these small tundra drainages to feed, with individual fish showing fidelity to the same tributary system. It appears that the Timgniaqsugvik (Ublutuoch River) functions primarily as a migratory corridor for many of the larger grayling that are heading for specific stream/lake tributary systems. There is likely a portion of the population that remains within the main river through the summer. A similar pattern likely occurs in broad whitefish that are heading for feeding areas in lakes, although tag returns to date have been too low to validate this conclusion.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Abstract: This document provides guidelines for design of stream crossings to aid upstream and downstream passage of migrating salmonids. It is intended to facilitate the design of a new generation of stream crossings, and assist the recovery of threatened and endangered salmon species. These guidelines are offered by the National Marine Fisheries Service, Southwest Region (NMFS-SWR), as a result of its responsibility to prescribe fishways under the Endangered Species Act, the Magnuson-Stevens Act, the Federal Power Act, and the Fish and Wildlife Coordination Act. The guidelines apply to all public and private roads, trails, and railroads within the range of anadromous salmonids in California.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method

Ref ID: 73
Reprint: In File
Keywords: Alaska/North Slope/Oil fields/Prudhoe Bay/Environmental impact statements/Congresses/caribou/Monitoring
Abstract: Oil and gas production on the North Slope has brought positive and negative consequences-economic, social, and environmental. Environmental consequences of concern include the effects of oil-related structures and activities on the migration of fish and marine and terrestrial mammals, especially bowhead whales and caribou. Also of concern are the effects of oil activities and structures on endangered or threatened species, migratory birds, polar bears and other mammals, and on wildland (wilderness) values. Considerable research has been done on various actual and potential effects of oil and gas activity on the North Slope’s physical, biotic, and human environments. Reviews of this research have appeared in environmental impact statements (EISs), in reports funded by the Department of the Interior and other federal and state agencies, in oil industry publications, in journals, and in National Research Council reports, among others. However, there has been little assessment of the cumulative effects of those activities, the elucidation of which is critical to support informed, long-term decision-making about resource management. To address this lack of information and understanding, the Congress requested that the National Academies review and assess what is known about the cumulative environmental effects of oil and gas activities on Alaska’s North Slope.
Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method

Ref ID: 62
Reprint: In File
Keywords: Alaska/Fishery resources/National Petroleum Reserve/National Petroleum Reserve (Alaska)/Petroleum/Monitoring/Water/Lakes/Whitefish/lake trout
Abstract: Aquatic resources were surveyed during mid-summer in 89 representative waters of the coastal plain of NPR-A north of the Colville drainage. Ninerspine stickleback were the most abundant of the 18 species taken. Species other than stickleback were taken at 51 sites and no fish of any species were taken at 19 sites. Lakes in the eastern half of the study area were deeper and contained greater diversity and abundance of fish than those in the western half. Lakes that were large, deep, clear and with outlets were more likely to contain fish than smaller, shallow, turbid lakes without outlets. Salmon were taken at two sites. Other species of importance to man included cisco, whitefish, lake trout and grayling. Future work should include consolidation of all fisheries information; use of remote sensing techniques; studies of overwintering areas, effects of man’s activities, and other pertinent life history information; development of a NPR-A fishery plan; and continuous close coordination between fishery and water resource studies.
Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method
Appendix D. Annotated Bibliography

Ref ID: 205
Reprint: In File
Keywords: Monitoring/Streams/Fishes/Habitat/impact assessment
Abstract: Resource managers need to predict effects of pollution episodes on aquatic biota, and suspended sediment is an important variable in considerations of freshwater quality. Despite considerable research, there is little agreement on environmental effects of suspended sediment as a function of concentration and duration of exposure. More than 70 papers on the effects of inorganic suspended sediments on freshwater and marine fish and other organisms were reviewed to compile a data base on such effects. Regression analysis indicates that concentration alone is a relatively poor indicator of suspended sediment effects ($r^2 = 0.14$, NS). The product of sediment concentration (mg/L) and duration of exposure (h) is a better indicator of effects ($r^2 = 0.64$, P < 0.01). An index of pollution intensity (stress index) is calculated by taking the natural logarithm of the product of concentration and duration. The stress index provides a convenient tool for predicting effects for a pollution episode of known intensity. Aquatic biota respond to both the concentration of suspended sediments and duration of exposure, much as they do for other environmental contaminants. Researchers should, therefore, not only report concentration of suspended sediment but also duration of exposure of aquatic biota to suspended sediments.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 206
Reprint: In File
Keywords: Monitoring/Streams/Fishes/Habitat/impact assessment
Abstract: Our meta-analysis of 80 published and adequately documented reports on fish responses to suspended sediment in streams and estuaries has yielded six empirical equations that relate biological response to duration of exposure and suspended sediment concentration. These equations answer an important need in fisheries management: quantifying the response of fishes to suspended sediment pollution of streams and estuaries has been difficult historically, and the lack of a reliable metric has hindered assessment for risk and impact for fishes subjected to excess sedimentation. The six equations address various taxonomic groups of lotic, lentic, and estuarine fishes, life stages of species within those groups, and particle sizes of suspended sediments. The equations all have the form $z = a + b(\log x) + c(\log y)$; $z$ is severity of ill effect, $x$ is duration of exposure (h), $y$ is concentration of suspended sediment (mg SS/L), $a$ is the intercept, and $b$ and $c$ are slope coefficients. The severity of ill effect (z) is delineated semiquantitatively along a 15-point scale on which is superimposed four "decision" categories ranging from no effect through behavioral and sublethal effects to lethal consequences (a category that also includes a range of paralethal effects such as reduced growth rate, reduced fish density, reduced fish population size, and habitat damage). The study also provided best available estimates of the onset of sublethal and lethal effects, and it supported the hypothesis that susceptible individuals are affected by sediment doses (concentration x exposure duration) lower than those at which population responses can be detected. Some species and life stages show "ultrasensitivity" to suspended sediment. When tested against data not included in the analysis, the equations were robust. They demonstrate that meta-analysis can be an important tool in habitat impact assessment.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 351
Reprint: In File
Keywords: Streams/Monitoring/Habitat
Abstract: Stream channel cross-sectional transects can be used to evaluate effects of management on stream channel morphology and therefore on fish habitat quality. We describe four indices that summarize raw data from stream channel cross sections to detect change in channel morphology over time. The net percent change in area under the transect quantifies net degradation or aggradation. The absolute percent change in area quantifies cumulative streambed or streambank material movement. The width/depth ratio is a relative index of channel shape. The Gini coefficient describes the channel cross-sectional profile. This coefficient indicates whether the channel is becoming wider and flatter or narrower and deeper, independent of change in area under the transect. These indices provide a repeatable measurement of stream channel morphology, with estimable confidence limits. They are being used to evaluate changes in channel morphology of a
Abstract: Alteration of natural flow regimes by river regulation affects fish distribution and assemblage structure, but causative pathways are not always direct and may go unrecognized. The Colorado River population of the endangered Colorado pikeminnow, Ptychocheilus lucius, suffers from low rates of recruitment and reduced carrying capacity. We hypothesized that availability of prey fish for this large-bodied native piscivore may, in part, be limited by reduced standing crops of periphyton and macroinvertebrates resulting from accumulation of fine sediment in the riverbed. We stratified the 373-km-long study area into 11 strata and sampled various physical and biological parameters in runs and riffles of three randomly selected 1- to 3-km-long study reaches in each stratum during base flows of spring and fall 1994-1995. Significant correlations were found between biomass of both chlorophyll a and macroinvertebrates and various physical metrics that described the degree of fine sediment accumulation in gravel-cobble substrates. Riffles were relatively free of fine sediment throughout the study area, but substrates of runs contained progressively more fine sediments with distance downstream.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
  - Physical Process
    - Structural or Physical Changes
    - Functional Response
- Method


Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
  - Physical Process
    - Structural or Physical Changes
    - Functional Response
- Method

87.
<table>
<thead>
<tr>
<th>Model Development</th>
<th>Stressor</th>
<th>Physical Process</th>
<th>Structural or Physical Changes</th>
<th>Functional Response</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>81. Peake, S., R. S. McKinley, and D. A. Scruton. 1997. Swimming performance of various freshwater Newfoundland salmonids relative to habitat selection and fishway design. Journal of Fish Biology 51: 710-723.</td>
<td>Ref ID: 281</td>
<td>Keywords: salmonids/Habitat/Fishes/fish communities/Composition/Monitoring/Anadromous</td>
<td>Abstract: Swimming ability of wild brook trout Salvelinus fontinalis, brown trout Salmo trutta, anadromous Atlantic salmon Salmo salar, and landlocked Atlantic salmon were examined using fixed and increasing velocity tests. Although brook trout and salmon parr were collected from the same site, brook trout were found generally in slow-moving pools whereas salmon were more common in faster rifflle areas. Salmon parr could hold station indefinitely in currents in which brook trout could only maintain themselves briefly. Therefore, selection of fast-water areas by salmon parr may impose a velocity barrier to sympatric juvenile brook trout, reducing competition between the species. Performance comparisons also indicate that anadromous Atlantic salmon possess slightly greater sustained ability than landlocked salmon, possibly due to altered selective pressure associated with their different life histories. Finally, fishways and culverts in Newfoundland can now be designed using models generated from performance data collected from native salmonid species.</td>
<td>Notes: Use in monitoring plan development:</td>
<td>Not Used</td>
</tr>
<tr>
<td>82. Peters, R. J., B. R. Missildine, and D. L. Low. 1998. Seasonal fish densities near river banks stabilized with various stabilization methods. First year report of the flood technical assistance project. Final Report December 1998. U.S. Fish and Wildlife Service, North Pacific Coast Ecoregion, Western Washington Office, Aquatic Resources Division, Lacey, Washington.</td>
<td>Ref ID: 209</td>
<td>Keywords: Monitoring/Habitat/Water/River</td>
<td>Abstract: This report describes results obtained from data collected during the first year of a two-year study to determine which methods of river bank stabilization are most commonly used for flood protection in western Washington and the impacts/benefits of these methods to fish densities. We also examined the influence of different habitat variables on fish densities. We mailed a survey to agencies and organizations involved with bank stabilization and received documentation of 667 river bank stabilization projects in western Washington. Riprap (414 of 667) and riprap with deflectors (82 of 667) were the most common methods used to stabilize river banks in western Washington. Methods commonly considered fish-and-wildlife friendly, such as bioengineering (16 of 667) and large woody debris (13 of 667), were rarely used. Using survey results, we selected five types of bank treatments to further evaluate their impacts/benefits to fish. We examined seasonal fish densities at streambanks stabilized using riprap, riprap with large woody debris (LWD) incorporated into the project, rock deflectors, rock deflectors with LWD (combination projects), and LWD. LWD-stabilized sites were the only project types that consistently had greater fish densities than their control areas during spring, summer, and winter surveys. Riprap sites consistently had lower fish densities than their control sites during all surveys. Fish densities were generally lower at deflector sites than their controls during the spring and summer, but greater during the winter. Although large differences (between stabilized sites and controls) existed in some cases, the differences were rarely statistically significant due to high variation and small sample size. Instream LWD cover and overhead riparian cover were the habitat variables that most consistently influenced fish densities at stabilized and control sites were surveyed. Fish densities were generally positively correlated with increasing surface area of LWD and increased overhead riparian cover within 30 cm of the water surface. We recommend using LWD cover when possible, based on these preliminary findings. LWD incorporated into riprap and rock deflectors needs to be larger and provide more complex cover than what is currently used.</td>
<td>Notes: Use in monitoring plan development:</td>
<td>Not Used</td>
</tr>
</tbody>
</table>
Ref ID: 145
Reprint: In File
Keywords: Habitat/Monitoring/Water/Composition/benthic macroinvertebrates/Arctic grayling/Whitefish
Abstract: Isolated (dry) crossing techniques (i.e., dam and pump, or flumed) are required by many government agencies to minimize the effects of instream construction during pipeline water crossing installation. Although there is considerable anecdotal information regarding the effectiveness of these techniques, limited empirical data has been collected to document their effectiveness to minimize the release of sediment into watercourses. The construction of the Alliance Pipeline from northwest Alberta to the Canada/USA border near Elmore, Saskatchewan required the crossing of 505 watercourses, of which more than 70 were classified as sensitive to instream construction. Pipeline construction during the winter of 1999/2000 required the crossing of 18 sensitive watercourses supporting coldwater fish species (Arctic grayling, bull trout, and mountain whitefish). These crossings were constructed using isolated crossing methods. A series of monitoring studies were undertaken to evaluate the effectiveness of the applied crossing techniques, to limit sediment release into the watercourse and subsequent changes to habitat conditions during, and after instream construction. Results indicate that dam and pump and superflume methods can be very effective at limiting sediment release during the crossing of small to medium sized watercourses and thereby protect downstream fish habitat.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 146
Reprint: In File
Keywords: Habitat/Monitoring/Water/Composition/benthic macroinvertebrates/Arctic grayling/Whitefish/fish communities
Abstract: During the fall of 1998, two exposed natural gas pipeline crossings of Big Darby Creek, Ohio were removed and then replaced using open-cut (wet) and flumed (dry) crossing techniques. Big Darby Creek, a national and state scenic river, supports a diverse warmwater fish community that includes several state-listed threatened and endangered species. Instream construction resulted in short-term increases to downstream suspended sediment concentrations, sediment deposition rates, and the amount of fine sediment in riffle habitats. Jersey barrier and sandbag dams, used during the flumed crossing provided a poor seal from the creek flow. Therefore, a similar amount of sediment was released downstream as the open-cut replacement. Increased fine sediment in riffle habitats immediately downstream of the crossing coincided with short-term (<1 year) changes in the abundance and community structure for benthic invertebrates. Small post-construction changes of the abundance and species composition of fish communities were measured at riffles and runs upstream and downstream of construction and therefore, are not considered due to sediment released during instream construction. No long-term (>1 year) changes to benthic invertebrate and fish communities were observed.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 286
Reprint: In File
Keywords: Monitoring/stream habitat/Habitat/Fish populations
Abstract: Millions of dollars are spent annually on watershed restoration and stream habitat improvement in the U.S. Pacific Northwest in an effort to increase fish populations. It is generally accepted that watershed restoration should focus on restoring natural processes that create and maintain habitat rather than manipulating instream habitats. However, most process-based restoration is site-specific, that, conducted on a short stream reach. To synthesize site-specific techniques into a process-based watershed restoration strategy, we reviewed the effectiveness of various restoration techniques at improving fish habitat and developed a hierarchical strategy for prioritizing them. The hierarchical strategy we present is based on three elements: (1) principles of watershed processes, (2) protecting existing high-quality habitats, and (3) current knowledge of the effectiveness of specific techniques. Initially, efforts should focus on protecting areas with intact processes and high-quality habitat. Following a watershed assessment, we recommend that restoration focus on reconnecting isolated
high-quality fish habitats, such as instream or off-channel habitats made inaccessible by culverts or other artificial obstructions. Once the connectivity of habitats within a basin has been restored, efforts should focus on restoring hydrologic, geologic (sediment delivery and routing), and riparian processes through road decommissioning and maintenance, exclusion of livestock, and restoration of riparian areas. Instream habitat enhancement (e.g., additions of wood, boulder, or nutrients) should be employed after restoring natural processes or where short-term improvements in habitat are needed (e.g., habitat for endangered species). Finally, existing research and monitoring is inadequate for all the techniques we reviewed, and additional, comprehensive physical and biological evaluations of most watershed restoration methods are needed.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method

Ref Type: Journal (Full)
Ref ID: 228
Keywords: Alaska/Anadromous/Ecology/Overwintering Habitat/River/Sagavanirktok/Water/Habitat/impact assessment/Fish populations/Colville River Delta/Water quality/Broad Whitefish/Whitefish/Arctic/Arctic cisco/Least Cisco/Monitoring/Colville River
Reprint: In File
Abstract: Anadromous fish of the Alaskan Beaufort Sea overwinter for 8-9 months in isolated pools of coastal rivers where free water remains under the ice. Available overwintering habitat represents only about 3 percent of the total water volume available during the short summer. Although current fish impact assessment focuses on summer distribution and abundance, the availability of suitable overwintering habitat may be one of the major limiting factors of anadromous fish populations. Results of the winter 1985-1986 investigation show that the amount of fish habitat available in the Sagavanirktok River delta is small in comparison to the Colville River delta. Physical and chemical measurements taken during the winter indicate that water quality in terms of life support was generally sufficient; however, marine water intrusions into the Sagavanirktok Delta may cause large-scale avoidance migrations upstream. The resultant crowding at an upstream location was no doubt responsible for near-anoxic conditions and subsequent mortality. Population estimates at this and other locations were calculated from results of diver transects and seine hauls. The results of length/weight measurements provided a unique insight into the overwintering experience. The broad whitefish population in the Sagavanirktok Delta did little feeding and lost weight, for a given length, as expected. By contrast, the population of Arctic cisco in the Sagavanirktok and Colville Deltas and least cisco in the Colville had a higher mean body weight at the end of winter. Feeding occurred but the amount of biomass consumed was small and independent of prey availability. Examination of length/weight regressions reveals that mortality may have a profound influence by causing the lighter fish, across the entire length range, to be removed from these populations during the course of the winter.
Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method

Ref ID: 288
Reprint: In File
Keywords: Monitoring/salmonids/Habitat
Abstract: Knowledge of movement patterns is critical to the management and conservation of inland salmonids. We studies the movements of Bonneville cutthroat trout (Oncorhynchus clarki utah) in a drainage in western Wyoming, USA. Our objectives were to (I) characterize the postspawning movement patterns of adult Bonneville cutthroat trout, (ii) contrast postspawning and summer movement patterns, and (iii) identify factors that disrupt the movements of Bonneville cutthroat trout. Our data showed that postspawning movements of Bonneville cutthroat trout formed a continuum, with fish moving from 0.5 to 82.0 km. Postspawning distance was positively related to fish length. Despite the wide range of movement observed during the spring, fish did not move more than 0.5 km during the summer. A road culvert and an irrigation diversion dam did not seem to pose barriers to the upstream movement of Bonneville cutthroat trout to headwater spawning areas in the spring. However, 23% of radio-tagged fish in 2000 moved into the irrigation diversion ditch as they moved downstream after spawning and subsequently died there. Maintaining drainage connectivity is an important conservation concern for trout populations such as this one, where fish move between complementary spawning and summer habitats.
Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 43
Reprint: On Request 03/20/08
Keywords: Alaska/Environmental aspects/National Petroleum Reserve (Alaska)/Oil fields/Petroleum industry and trade/Monitoring
Abstract: Describes oil development activities and facilities that would occur if economically recoverable oil and gas is found in NPR-A and how development would affect the environment. Note: Full report available at ARLIS.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 291
Reprint: In File
Keywords: Habitat/Monitoring/Water/Composition
Abstract: The effects of limestone baffles on the hydrological and fish assemblage characteristics of two separate 24 m-wide box culverts along the course of a cold headwater trout stream in southeastern Wisconsin were examined. Alternating limestone baffles were placed along the upstream half of one culvert, and the adjacent downstream half was left unmanipulated. The effects of the baffles on water depth, velocity, substrate, and fish abundance were assessed by comparing sites (control versus manipulated) among years from 1994 to 1996 (5, 18, and 32 months after manipulation). The manipulated section exhibited greater mean and variance in depth, velocity, and substrate composition, resulting in a more dynamic and natural stream channel compared with the control reach. Fish abundance and species diversity were greater within the manipulated section than in the control. In addition, average total fish species abundance and diversity within the section with the experimental baffle were comparable with adjacent sites in the natural stream directly upstream and downstream from the culvert. Baffles were placed along the entire length of a second culvert, which resulted in stream channel and fish assemblage characteristics similar to those observed in the manipulated section of the first culvert. These results demonstrate that manipulations within box culverts can increase habitat heterogeneity and enhance resident stream fish abundance and diversity. This alternate baffle design offers managers an inexpensive way to increase fish abundance and diversity and to help mitigate the loss of habitat caused by culverts in stream systems.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 13
Reprint: In File
Keywords: Freshwater fishes/Alaska/National Petroleum Reserve/National Petroleum Reserve (Alaska)/Water/Habitat/Monitoring/Fish surveys/Lakes/Anadromous/Arctic/River
Abstract: Study was undertaken to gather information available on the wintering habitat of fresh water fish within NPR-4. Little is known about the dynamics of anadromous fish population in the Arctic; when they migrate, where they spawn, where they overwinter. Systematic fish surveys in the Reserve have never been undertaken. Specific locations where fish overwinter can only be guessed at from the existence of fishing camps and scanty information on the location of deep lakes and deep holes in rivers. The rivers and lakes are shallow and ordinarily freeze to the bottom, except for pools deeper than about two meters. Stream flow ceases in all rivers within the Reserve, and most lakes freeze to the bottom in winter. There are no known springs of any significant size. The study is not inclusive, but should be of value in indicating the extent of what is known and what is unknown about the fish resources of NPR-4.

Ref ID: 297
Reprint: In File
Keywords: Monitoring/River/Land use/Hydrology/Habitat/Water/water resources/Water chemistry/fish communities/Streams

Abstract: This report describes the effects of urbanization on physical, chemical, and biological characteristics of stream ecosystems in 28 basins along an urban land-use gradient in the South Platte River Basin, Colorado and Wyoming, from 2002 through 2003. Study basins were chosen to minimize natural variability among basins due to factors such as geology, elevation, and climate and to maximize coverage of different stages of urban development among basins. Because land use or population density alone often are not a complete measure of urbanization, land use, land cover, infrastructure, and socioeconomic variables were integrated in a multimetric urban intensity index to represent the degree of urban development in each study basin. Physical characteristics studied included stream hydrology, stream temperature, and habitat; chemical characteristics studied included nutrients, pesticides, suspended sediment, sulfate, chloride, and fecal bacteria concentrations; and biological characteristics studied included algae, fish, and invertebrate communities. Semipermeable membrane devices (SPMDs), passive samplers that concentrate trace levels of hydrophobic organic contaminants like polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs), also were used. The objectives of the study were to (1) examine physical, chemical, and biological responses along the gradient of urbanization; (2) determine the major physical, chemical, and landscape variables affecting the structure of aquatic communities; and (3) evaluate the relevance of the results to the management of water resources in the South Platte River Basin. Commonly observed effects of urbanization on instream physical, chemical, and biological characteristics, such as increased flashiness, higher magnitude and more frequent peak flows, increased concentrations of chemicals, and changes in aquatic community structure, generally were not observed in this study. None of the hydrologic, temperature, habitat, or chemical variables were correlated strongly (Spearman's rho greater than or equal to 0.7) with urban intensity, with the exception of some of the SPMD-based toxicity and chemical variables. SPMD-based measures of potential toxicity and PAH concentrations were positively correlated with urban intensity. The PAH concentrations also were positively correlated with measures of road density and negatively correlated with distance to the nearest road, indicating that automobile exhaust is a major source of these compounds in the study area. This source may be localized enough that the transport of PAHs would be minimally affected by water-management practices such as diversion or storage upstream. In contrast, the predominant sources of nutrients, bacteria, suspended sediment, sulfate, chloride, and pesticides may be more dispersed throughout the drainage area and, therefore, their transport to downstream sites may be subject to greater disruption by water regulation. Although no direct link was found between most water-chemistry characteristics and urbanization, invertebrate, algae, and fish-community characteristics were strongly associated with nutrients, pesticides, sulfate, chloride, and suspended sediment. None of the biological community variables were strongly correlated with the urban intensity index. Algal biomass predominantly was associated with total nitrogen concentrations, nitrite-plus-nitrate concentrations, and the duration of high flows. Fish communities predominantly were associated with housing age, the percentage of suspended sediment finer than 0.063 millimeters and chloride concentrations. Invertebrate communities predominantly were associated with the frequency of rising and falling flow events, the duration of high flows, total nitrogen concentrations, nitrite-plus-nitrate concentrations, and total herbicide concentrations. Historical records indicate that aquatic communities in the region may have been altered prior to any substantial urban development by early agricultural and water-management practices. Present-day aquatic communities are composed primarily of tolerant species even in areas of minimal urban development; when development does occur, the communities already may be resistant to disturbance. In addition to the effects of historical stressors on aquatic community structure, it is possible that current water-management practices in the study basins are having an effect. In the absence of natural, unaltered hydrologic conditions, more sensitive taxa may be unable to recolonize urban streams. The movement and storage of water also may lead to a disconnect between the land surface and streams, resulting in instream physical, chemical, and biological characteristics that, to some degree, are independent of land-cover characteristics.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 213
Reprint: In File
Keywords: Monitoring/Water/River

Abstract: Juvenile chinook salmon, Oncorhynchus tshawytscha, migration is regulated by a host of both physiological and environmental variables. This research used a combination of mathematical and statistical models to investigate two datasets on juvenile chinook salmon migration: radio telemetry data from the Grande Ronde and Snake Rivers and in-stream capture rate data from the Skagit River. Using the radio-telemetry data, a two-state Markov chain model was developed to estimate parameters that describe unobservable fish behavior. The model provides a method for comparing migratory behavior across species, watersheds, or seasons. The same fisheries data was then combined with data on water flow, temperature, and clarity to assess the impact of in-stream factors on fish travel speed and migration timing. Fish traveled faster in the clear, upstream waters than in the slower moving, murky waters downstream. Most migration occurred at night; mid-day movements were much more common with reduced water clarity. Similar patterns were detected for wild, chinook salmon on the Skagit River. More fish were captured when visibility was low than when visibility was high. Water temperature was not a significant factor in explaining migration patterns for either analysis. Horizontal viewing discs for measuring water clarity were evaluated and found to be a good, inexpensive measure that can be used in a wide variety of situations.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method


Ref ID: 292
Reprint: In File
Keywords: Streams/Monitoring/Fishes/River/Water

Abstract: Artificial barriers are important management tools for protecting populations of native fishes from encroaching nonnative species. We evaluated the effectiveness of gabion and culvert barriers in preventing upstream movement of brook trout Salvelinus fontinalis in four small Rocky Mountain streams that contained native populations of Colorado River cutthroat trout Oncorhynchus clarki pleuriticus. A rock-filled gabion in one stream and a road culvert in a second stream appeared to block upstream movement of brook trout; no fish marked and released downstream of the barriers were subsequently found upstream of the barriers. However, in a third stream, 18 of 86 brook trout marked and placed downstream of a rock-filled gabion barrier were later found upstream of the barrier during 3 years of evaluation. These fish ranged in length from 81 to 224 mm total length, so all size-classes were able to navigate past the structure. One brook trout moved upstream past the gabion twice, the second time during low flows when all water was percolating through the structure. We concluded that brook trout were able to move upstream through the rocks in this gabion barrier because fine sediments had not filled in all the interstitial spaces. Attention should be given to preventing movement of fish through gabion-type barriers, not just over or around them. In the fourth stream, 1 of 48 marked brook trout was found upstream from a road culvert barrier. Because this barrier appeared to be functioning properly during our study, we suspect this fish was moved upstream by an angler.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method


Ref ID: 147
Reprint: In File
Keywords: Habitat/Monitoring/Water/Composition/benthic macroinvertebrates/Arctic grayling/Whitefish/Fishery resources/Environmental conditions

Abstract: Northern Ecological Associates, Inc. (NEA) conducted a comprehensive turbidity (nephelometric turbidity unit [NTU]) and suspended sediment (Total Suspended Sediment [TSS]) monitoring program (Program) during construction of the Portland Natural Gas Transmission System (PNGTS) and PNGTS/Maritimes Joint Facilities Pipeline Projects (Project) in New Hampshire. The Program was developed and conducted to monitor NTU/TSS generated during pipeline construction, and to use this data to assess pipeline construction impacts on fishery resources. Monitoring crews collected NTU/TSS data on over 300 stream crossings in New Hampshire. Water samples were collected using automatic water samplers schedules identified by the New Hampshire Department of Environmental Services (NHDES). Crews also collected streambed sediment samples, and complementary ecological data for each crossing. NEA personnel compared NTU and TSS measurement to develop stream specific relationships between the two parameters, and determined that NTU is not an
accurate proxy for TSS. NEA documented that the majority of stream crossing has a minimal impact (within the sublethal effects class) on fishery resources as predicted by Newcome and Jensen's 1996 mathematical model. Crossings with a significant fishery impact were typically ones with unique environmental conditions that resulted in extended crossing duration. NEA analyzed streambed sediment samples to determine grain size distribution to correlate with TSS magnitude and duration, and found that grain size distribution was useful in predicting potential fishery impacts. NEA's Program successfully added substantial new information describing construction impacts in aquatic systems.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method

Ref ID: 104
Reprint: In File
Keywords: Alaska/North Slope/Monitoring/Arctic
Abstract: [Summarizes the history of the Arctic Refuge as it relates to oil in Alaska and the potential impacts of oil and gas development on refuge resources.]
Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method

Ref ID: 294
Reprint: In File
Keywords: Monitoring/Streams/Fishes/Water/Fish Passage
Abstract: We used mark-recapture techniques to examine the effects of four types of road crossings on fish movement during spring base flows and summer low flows in small streams of the Ouachita Mountains, west-central Arkansas. We assessed movement for 21 fish species in seven families through culvert, slab, open-box, and ford crossings and through natural reaches. We detected no seasonal or directional bias in fish movement through any crossing type or the natural reaches. Overall fish movement was an order of magnitude lower through culverts than through other crossings or natural reaches, except no movement was detected through the slab crossing. In contrast, open-box and ford crossings showed little difference from natural reaches in overall movement of fishes. Numbers of species that traversed crossings and movement within three of four dominant fish families (Centrarchidae, Cyprinidae, and Fundulidae) also were reduced at culverts relative to ford and open-box crossings and natural reaches. In spring, retention of fishes was consistently highest in stream segments upstream of crossings and lowest in downstream segments for all crossing types, a response attributed to scouring associated with spring spates. Water velocity at crossings was inversely related to fish movement; culvert crossings consistently had the highest velocities and open-box crossings had the lowest. A key requirement for improving road crossing designs for small-stream fish passage will be determination of critical levels of water velocity through crossings.
Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method

Ref ID: 222
Reprint: In File
Keywords: Fish Passage/Monitoring/Hydrology
Abstract: Design of Road Culverts for Fish Passage serves as guide for property owners and engineers who are designing permanent road-crossing culverts to facilitate upstream fish migration. It provides guidance for projects involving new culvert
construction as well as retrofitting or replacing existing culverts. The designer will need to have a working knowledge of hydraulic engineering, hydrology and soils/structural engineering to accomplish an appropriate design.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 244
Reprint: In File
Keywords: Streams/Monitoring
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 148
Reprint: In File
Keywords: Hydrology/Arctic grayling/Alaska/Monitoring/Water/Water chemistry
Abstract: Culverts are a very simple hydraulic structure. However, because the engineer must design for peak flows passing through the culvert while fish are trying to move upstream problems arise. Almost all culvert installations in interior and northern Alaska were casually examined, with approximately 100 examined in detail where hydraulic problems existed that may retard fish passage. Data from the field program are included in an appendix to this report. The two major hydraulic problems in regard to fish passage were high velocities and perching; inlet drops caused by deposited sediment, aufeis, alignment of culvert with stream, and non-uniform culvert slopes are some of the other fish passage deterrents that were observed. Also, all known baffled structures were evaluated. Numerous recommendations were made that should improve the hydraulic conditions that exist at a culvert relative to fish passage. Also, it is recommended that further studies be carried out to evaluate the swimming performance of the native fish. Present design criteria are based on very limited studies. Lastly, it is recommended that the concept of the velocity in the occupied zone (area in culvert where fish swim) be considered as the culvert design velocity for fish passage in place of the presently used average cross-sectional velocity.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 223
Reprint: In File
Keywords: Arctic/Arctic grayling/Streams/Alaska/Monitoring/Water/Lakes/River
Abstract: During 1984 and 1985, 67 adult Arctic grayling Thymallus arcticus with surgically implanted radio transmitters were released at their summer feeding areas in three river systems of the Arctic National Wildlife Refuge, Alaska. We tracked the fish from aircraft to determine patterns of autumn migration to overwintering locations. During August or September in each area, fish left the small tundra streams where they were tagged and migrated into larger streams. Migration rates peaked at 5-6 km/d about 1 September and averaged 1 km/d. Fish in two river systems moved into adjacent rivers after passage through estuarine waters. Migration distances from spawning or summer feeding areas to overwintering sites were as great
as 101 km. Potential overwintering areas determined from transmitter relocations included deep pools, spring-fed areas, and lakes. Management problems associated with these extensive seasonal migrations may include the maintenance of the species migratory circuit in a region that may face future development.

Notes: Use in monitoring plan development: Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 234
Reprint: In File
Keywords: Monitoring/Arctic/Habitat/Hydrology/Water/Water quality/conceptual model/Lakes/Ecology
Abstract: The purpose of this project is to implement a monitoring program for fish resources in the Arctic within the context of oil and gas development. Although potential impacts from oil development on fish are multi-faceted, the most prominent habitat elements of concern are physical hydrology and water quality. This was agreed upon through the development of a conceptual model in coordination with the RMT. In order to develop an appropriate and effective long-term monitoring plan, the physical and chemical processes of the habitat must be better understood. More specifically, small tundra drainages associated with lakes appear to be an important part of the life cycle for many species of fish in the Arctic, but there is little information regarding the ecology of these systems. This project aims at establishing a network of data collection sites within small tundra stream drainages with lakes in order to address this knowledge gap. These drainages are concentrated within the proposed Alpine Satellites Development Area, in the vicinity of CD6 and CD7. By conducting the project in this area it can serve as both a monitoring effort as well as a scientific investigation. The proposed project consists of four years of data collection and a fifth year to complete data processing and reporting. Project Timeline: 2008-2012
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 241
Reprint: In File
Keywords: Water/Water quality/River/Monitoring/Habitat
Abstract: Changes in periphyton and macroinvertebrate community structure along a stream system were used to assess the effects of urbanization on water quality. Epilithic diatom and macroinvertebrate samples collected in 1995 and 1996 from Laurel Creek, a rapidly urbanizing sub-watershed of the Grand River in southern Ontario were related to measured water quality variables using canonical correspondence analysis (CCA) and principal components analysis (PCA). A distinct separation between urban and rural sites was observed in the ordinations, and sites also differed in terms of macroinvertebrate functional feeding groups. Water quality and habitat changes resulting from urban and agricultural development in the watershed have had fundamental effects (exacerbated by the presence of impoundments) on the benthic community of Laurel Creek. Major restoration will be required to improve water and habitat quality in the stream, in particular the rehabilitation of several impoundments. The implementation of urban stormwater and agricultural runoff controls, and minimization of erosion from areas currently under urban development, are imperative to prevent further deterioration in stream condition.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method


Ref ID: 135
Reprint: In File

Keywords: Arctic grayling/Kuparuk/Monitoring/Alaska/Habitat/Arctic

Abstract: Arctic grayling were captured at seven locations within the Sagavanirktok River drainage near Happy Valley Creek 21-25 June 1989. Two hundred ten arctic grayling, ranging in length from 176 to 399 mm, were transplanted to Kuparuk Mine Site B on 26-27 June 1989. ARCO Alaska, Inc. completed a habitat enhancement project in May 1989 at Kuparuk Mine Site B that contained features that ADF&G believed would increase the long-term success of the arctic grayling transplant. A description of these features, their importance to the long-term success of the transplant, and their benefits to other fish and wildlife at the site is presented. Sampling in the Kuparuk River downstream of the Spine Road crossing indicated that limited numbers of large arctic grayling use this area in mid July. Numbers of large arctic grayling were insufficient to conduct disease screening of arctic grayling in the Kuparuk River at this time. A complete assessment of the success of the arctic grayling transplant experiment will require several years of continued sampling within the Kuparuk Mine Site B/East Creek system.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method


Ref ID: 134
Reprint: In File

Keywords: Monitoring/Habitat/Alaska/Whitefish/Fish surveys/Lakes/Least Cisco/Broad Whitefish/Humpback Whitefish/Streams/Arctic/Arctic grayling

Abstract: Limited freshwater fish investigations have been conducted in the area of the proposed Point Thomson Gas Cycling Project. Seven tundra streams in the area were surveyed for suitable fish habitat by helicopter in August 1983. Other than this brief survey, no freshwater fish investigations have occurred in the project area. Surveys of drainages to the west, from the Badami Oilfield to the Sagavanirktok River, yielded mostly ninespine stickleback with the occasional Arctic grayling (*Thymallus arcticus*), Dolly Varden (*Salvelinus malma*), round whitefish (*Prosopium cylindraceum*), and fourhorn sculpin. In the Arctic National Wildlife Refuge to the east, Arctic grayling, ninespine stickleback, and Dolly Varden were the most common species found in the coastal streams. We conducted fish surveys in streams crossed by the proposed Point Thomson Gas Cycling Project. All streams within the project area were small coastal plain originating streams. All 15 stream systems sampled in 2002 contained ninespine stickleback as did the flooded gravel mine site. Seven of the 15 streams sampled in 2002 contained 42 anadromous juvenile Dolly Varden. Several species of anadromous whitefish are known to ascend coastal streams systems with connected lakes. These species, least cisco (*Coregonus sardinella*), broad whitefish (*Coregonus nasus*), and humpback whitefish (*Coregonus pidschian*), were caught in sampling efforts conducted in Lions Lagoon offshore of the project area in 1999. None of these species were caught in the sampled lakes or their associated streams. Species captured other than ninespine stickleback and Dolly Varden were limited to Arctic grayling and fourhorn sculpin.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
**WATER QUANTITY**

   Ref ID: 299
   Reprint: In File
   Keywords: Lakes/North Slope/Alaska/Monitoring/Water/water resources/Fish populations/Water-supply
   Abstract: Lakes are important water resources on the North Slope of Alaska. Freshwater is required for oilfield production as well as exploration, which occurs largely on ice roads and pads. Since most North Slope lakes are shallow, the quantity and quality of the water under ice at the end of winter are important environmental management issues. Currently, water-use permits are a function of the presence of overwintering fish populations, and their sensitivity to low oxygen concentrations. Sampling of five North Slope lakes during the winter of 2004-2005 shed some light on the winter chemistry of four lakes that were used as water supplies and one undisturbed lake. Field analysis was conducted for oxygen, conductivity, pH, and temperature throughout the lake depth, as well as ice thickness and water depth. Water samples were retrieved from the lakes and analyzed for Na, Ca, K, Mg, Fe, dissolved-organic carbon, and alkalinity in the laboratory. Lake properties, rather than pumping, were the best predictors of oxygen depletion, with the highest dissolved-oxygen levels maintained in the lake with the lowest concentration of constituents. Volume weighted mean dissolved-oxygen concentrations ranged from 4 to 94% of saturation in March. Dissolved oxygen and specific conductance data suggested that the lakes began to refresh in May.
   Notes: Use in monitoring plan development: Not Used
   Baseline Data
   Model Development
   Stressor
   Physical Process
   Structural or Physical Changes
   Functional Response
   Method

   Ref ID: 301
   Reprint: In File
   Keywords: Water/Lakes/Monitoring/Overwintering Habitat/Habitat/Pike/Fishes/Alaska/Plants
   Abstract: The effects of water level fluctuations on fish and other aquatic biota, with an emphasis on winter water withdrawal in northern regions is reviewed. Water demands for population growth and development are adding pressure on water reserves, particularly when coupled with changing climatic conditions. Water level fluctuations can have adverse effects on the environment, most notably to hydrologic and biotic processes ranging in magnitude from the micro-scale to landscape level. Water level management of lakes and reservoirs can affect all forms of aquatic biota. The severity of effect is dependant on the magnitude, duration and timing of the fluctuation, and the species exposed. In northwestern Canada and northern Alaska, water is withdrawn from water bodies to construct ice-roads and other winter based developments. Biota in small, isolated water bodies are particularly sensitive to reductions in winter water levels. Water withdrawals can reduce the oxygen available to overwintering fish, while reduced water levels can reduce habitat for fish and furbearers, and freeze littoral areas killing plants, invertebrates, and fish eggs. Regulatory winter water withdrawal thresholds have been developed in the Northwest Territories and Alaska and continue to be refined as new data becomes available. The use of thresholds can help minimize or avoid negative impacts to the environment, particularly fish, from winter water withdrawal activities. Many different factors may influence the effect that winter water withdrawal has on a water body, such as basin shape, substrate and location. More research is warranted to better understand the linkages between anthropogenic and natural water level fluctuations and their combined effect on aquatic ecosystems. A general decision support system is proposed for minimizing risk to aquatic life from winter water withdrawal activities.
   Notes: Use in monitoring plan development: Not Used
   Baseline Data
   Model Development
   Stressor
   Physical Process
   Structural or Physical Changes
   Functional Response
   Method

Abstract: In northern regions, large volumes of water are needed for activities such as winter road construction. Such withdrawals, particularly from small lakes, can reduce oxygen concentrations and water levels, potentially affecting aquatic organisms. Withdrawal limits have been developed by regulatory agencies, but are largely theoretical. Water withdrawal thresholds were tested in two small lakes by removing 10% and 20% of their respective under-ice volumes and comparing oxygen parameters, temperature, overwintering habitat, and northern pike (Esox lucius) abundance to reference conditions. Because of a milder winter, oxygen parameters were elevated in reference lakes in the period following withdrawal compared to the prewithdrawal period. The 10% withdrawal resulted in a 0.2 m shift in the oxygen concentration profile at 4 mg/l in that lake, but had no effect on total volume-weighted oxygen, or volume of over-wintering habitat. In contrast, the 20% withdrawal caused 0.7 m reduction in the oxygen concentration profile at 4 mg/l compared to the previous year, a 26% decline in the volume-weighted oxygen concentration, and a 23% reduction in the volume of over-wintering habitat compared to prewithdrawal conditions. Water temperatures were slightly (± 10%) colder in the upper strata in the year following the withdrawal in both withdrawal and reference lakes. Northern pike abundance was not impacted by water withdrawals in either of the lakes. The results of this study show that the effects of water withdrawal on the parameters investigated reflected the characteristics of the lakes, and would therefore be expected to vary from lake to lake. Policy development to mitigate impacts must therefore reflect the site-specific nature of water withdrawal.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development

Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 193
Reprint: In File
Keywords: Monitoring/Water/Fish populations/salmonids/Habitat
Abstract: This article reviews the sensitivity, responses, response thresholds, and minimum oxygen requirements of marine and freshwater organisms with strong emphasis on Canadian species. The analysis attempts to define low dissolved oxygen thresholds which produce some physiological, behavioral, or other response in different species. Oxygen availability is discussed with reference to seasonal, geographical, or spatial variation in dissolved oxygen. Factors affecting availability of dissolved oxygen include atmospheric exchange, mixing of water masses, upwelling, respiration, photosynthesis, ice cover, and physical factors such as temperature and salinity. Dissolved oxygen terminology is summarized and tables are included for both fresh and saltwater O2 solubility at different temperatures. Incipient O2 response thresholds are used in a statistical analysis to develop oxygen criteria for safeguarding various groups of freshwater and marine fish. These include mixed freshwater fish populations including or excluding salmonids, freshwater salmonid populations, salmonid larvae or mature salmonid eggs, marine anadromous and nonanadromous species. Criteria are based on threshold oxygen levels which influence fish behavior, blood O2 saturation, metabolic rate, swimming ability, viability and normal development of eggs and larvae, growth, circulatory dynamics, ventilation, gaseous exchange, and sensitivity to toxic stresses. The criteria provide three levels of protection for each fish group and are expressed as percentage oxygen saturation for a range of seasonal temperature maxima. Oxygen tolerances and responses of aquatic invertebrates to low oxygen are reviewed for freshwater and marine species according to habitat. No invertebrate criteria are proposed owing to the capacity for many invertebrate species to adopt anaerobic metabolism during low O2 stress. It is suggested that the criteria proposed for fish species will provide a reasonable safeguard to most invertebrate species. It appears likely, however, that a change in oxygen regime to one of increased O2 scarcity will probably influence invertebrate community structure. It is suggested that criteria for protection of aquatic life be implemented by groups of experienced individuals. The group should consider the natural oxygen regime for a specific water body and its natural variability, the aquatic life therein and its value, importance, relative O2 sensitivity, and the possibility of interactions with toxicants and other factors that may compound the stress produced by low O2 on aquatic life. Each water body and its aquatic life should be considered as a unique situation and criteria application should not encompass diverse areas, habitats, or biological associations as if they were identical.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development

Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Canadian Journal of Fisheries and Aquatic Sciences 41: 118-125.
Ref ID: 270
Reprint: In File
Keywords: Water/Fish populations/Monitoring/Habitat/Whitefish/Pike/Fishes
Abstract: Regulated discharge into Cross Lake, Manitoba, resulted in average summer water volumes in 1980 and 1981 that were 49% lower than prereregulated volumes. Water level drawdown in the summer reduces the amount of available habitat. Consequently, the standing crops of lake whitefish (Coregonus clupeaformis), walleye (Stizostedion vitreum vitreum), northern pike (Esox lucius), and cisco (Coregonus artedii) are lower now than in preregulation and early postregulation years. Unusually early and rapid drawdown in March 1981 resulted in a severe winterkill, causing a substantial decrease in catches per unit of effort (CPUE) for most species from 1980 to 1981. The most affected species were whitefish and cisco, which showed a 50% reduction in CPUE from 1980 to 1981. The amount of fall to late spring drawdown and the year-class strengths of coregonid fishes were inversely related. A marked overwinter drawdown reduces whitefish and cisco hatching success apparently by dewatering their spawning areas and desiccating the eggs. Low water levels in spring prevented pike and walleye access to spawning areas.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method

Ref ID: 246
Reprint: In File
Keywords: Lakes/North Slope/Alaska/Monitoring
Abstract: Tundra lakes on the North Slope, Alaska, are an important resource for energy development and petroleum field operations. A majority of exploration activities, pipeline maintenance, and restoration activities take place on winter ice roads that depend on water availability at key times of the winter operating season. These same lakes provide important fisheries and ecosystem functions. In particular, overwintering habitat for fish is one important management concern. This study focused on the evaluation of winter water use in the current field operating areas to provide a better understanding of the current water use practices. It found that under the current water use practices, there were no measurable negative effects of winter pumping on the lakes studied and current water use management practices were appropriately conservative. The study did find many areas where improvements in the understanding of tundra lake hydrology and water usage would benefit industry, management agencies, and the protection of fisheries and ecosystems.
Notes: see related Ref. ID 296: The physical and chemical effects of mid-winter pumping of tundra lakes on the North Slope, Alaska
Use in monitoring plan development:
Not Used
Baseline Data
Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method

Ref ID: 304
Reprint: In File
Keywords: Water/Lakes/Monitoring/Overwintering Habitat/Habitat/Pike/Fishes/Alaska/Plants/Arctic/North Slope
Abstract: Industrial activity in Canada's north is increasing, placing demands on the use of water from lakes to build ice roads. Winter water withdrawal from these lakes has the potential to impact overwintering fish. Removal of water from small lakes can decrease oxygen and habitat available to fish. To address this issue, a protocol has been developed by the Department of Fisheries and Oceans outlining water withdrawal thresholds. Bathymetric surveys are the traditional method to determine lake depth, but are costly given the remoteness of northern lakes. This paper investigates the use of satellite C-band synthetic aperture radar (SAR) remote sensing technology as a potential alternative or complement to traditional survey methods. Previous research has shown that a SAR can detect the transition from grounded to floating ice on lakes, or if a lake is completely frozen. Grounded ice has a dark signature while floating ice appears very bright in contrast. Similar results were observed for the datasets acquired in the study area. This suggests that lakes that freeze completely to the bottom can be identified using SAR. Such water bodies would not be viable fish overwintering habitat and can therefore be used as water sources without thresholds necessary. However, attempts to accurately calculate the depth of the ice at the grounded-floating ice boundary using bathymetric profiles acquired in the summer and lake ice thickness measurements from a reference lake near Inuvik proved to be unreliable.
Notes: Use in monitoring plan development:
Ref ID: 247
Reprint: In File
Keywords: Lakes/Water/Plant communities/Monitoring/Composition/Habitat
Abstract: Summary of principle findings and management recommendations: (A) Major impacts of reservoir drawdown on fish and fish food organisms: (1) reduced spawning opportunities for fall and spring spawners, (2) increased mortality of littoral invertebrates and fish eggs and fry, (3) increased year-class fluctuations in major fish species, (4) reduced abundance and biomass of macroinvertebrates and fish. (B) Extent of drawdown effects is known to depend on: (1) magnitude, length, and timing of drawdown, (2) reservoir morphometry, sediment characteristics, trophic status, and cover with aquatic macrophytes or former terrestrial vegetation, (3) composition of the resident fish fauna and reproductive type(s) of dominant species. (C) Recommendations for the management of temperate reservoirs affected by winter drawdowns: (1) limit the depth of drawdown to smallest possible extent, (2) employ an ecologically based regulation practice: adjust the timing, progression, and magnitude of drawdown to the specifics of the managed water body (e.g. spawning time and locations of spawning sites of the major species), (3) for fall spawners, complete drawdown before the height of the spawning time (4) for spring spawners, restore summer water levels before spawning time, (5) as habitat improvement measures (a) leave most plant material in place during reservoir impoundment, (b) consider constructing ‘deadwood’ reefs below the drawdown limit, (c) consider constructing artificial spawning beds in cases where reproduction of fall spawners is strongly impaired because of lack of suitable spawning sites.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 194
Reprint: In File
Keywords: Water/Monitoring/Habitat
Abstract: The purpose of this paper is to analyze downstream effects of freshwater flow diversion from a small, active-continental-margin river basin. The Skokomish River delta is a tributary estuary to Hood Canal in Washington state that receives drainage from the southeastern side of the Olympic Mountains. Its drainage basin is steep, and rainfall is high. Approximately 40% of the annual average runoff of the entire system has been diverted from the North Fork Skokomish River for power production since completion of two dams in 1930; this water does not pass through the lower river or over the delta. Extensive logging has occurred in the remainder of the basin. Comparison of prediversion (1885) and postdiversion (1972) bathymetric surveys show that deposition (about 0.013 to 0.022 m yr\(^{-1}\)) has occurred on the inner delta and erosion (up to 0.033 m yr\(^{-1}\)) on the outer delta. This steepening of the delta surface has apparently been caused by a loss of sediment transport capacity in the lower river and estuary combined with an increased sediment supply due to logging. Although the total area of unvegetated tidal flats has decreased by only about 6%, there has been a more than 40% loss of highly productive low intertidal surface area. A conservative estimate of loss of eelgrass (\textit{Zostera marina}) beds is 18%; a reduction in the size of mesohaline mixing zone has also occurred. These habitat losses are similar to those observed elsewhere in the world in larger river basins that have suffered water withdrawals of the same magnitude, but their impacts cannot either be evaluated or understood causally through consideration of simple measures like changes total estuarine deltaic area. Evaluation of estuarine effects of anthropogenic modification must, therefore, include consideration of both changes in habitat function and in the physical processes. These must be evaluated within the totality of the river basin-estuary system that cause these changes. In this case, sediment transport constitutes the critical link between fluvial alterations and the remote downstream, estuarine consequences thereof.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Ref ID: 132
Reprint: In File
Keywords: Water/Monitoring/Water-intake/Fish Protection
Abstract: Light-weight, easily-deployable, four-inch (101.6 mm) and six-inch (152.4 mm) screened aluminum water pump intake cylinders were evaluated for risk of fish entrainment, entrapment, and impingement. The intake cylinders incorporate an off-round design, solid bottom, 0.25-inch (6.35 mm) outer screen surface, and a perforated inner aluminum sleeve. The cylinders are designed to rest on the channel bottom in riffle-sections which weaker-swimming fish typically do not occupy. The intake cylinders align longitudinally with the channel current to facilitate self-cleaning and flushing. Design flows for the four-inch (101.6 mm) and six-inch (152.4 mm) pumps were 600 gpm (37.85 1/s), respectively. Approach water velocities for the second-generation six-inch (152.4 mm) and first-generation four-inch (101.6 mm) pump intake cylinders were non-detectable across the outer screen surface using a pygmy gurley velocity meter.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 103
Reprint: In File
Keywords: Monitoring/Petroleum/Water/Water quality/Lakes/Planning
Abstract: This report summarizes hydrologic observations and measurements made during a lake monitoring and recharge study conducted in the National Petroleum Reserve-Alaska (NPR-A) in 2002 by Michael Baker Jr., Inc. (Baker). It consisted of multi-season water surface elevation, depth, and ice thickness surveys; in situ physical and water quality parameter measurements; analytical water quality sampling and testing; and lake recharge observations at nine fresh water lakes over a period of eight months. The study area was located generally west of the village of Nuiqsut in the northeast planning area of NPR-A. Water surface elevations decreased in most lakes between the pre-pump and post-pump sampling events with the exception of two reference lakes where very slight increases were noted. These water level changes in pump lakes were almost certainly the result of winter water withdrawal. Water surface elevations in all lakes increased to well above pre-pump levels as the lakes were recharged in the spring. The primary mechanism for recharge in 2002 was snowmelt and snowmelt runoff for all of the study lakes. Water surface elevations in all lakes declined over the summer to levels below those measured during the Pre-pump sampling event. Summer declines in water surface elevations were the result of lake outflow and/or evaporation. Pumping appears to have had no effect on ice growth. Temperature, pH, turbidity, sulfate, and nitrate levels do no appear to have been affected by pumping. Dissolved oxygen concentrations decreased in all lakes between pre-pump and post-pump sampling events; however, pump lakes appear to have remained more oxygenated through the mid-winter period. Average post-pump dissolved oxygen concentrations in pump lakes were higher than average post-pump concentrations measured in reference lakes. Higher levels of oxygenation in pump lakes may be a result of pumping methods used by the ice road subcontractor.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 354
Reprint: In File
Keywords: Alaska/Colville River Delta/Habitat/Hydrology/Monitoring/Stream Crossings/Streams/Water/Colville River/River
Abstract: This report references the results of a hydrologic investigation to estimate the magnitude of design discharge at nine small stream crossings along proposed gravel access roads in NPR-A, as presented in the 2005 Colville River and Fish Creek Basin Spring Breakup and Hydrologic Assessment, December 2005. Also presented are the results of a hydraulic
analysis of existing channels and proposed conditions to evaluate the necessity, and estimate the capacity, of drainage structures. Recommendations are presented concerning the number and dimensions of drainage structures suitable for each of the proposed crossings.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
  - Stressor
  - Physical Process
  - Structural or Physical Changes
  - Functional Response
  - Method

Ref ID: 212
Reprint: In File
Keywords: Habitat/Stream Crossings/Colville River Delta/Lakes/Monitoring/Alaska/Water/Colville River/River/Lake
Abstract: This report summarizes hydrologic observations, measurements, and analyses made during the 2007 Colville River Delta Lakes Recharge Monitoring and Analysis Project. Tasks consisted of prebreakup and breakup monitoring, including delineation of lake drainage basins, water surface elevation and snow water equivalent surveys, and lake recharge observations. Thirty permitted lakes were included in the recharge study.
Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
  - Stressor
  - Physical Process
  - Structural or Physical Changes
  - Functional Response
  - Method

Ref ID: 296
Reprint: In File
Keywords: Lakes/North Slope/Alaska/Monitoring/Arctic/Petroleum/Water/Water quality
Abstract: Tundra lakes are a valuable freshwater resource on the Alaskan Arctic Coastal Plain and are of increasing relevance as the petroleum industry in Alaska continues to rely on the freshwater resource to support exploration and production activities. An investigation of the physical and chemical effects of mid-winter pumping activities was conducted at four tundra lakes on the Alaska Arctic Coastal Plain during the 2002-2003 and 2003-2004 winters. The purpose of the study was to determine the impact of removing water from tundra lakes for the construction of ice roads and pads. Measurements of water surface level, specific conductance, temperature and dissolved oxygen were recorded in near real-time, providing an opportunity to detect immediate and cumulative responses from pumping activities. Water quality variables and recharge processes were also examined to further determine the impacts of mid-winter pumping activity. In examining and characterizing the effects of the water withdrawal, changes in water surface level were detected but no chemical or thermal differences were detected due to pumping.
Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
  - Stressor
  - Physical Process
  - Structural or Physical Changes
  - Functional Response
  - Method

Ref ID: 11
Reprint: In File
Keywords: Fishes/Alaska/National Petroleum Reserve/Fish populations/Habitat/Lake ecology/National Petroleum Reserve (Alaska)/Lakes/Monitoring/Water/Water chemistry/Colville River/River
Abstract: The objectives of the study are to document fish presence and habitat use in eastern NPR-A lakes. Selected lakes include those that may be used to support exploration. The area surveyed during 1999-2000 lies between the Nechelik Channel of the Colville River and the confluence of Fish and Judy creeks, then continues south along Judy Creek. Bathymetric and water chemistry data were collected in conjunction with fish sampling. The bathymetric information allows estimating lake volumes. Water chemistry parameters measured include water temperature, specific conductance, dissolved oxygen, and pH.
Ref ID: 10
Reprint: In File
Keywords: Fishes/Alaska/Ublutuoch River Region/Judy Creek Region/Fish Creek Region (National Petroleum Reserve)/National Petroleum Reserve/Habitat/Water quality/Lakes/Monitoring
Abstract: The objective of the study was to document fish presence and habitat use in eastern NPR-A lakes. Selected lakes include those that may be used to support exploration. The area surveyed during 1999-2001 lies between the Nechelek Channel of the Colville River and the confluence of Fish and Judy creeks, then continues south along Judy Creek and west along upper Fish Creek. Based on the above lake evaluation, 33 lakes were confirmed to contain fish, another 17 have potential to be fish-bearing (based on this report and information from Nuiqsut elders), and 43 likely do not represent fish habitat. Of the 33 lakes containing fish, 24 contained sensitive species and 9 contained more resistant species.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 127
Reprint: In File
Keywords: Lakes/Monitoring/Alaska/Habitat/Water/Broad Whitefish/Whitefish/Least Cisco/lake trout/Arctic/Arctic grayling
Abstract: ConocoPhillips Alaska, Inc. has been preparing to explore for oil in an area named Puviaq, which lies between the Ikpikpuk River and Teshekpuk Lake. For agency review of exploration permits, information is required on the biological sensitivity of lakes in the region. The study was designed to provide physical and biological information on these lakes to understand their use by various fish species. The objectives of the study are to document fish presence and habitat use in lakes that may be used as water sources to support the Puviaq Exploration. The area surveyed during 2001-2002 lies along a potential ice road from Barrow to Puviaq and the immediate area around the proposed drill sites. A total of 26 lakes were evaluated as water sources in 2001-2002 for the Puviaq Exploration Prospect in NPR-A. Twenty of the 26 lakes were sampled for fish in 2002. Broad whitefish, least cisco, arctic grayling and lake trout were captured by gill net in the Puviaq area lakes, which was consistent with earlier reports from the region. Ninespine stickleback were also caught in minnow traps. Gill net sets were relatively short, however, so absence of catch does not necessarily mean a lake does not support fish. Based on the above lake evaluation, 19 lakes were confirmed to contain fish. Three additional lakes (M0218, M0223 and M0227) were not sampled because they were connected to streams or other fish-bearing lakes, and are assumed to support fish. Four additional lakes where fish were not caught (M0183, M0184, M0214, M0225) were large, deep lakes capable of supporting fish and are listed as potential fish-bearing lakes. Only lake M0208, appeared to be marginal fish habitat and ninespine stickleback were observed in this lake.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 65
Reprint: In File
Keywords: Fishes/Habitat/Alaska/National Petroleum Reserve/Fish surveys/Petroleum/Water/Lakes/Monitoring
Abstract: Six lakes were sampled in 2002 and 30 in 2003 in connection with potential exploration in the Kokoda region of NPR-A. Lake trout, broad whitefish, least cisco and/or Arctic grayling were captured by gill net or observed in 9 of the NPR-A
NPR-A Fisheries Monitoring Implementation Plan

   Ref ID: 4
   Reprint: In File
   Keywords: Fish populations/Alaska/National Petroleum Reserve/Fish surveys/Fishes/Habitat/Lake ecology/Lakes/Hydrology/National Petroleum Reserve (Alaska)/Environmental conditions/Water/Water chemistry/Monitoring
   Abstract: Objectives were to inventory fish species, determine relative abundance, obtain basic descriptive population data, measure lake depths to estimate volumes, and measure water chemistry. Seventeen lakes were sampled for the first time in 2002 in connection with potential exploration in the Upper Fish Creek region of NPR-A. Broad whitefish, humpback whitefish, least cisco, and arctic grayling were captured by gill net in nine of the NPR-A lakes, which is consistent with earlier reports from the region. Ninespine stickleback were also caught in two lakes by seine. Lakes in the Upper Fish Creek region, and especially in the Kokoda area, were deflation lakes. These lakes are characterized by wide sandy shoals on the west and east sides, where sand dunes have eroded into the lakes. Deep water is often confined to a relatively small portion of the lake surface, as compared to lakes farther east, which tend to deepen rapidly near shore. Based on the lake evaluation, 11 lakes were confirmed to contain fish, with 9 containing sensitive species and 2 containing ninespine stickleback. Fish were not detected in the remaining five lakes.
   Notes: Use in monitoring plan development:
   Not Used
   Baseline Data
   Model Development
   Stressor
   Physical Process
   Structural or Physical Changes
   Functional Response
   Method

   Ref ID: 353
   Reprint: In File
   Keywords: Alaska/Chipp River/Fish populations/Fish surveys/Fishes/Habitat/Ikpikpuk River/Lake/Lakes/Monitoring/National Petroleum Reserve (Alaska)/Petroleum/Water/Water-supply/Water chemistry/Oil and gas leases/National Petroleum Reserve/Planning/River/Turbidity
   Abstract: FEX L.P. (FEX) formerly Fortuna LLC, an energy company located in Calgary, Alberta, Canada and holding oil and gas leases in the Northwest National Petroleum Reserve- Alaska (NW NPR-A), is planning to drill exploratory wells during the winter of 2006/2007. An initial exploration season was conducted during winter 2005/2006. Exploration includes crossing rivers and lakes with ice roads and withdrawal of water from lakes to support both industrial and domestic needs.
   During review of exploration, and potentially development, permits, information is required on the biological sensitivity of lakes in the region. The study was designed to provide physical and biological information on these lakes to understand their use by various fish species. In addition, results of the survey can be used, in concert with previous surveys within the area, to direct any future investigations that may be needed. Objectives of the study were to document fish presence and habitat use in lakes for lakes that may be used to support exploration activities in association with drilling operations or to support ice road construction between drill sites. Lakes in the area may be needed as sources of freshwater during oil exploration, for ice road and ice pad construction, as well as for short-term potable water supplies. Permitting decisions on water withdrawal will need to consider potential impacts to fish that depend on an adequate water supply for surviving winter. The inventory of fish and fish habitat provides information for assisting permitting decisions regarding water use and ice road routing. Surveys in lakes consisted of short-duration gill net sampling during August, supplemented with minnow trap sets, seine hauls and visual observations. Bathymetric and water chemistry data were collected in conjunction with fish sampling. The bathymetric information allows estimating lake volumes. Water chemistry parameters measured include water temperature, specific conductance, dissolved oxygen, pH and turbidity.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method

Reprint: In File

Keywords: climate change/sustainability/Alaska/caribou/Petroleum/Petroleum reserves/Water/Lakes/Habitat/lake trout/Broad Whitefish/Whitefish/Least Cisco/Kuparuk/Monitoring

Abstract: The study was designed to provide physical and biological information on these lakes to understand their use by various fish species. The inventory of fish and fish habitat provides information for assisting permitting decisions regarding water use and ice road routing. One lake (DS-3H) was sampled for fish in 2006 for the first time (Table 2). MC7901 was resampled because the last sampling was in 1979. Neither of the sampled lakes produced fish species. DS-3H is a tundra lake immediately west of Kuparuk Drill Site DS-3H. The lake has no defined drainage to Kalubik Creek. MC7901 is a large shallow lake (mostly 5 feet deep) that appears to have an active connection to lower Kalubik Creek, however gill net sampling and extensive seining failed to detect fish in 2006. Lake M0679 was not sampled because the lake had a maximum depth of 5 feet, with no visible outlet. Lake M0680 was breached to Harrison Bay and functioned as a coastal lagoon, thus was not considered to be suitable as a water source. Historical fish sampling data were used to evaluate the remaining 11 lakes. Based on the above lake evaluation, the 15 lakes surveyed in 2006 for the Makua Exploration should provide 225.3 million gallons of water for under-ice withdrawal during winter. This estimate does not include volumes associated with ice aggregate removal. The area covered by water less than 4 feet deep, and therefore likely to be suitable for removing ice aggregate, was estimated for each lake (Table 5). A map of the potential ice aggregate area for each lake is included in the individual lake summaries. Based on the above analysis, 581 acres are likely to be available for ice chips from lakes surveyed for the Makua Exploration during 2006, which is equivalent to 45.4 million gallons of water.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method


Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method

Keywords: Fish populations/Monitoring/Alaska/Colville River Delta/Ublutuoch River Region/Fishes/Habitat/Water chemistry/Fish surveys/National Petroleum Reserve (Alaska)/Lakes/Petroleum/Water/Water-supply

Abstract: Two lakes, designated L9312 (or U6.1) and L9313 (or T6.1), provide the permanent water supply for the Alpine development. A series of permits have been issued by Alaska Department of Fish and Game (ADF&G) that allow water withdrawal from the lakes under restrictions intended to protect fish residing within the lakes. These permits have been modified as information on the lakes has improved and as project needs have changed. Fish populations in the lakes had been surveyed prior to issuance of water withdrawal permits, beginning in 1995 with baseline studies specific to the Alpine Development. Both of the water-source lakes support fish, with eleven species identified from L9312 and seven identified from L9313. Water use has varied considerably in the two lakes over the last three winters as permit conditions have been modified. The initial water use permits that designated the lakes as permanent water sources, issued March 30, 1999, allowed 15% of the estimated minimum winter volume to be removed. The volume allowed for removal was increased to 30% of the minimum winter volume on January 27, 2000.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method
Reprint: In File
Keywords: Fish populations/Monitoring/Alaska/Colville River Delta/Ublutuoch River Region/Fishes/Habitat/Water chemistry/Fish surveys/National Petroleum Reserve (Alaska)/Lakes/Petroleum/Water/Water-supply
Abstract: Four lakes were evaluated for fish for the first time in 2006. Two of the lakes (M0675 and M0677) were tapped lakes that had direct connections to river channels, so a variety of fish are likely to be abundant. Another (M0675) had a seasonal connection and contained least cisco. The fourth lake, M0678, although near a channel, had no obvious connection and appeared isolated from the river. Information from fish sampling and depth measurements was used to evaluate each lake regarding its potential to support fish. Based on the above lake evaluation, the 30 lakes surveyed in 2006 for the Alpine Development should provide 236 million gallons of water for under-ice withdrawal during winter. This estimate does not include volumes associated with ice aggregate removal. The area covered by water less than 4 feet deep, and therefore likely to be suitable for removing ice aggregate, was estimated for each lake. A map of the potential ice aggregate area for each lake is included in the individual lake summaries. Based on the above analysis, 926 acres are likely to be available for ice chips from lakes surveyed for the Alpine Development during 2006, which is equivalent to 72.5 million gallons of water.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Reprint: In File
Keywords: Alaska/Chipp River/Fish populations/Fish surveys/Fishes/Habitat/Ikpikpuk River/Lake/Lakes/Monitoring/National Petroleum Reserve (Alaska)/Petroleum/Water/Water-supply/Water chemistry/Oil and gas leases/National Petroleum Reserve/Planning/River/Turbidity
Abstract: Petro-Canada (Alaska), an energy company holding oil and gas leases in the Northwest National Petroleum Reserve - Alaska (NW NPR-A), is planning to drill exploratory wells during the winter of 2007/2008. Exploration includes crossing rivers and lakes with ice roads and withdrawal of water from lakes to support both industrial and domestic needs. During review of exploration, and potentially development, permits, information is required on the biological sensitivity of lakes in the region. The study was designed to provide physical and biological information on these lakes to understand their use by various fish species. In addition, results of the survey can be used, in concert with previous surveys within the area, to direct any future investigations that may be needed. Objectives of the study were to document fish presence and habitat use in lakes for lakes that may be used to support exploration activities in association with drilling operations or to support ice road construction between drill sites. Lakes in the area may be needed as sources of freshwater during oil exploration, for ice road and ice pad construction, as well as for short-term potable water supplies. Permitting decisions on water withdrawal will need to consider potential impacts to fish that depend on an adequate water supply for surviving winter. The inventory of fish and fish habitat provides information for assisting permitting decisions regarding water use and ice road routing. Surveys in lakes consisted of short-duration gill net sampling during August, supplemented with minnow trap sets, seine hauls and visual observations. Bathymetric and water chemistry data were collected in conjunction with fish sampling. The bathymetric information allows estimating lake volumes. Water chemistry parameters measured include water temperature, specific conductance, dissolved oxygen, pH and turbidity.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Reprint: In File
Keywords: Fish populations/Monitoring/Alaska/Colville River Delta/Ublutuoch River Region/Fishes/Habitat/Water chemistry/Fish surveys/National Petroleum Reserve (Alaska)/Lakes/Petroleum/Water/Water-supply/Lake/North Slope
Abstract: Two lakes, designated L3912 (or U6.1) and L9313 (or T6.1), provide the permanent water supply for the Alpine development. Two naming conventions are used to identify the lakes in the Colville Delta region – one name conveys information on initial sampling and the investigator responsible for the sampling, the other name conveys information on
location within the North Slope Emergency Response grid. A series of permits have been issued by Alaska Department of Fish and Game (ADF&G) that allow water withdrawal from the lakes under restrictions intended to protect fish residing within the lakes. These permits have been modified as information on the lakes has improved and as project needs have changed. A permit stipulation added to the March 30, 1999 amendments was that each lake would be monitored for fish presence at least twice during the ice-free season for a period of three years. On September 1, 2000, an additional modification specified that the fish monitoring be continued for a minimum of 5 years. This stipulation was fulfilled by the 2003 sampling and subsequent report. Fish populations in the lakes had been surveyed prior to issuance of water withdrawal permits, beginning in 1995 with baseline studies specific to the Alpine Development. Both of the water-source lakes support fish, with eleven species identified from L9312 and seven identified from L9313. In 2004, UAF initiated studies on the effects of water withdrawal on water chemistry in Lake L9312. Objectives of this study were to provide information on fish using the lakes to assist the assessment of water withdrawal and compare 2007 catch patterns to those observed in previous years. Results of the 1999 through 2006 monitoring are reported in previous reports.

Notes: Use in monitoring plan development:
- Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 112
Reprint: In File
Keywords: National Petroleum Reserve/Petroleum/Alaska/Habitat/Water/Whitefish/lake trout/Lakes/Arctic/Arctic grayling/Monitoring
Abstract: LCMF, LLC and OASIS Environmental, Inc., collected the required bathymetric and biological information via the non-uniform bathymetric survey procedure and appropriate fish sampling techniques. The objectives of this study are to identify fish species present, and winter habitat availability to coincide with water use for industrial purposes. Some fish species are more sensitive to environmental alterations than others (Arctic grayling, and whitefish), and hold specific stipulations. Arctic grayling and ninespine stickleback are the only species captured during the lake sampling effort. No whitefish species or lake trout were captured in any of the lakes sampled within the Northeast NPRA. Data for the type of gear used, date, hours of effort, species caught, and fork length of fish caught for each lake are presented. Results for the Northeast NPRA and Northwest NPRA sampling events are included.

Notes: Use in monitoring plan development:
- Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 280
Reprint: In File
Keywords: fish communities/Monitoring/Fishes/Composition/Habitat
Abstract: Par Pond, a 10.5-sq km reservoir in South Carolina, was drained over a period of 3 months to less than 50% of its former surface area and volume; it was maintained in that state for approximately 3.5 years. The draw down resulted in significant reductions in fish abundance and number of fish species, changes in the relative abundance of fishes, and changes in the size structure of individual species of fish. An important factor contributing to these changes was complete loss of the original littoral zone. Within approximately 9 months of the refill of Par Pond to its former level, the fish community had recovered in terms of number of species and overall fish abundance, and had nearly recovered in terms of species composition. However, size structures after refill were different than before the drawdown: large individuals were fewer and small individuals greater in number. Factors contributing to the recovery of the Par Pond fish community included recolonization from refugia, high reproductive rates of resident species, and the shelter for small fishes provided by inundated terrestrial vegetation and rapidly regrowing aquatic vegetation. These results suggest that at least some reservoir fish communities are resilient to disturbances of their physical habitat and, in this respect, resemble stream fish communities.

Notes: Use in monitoring plan development:
- Not Used

Baseline Data
Model Development
Stressor
Physical Process
Ref Type: Abstract
Ref ID: 284
Keywords: Monitoring/River/salmonids/Database/Water
Abstract: Geographic Information Systems (GIS) technology is being used to evaluate proposed enhancement efforts aimed at increasing the survival of Snake River salmonids, specifically migratory smolts and adults of salmon protected under the Endangered Species Act. The relational database was used to evaluate different flow option effects for proposed drawdowns of Lower Granite Reservoir on the salmon stocks, while recognizing the possible tradeoffs that lower reservoir water elevations could impose on the reservoir ecosystem that has equilibrated since reservoir filling in 1975.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Method

Ref ID: 123
Reprint: In File
Abstract: On August 5, 2000 Reanier & Associates was tasked by Phillips Alaska, Inc. to conduct lake studies to include depth and water quality measurements for lakes in the National Petroleum Reserve-Alaska (NPR-A) that had been identified as potential water sources for ice road and ice pad construction. This study primarily addresses lake depths, volume estimates, and water quality measurements. It does not address the presence or absence of fish in lakes, except indirectly by noting possible indications of fish observed on depth sounders while recording lake depths, and it does not address the question of goose habitat. This study of lakes in the NPR-A has evaluated 32 lakes that might potentially be used for water withdrawals to construct ice roads and ice pads. Of the 32 lakes studied, 19 have depths great enough to allow some water withdrawal even if fish are present in the lake. Water quality data indicate that all of the 32 lakes studied have salinities low enough for their water to be used in ice road and ice pad construction.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 285
Reprint: In File
Abstract: Adult northern pike Esox lucius and largemouth bass Micropterus salmoides were monitored with ultrasonic transmitters in two 25-ha lakes in Colorado to evaluate the effect of water level drawdown on movement. Water levels in one lake were reduced from September through November, whereas an adjacent lake was held at full pool levels. Largemouth bass in the treatment lake moved greater distances and exhibited larger 24-h use areas during drawdown conditions. Increases in movement and use areas by northern pike associated with low water levels were not significantly different from those at full pool levels. Movement of largemouth bass and northern pike in the stable lake remained constant throughout the study. These results suggest that water level fluctuations may alter predator behavior.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes

Ref ID: 302
Reprint: In File
Keywords: Water/Lakes/Monitoring/Overwintering Habitat/Habitat/Pike/Fishes/Alaska/Plants/Arctic
Abstract: Discussion of water use from Arctic lakes; identifying lakes for water use and the related impacts from such use.
Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method


Ref ID: 293
Reprint: In File
Keywords: fish communities/Habitat/Monitoring/Water
Abstract: A 1995-96 habitat enhancement project was conducted at Lake Kissimmee, Florida, which included a major drawdown and organic sediment removal from about half of the lake's shoreline. Previous studies have compared communities change through time in enhanced habitats. We sampled plant and fish communities in two enhanced littoral areas three times each summer from 1998 to 2000. Quality fish habitat (i.e. sandy bottom, moderate coverage of aquatic macrophytes, high dissolved oxygen concentrations) was present in enhanced sites throughout this study. Irrespective of water level, plant abundance (percent covered, PAC) and biomass increased during the study period, but mean plant biomass and abundance were < 2 kg m\(^2\) and < 50%, respectively, in 2000. Mean dissolved oxygen concentrations in enhanced sites generally exceeded 3 mg L\(^-1\) in all years. Diverse fish communities also reflected quality habitat in enhanced sites. No fish variables differed between sites, but fish diversity and richness were highest during 1999 when water levels were high. Mean water depth and PAC, when significant, were positively related to fish variables (e.g. biomass, diversity). The results of this study suggest that the benefits of the 1995-96 Lake Kissimmee habitat enhancement were prolonged compared to a previous effort, which may be due, in part, to herbicide treatments.
Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method


Ref ID: 298
Reprint: In File
Keywords: Plant communities/Monitoring/Lakes/Water chemistry/climate change
Abstract: Water-surface elevation in lake 226 (L226) of the Experimental Lakes Area in northwestern Ontario, Canada, was lowered experimentally by 2-3 m during each of three successive winters, and increased naturally but incompletely during the ensuing summers. Our objective was to compare the responses of the littoral and pelagic plant communities to this physical disturbance. Water-chemistry changes were muted, and neither nitrogen nor phosphorus concentration changed. Phytoplankton biomass, species assemblages, productivity, and nutrient status were largely unaffected except for small changes in species diversity and relative abundance of cyanobacteria and cryptophytes. Despite possible transient changes in functional and structural properties, the principal disruption for benthic algae was loss of colonizable surfaces. Floating-leaved and submerged macrophytes (hydrophytes) responded initially with large decreases in biomass and cover. The subsequent response of hydrophytes to drawdown varied: relative frequency of Isoetids such as Eriocaulon septangulare decreased, while that of pondweeds such as Potamogeton spirillus increased. The trophic impacts of declining lake levels, whether due to hydroelectric reservoir manipulations or climate change, are likely to be much greater in the littoral zone than in the pelagic zone if major nutrients are unaltered.
Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
<table>
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<tr>
<th>Physical Process</th>
<th>Structural or Physical Changes</th>
<th>Functional Response</th>
<th>Method</th>
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Reprint: In File
Keywords: Monitoring/Petroleum/North Slope/Alaska/Water/Lakes/Habitat/Water quality
Abstract: Current winter oil and gas exploration and development practices on the North Slope of Alaska include construction of ice roads and ice pads to facilitate vehicle and equipment mobilization and stable camp and work areas. Construction of these ice roads and pads requires withdrawal of water from nearby lakes during winter. The purpose of the Lake Recharge Study is to fulfill the following stipulation contained in the Finding of No Significant Impact - Record of Decision (FONSI-ROD) prepared by the Bureau of Land Management (BLM) for Permit to Drill 3100.00 and Right-of-Way Permit 2884.01. Concern exists that water withdrawal from North Slope lakes could lower water levels to such an extent that the lakes freeze completely or otherwise adversely impact fish overwintering habitat by disturbing bottom sediments, disrupting stratification or effecting water quality in the free water beneath the surface ice. The 2001 Monitoring Plan includes two of the previously studied lakes (M9906 and M9915) for this purpose as well as for data comparison. The lakes included in this study are tundra lakes, meaning they are not connected to a river channel. Water quality sampling included analysis for hardness, calcium, magnesium, sodium, potassium, iron, silicon, chloride and total dissolved solids. Water surface elevation measurements in this study showed that water level decreases caused by pumping did not advance the freezing rate of the lakes. Additionally, lake levels returned to the pre-pumping levels prior to freeze up. Overall, the water quality parameters measured directly and analyzed in a laboratory do not suggest that pumping caused a significant degradation in water quality. Since none of the study lakes contained fish, available water volumes suitable for overwintering fish habitat was not evaluated.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 346
Reprint: In File
Keywords: Arctic/Lakes/Lake/Monitoring/regional scale/Alaska
Abstract: Arctic lakes are significant emitters of methane (CH4), a potent greenhouse gas, to the atmosphere; yet no rigorous quantification of the magnitude and variability of pan-Arctic lake emission exists. In this study, we demonstrate the potential for a new method using synthetic aperture radar (SAR) imagery to detect methane bubbles in lake ice to scale up whole-lake measurements of CH4 ebullition (bubbling) to regional scales. We estimated ebullition from lakes, which is often the dominant mode of lake emissions, by mapping the distribution of bubble clusters frozen in early winter ice across surfaces of seven tundra lakes and one boreal forest lake in Alaska. Applying previously measured ebullition rates associated with four distinct classes of bubble clusters found in lake ice, we estimated whole-lake emissions from individual lakes. The percent surface area of lake ice covered with bubbles ($R^2 = 0.68$) and CH4 ebullition rates from lakes ($R^2 = 0.59$) and were correlated with radar return values from RADARSAT-1 Standard Beam mode 3 for the tundra lakes, suggesting that with appropriate scaling and consideration for variability in lake-ice conditions, this technique has the potential to be used for estimating broader-scale regional and pan-Arctic lake methane emissions.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 303
Reprint: In File
Keywords: Water/Lakes/Monitoring/Overwintering Habitat/Habitat/Pike/Fishes/Alaska/Plants/Arctic/North Slope
Abstract: Many arctic lakes freeze completely in winter. The few that retain unfrozen water for the entire winter period serve
as overwintering fish habitat. In addition to serving as fish habitat, water in arctic lakes is needed for industrial and domestic use. Permits for water extraction seek to maximize water use without impacting dissolved oxygen (DO) levels and endangering fish habitat. The relationship between lake volume, winter DO budget, and extraction of water through pumping has historically not been well understood. A management model that could estimate end-of-winter DO would improve our understanding of the potential impacts of different management strategies. Using under-ice DO measurements (November to April) taken from two natural lakes and one flooded gravel mine on the North Slope of Alaska, a physically based model was developed to predict end-of-winter DO concentration, water-column DO profiles, and winter oxygen depletion rate in arctic lakes during periods of ice cover. Comparisons between the measured and model-predicted oxygen profiles in the three study lakes suggest that the depth-based DO modeling tool presented herein can be used to adequately predict the amount of DO available in arctic lakes throughout winter.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 305
Reprint: In File
Keywords: Water/Lakes/Monitoring/Overwintering Habitat/Habitat/Pike/Fishes/Alaska/Plants/Arctic/North Slope/water resources/Water-supply/Petroleum/Colville River/River/Kuparuk
Abstract: Water resources are limited in many areas of the North Slope, Alaska, particularly during winter. Water is used by the oil industry for ice road construction and maintenance, drilling and facility operations, and potable water supplies. The coastal plain between Teshekpuk Lake, in the National Petroleum Reserve-Alaska (NPR-A) and the Colville River has numerous shallow lakes, but further south in the northern foothills of the Brooks Range, and east to the Canning River, lakes are fewer. While many oil and gas lease sales have been conducted, or are proposed, access to the leases may be limited because of the lack of available water for ice road construction. Ice roads are the main means by which exploration is conducted in the Arctic, putting a stress on freshwater bodies that do not freeze to the lakebed in winter. Lakes that do not freeze to the lakebed also serve as overwintering habitat for fish. The purpose of this paper is to report on the potential distribution of water bodies that may provide overwinter water in selected areas from Teshekpuk Lake to the Canning River. The project used synthetic aperture radar (SAR) imagery to search for the presence of water in lakes in March 2006. In the Kuparuk and Canning SAR images, 52 and 61% of lakes were frozen to their beds by March 2006, accounting for 49 and 57% of the lake area in these study regions. Conversely, only 2% of the lakes in the Teshekpuk region were frozen to the bottom by March 2006. Unfrozen water was more available because of deeper and more numerous lakes in the Teshekpuk Lake region (west) than in the Canning River area (east). While only specific SAR tiles were analyzed herein, the method will be a useful tool for land managers who seek to evaluate the potential for ice road construction across the Arctic.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 295
Reprint: In File
Keywords: Water/lake trout/Lakes/Monitoring
Abstract: Observations and data gathered from Bark Lake indicate that reproduction of lake trout (Salvelinus namaycush) is no longer possible because of water drawdown of as much as 10 m annually. The fishery is now sustained by hatchery plantings. Data and observations from Mary Lake indicate that natural reproduction of lake trout may be severely curtailed at one of two shoals due to winter drawdown of as much as 0.83 m. Bella Lake has no dam or water level drawdown. Spawning occurs in less than 0.3 m but ice thickness lessens toward shore and as a result, there is no egg loss.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method
### Water Discharge and Spills


   Ref ID: 182
   Reprint: In File
   Keywords: Monitoring/Water/Streams

   Abstract: The relative importance of dissolved oxygen and dissolved carbon dioxide in determining the lethal effect of an environment for rainbow trout and perch has been investigated with an apparatus which controls the concentrations of these gases in a body of water. It is shown that concentrations of carbon dioxide which sometimes occur in polluted streams can more than double the minimum concentration of dissolved oxygen necessary for the survival of half a population of rainbow trout fingerlings for 24 hr. Increase in temperature between 12.5 and 19.5°C shortens period of survival in solutions containing up to 67 p.p.m. CO2. Within the range of dissolved oxygen concentration which is lethal in the presence of 59 p.p.m. CO2 or more, perch are more resistant than rainbow trout in the lower, but less resistant in the higher, oxygen concentrations. The relation between carbon dioxide concentration and the oxygen tension at which rainbow trout blood is half saturated with oxygen is similar to the relation between carbon dioxide concentration and oxygen tension at which the median period of survival of this species is 1 hr.

   Notes: Use in monitoring plan development:
   Not Used
   Baseline Data
   Model Development
   Stressor
   Physical Process
   Structural or Physical Changes
   Functional Response
   Method


   Ref ID: 313
   Reprint: In File
   Keywords: Monitoring

   Abstract: This method provides a procedure for low level determination of chlorophyll a (chl a) and its magnesium free derivative, pheophytin a (pheo a), in marine and freshwater phytoplankton using fluorescence detection (1, 2). Phaeophorbides present in the sample are determined collectively as pheophytin a. For users primarily interested in chl a there is currently available a set of very narrow bandpass excitation and emission filters (Turner Designs, Sunnyvale, CA) that nearly eliminates the spectral interference caused by the presence of pheo a and chlorophyll b. The difference between the modified method and the conventional fluorometric method is that the equations used for the determination of chl a without pheo a correction (uncorrected chl a), are used instead of the equations for “corrected chl a”. This EPA laboratory has evaluated the modified filters and found the technique to be an acceptable alternative to the conventional fluorometric method using pheo a correction.

   Notes: Use in monitoring plan development:
   Not Used
   Baseline Data
   Model Development
   Stressor
   Physical Process
   Structural or Physical Changes
   Functional Response
   Method


   Ref ID: 314
   Reprint: In File
   Keywords: bioassessment/Streams/River/benthic macroinvertebrates/Monitoring/Biological Assessment

   Abstract: The primary purpose of this document is to describe a practical technical reference for conducting cost-effective biological assessments of lotic systems. The protocols presented are not necessarily intended to replace those already in use for bioassessment nor is it intended to be used as a rigid protocol without regional modifications. Instead, they provide options for agencies or groups that wish to implement rapid biological assessment and monitoring techniques. This guidance, therefore, is intended to provide basic, cost-effective biological methods for states, tribes, and local agencies that (1) have no established bioassessment procedures, (2) are looking for alternative methodologies, or (3) may need to supplement their existing programs (not supersede other bioassessment approaches that have already been successfully implemented).

   Notes: Use in monitoring plan development:
   Not Used
   Baseline Data
Reprint: On Request 09/09/08
Keywords: Streams/Monitoring
Abstract: The extent to which nutrients from Pacific salmon are transported to riparian areas may be influenced by differences in spawning behavior among species. Chum salmon Oncorhynchus keta, pink salmon O. gorbuscha, and sockeye salmon O. nerka typically spawn in dense aggregations, while species like steelhead O. mykiss and coho salmon O. kisutch spawn at lower densities. The contribution of nutrients to riparian vegetation was compared at two watersheds in western Washington, Griffin Creek (used by coho salmon) and Kennedy Creek (used by chum salmon). Salmonberry Rubus spectabilis foliage was collected at the channel edge above and below barriers to spawning salmon and at 20, 50, and 100 m upslope from the stream and analyzed for nitrogen stable isotope ratio (δ15N, an indicator of salmon-derived nitrogen), total nitrogen (N), and phosphorus (P) content. Cover, plant density, and the species richness of shrub and understory vegetation were compared between sites with and without salmon. The δ15N values in salmonberry leaves were higher at sites with salmon than at corresponding distances from the channel at sites without salmon at Kennedy Creek but not Griffin Creek. Salmonberry foliage adjacent to salmon spawning reaches possessed significantly higher levels of total N and P in both watersheds. Nitrogen content was positively associated with δ15N values at the Kennedy Creek sites but not at the Griffin Creek sites. At Kennedy Creek, shrub species diversity and understory plant density and species diversity were higher at sites with salmon than at sites without salmon. These results suggest that areas bordering streams utilized by high-density-spawning species like chum salmon receive a substantial nutrient contribution from the fish and that this subsidy influences the vegetation. We did not see clear evidence for a similar nutrient contribution from coho salmon.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Reprint: In File
Keywords: Monitoring/River
Abstract: This document describes the suite of biological methods of the U.S. Geological Survey- Biomonitoring of Environmental Status and Trends program for monitoring chemical contaminants and their effects on fish. The methods, which were selected by panels of experts, are being field-tested in rivers of the Mississippi River, Columbia River, and Rio Grande basins. General health biomarkers include a health assessment index based on gross observation; histopathological examination of selected organs and tissues; condition factor; and the heptosomatic and splenosomatic indices. Immune system indicators are plasma lysozyme activity and measures of splenic macrophage aggregates. Reproductive biomarkers include plasma concentrations of sex steroid hormones (17b-estradiol and 11-ketotestosterone) and vitellogenin, gonadal histopathology (including reproductive stage and, in females, gonadal atresia), and the gonadosomatic index. Indicators of exposure to polycyclic aromatic and polyhalogenated hydrocarbons are the H4IIE rat hepatoma cell bioassay (performed on solvent extracts of composite fish samples) and hepatic ethoxyresorufin-O-deethylase activity. Stable nitrogen isotope ratios are used to assess the trophic position of the fish and their exposure to sewage and other animal wastes. For each indicator we describe endpoint(s) and methods, and discuss the indicator's value and limitations for contaminant monitoring and assessment.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method
Ref ID: 250
Reprint: In File
Keywords: Monitoring/Water/Water quality/Lakes
Abstract: Unlike Canadian Water Quality Guidelines, Canadian Interim Sediment Quality Guidelines (ISQGs) are not based on clear cause-effect relationships. They were derived using a modified U.S. National Status and Trends Program (NSTP) approach in which biological effects were compared with contaminant concentrations in field-collected sediments. Exceeding an assessment value indicates an increased likelihood of toxic effects, but correlation is not proof of cause, and it cannot be assumed that the contaminant present in excess of the assessment value is necessarily responsible for the observed effects. This has sometimes caused confusion and misinterpretation of the toxicological significance of sediment chemistry data. An alternative approach to computing sediment guidelines, based on estimating the bioavailable contaminant concentration and comparing this with concentrations known to be toxic, is proposed. Examples are given of guidelines for cadmium, copper, nickel, lead, and zinc computed using both methods for toxicity data collected from sediments in Canadian Shield lakes near smelters. The cause-effect based guidelines can be much higher than those computed using the NSTP approach. They can also be higher than toxic thresholds estimated from experiments with metal-spiked sediments. Only true cause-effect based guidelines should be used for predicting the cause of toxicity in sediments.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
  Stressor
  Physical Process
  Structural or Physical Changes
  Functional Response
Method

Ref ID: 315
Reprint: In File
Keywords: Water/Water quality/Streams/Alaska/Monitoring/Habitat
Abstract: The Camp and Costello Creek watersheds are located on the south side of Denali National Park and Preserve. The Dunkle Mine, an abandoned coal mine, is located near the mouth of Camp Creek. Due to concern about runoff from the mine and its possible effects on the water quality and aquatic habitat of Camp Creek and its receiving stream, Costello Creek, these two streams were studied during the summer runoff months (June to September) in 1999 and 2000 as part of a cooperative study with the National Park Service. Since the south side of Denali National Park and Preserve is part of the U.S. Geological Survey’s National Water-Quality Assessment Cook Inlet Basin study unit, an additional part of this study included analysis of existing water-quality data at 23 sites located throughout the south side of Denali National Park and Preserve to compare with the water quality of Camp and Costello Creeks and to obtain a broader understanding of the water quality in this area of the Cook Inlet Basin. Analysis of water column, bed sediment, fish, invertebrate, and algae data indicate no effects on the water quality of Camp Creek from the Dunkle Mine. Although several organic compounds were found in the streambed of Camp Creek, all concentrations were below recommended levels for aquatic life and most of the concentrations were below the minimum reporting level of 50 ìg/kg. Trace element concentrations of arsenic, chromium, and nickel in the bed sediments of Camp Creek exceeded threshold effect concentrations (TEC), but concentrations of these trace elements were also exceeded in streambed sediments of Costello Creek above Camp Creek. Since the percent organic carbon in Camp Creek is relatively high, the toxicity quotient of 0.55 is only slightly above the threshold value of 0.5. Costello Creek has a relatively low organic carbon content and has a higher toxicity quotient of 1.19. Analysis of the water-quality data for other streams located in the south side of Denali National Park and Preserve indicate similarities to Camp Creek and Costello Creek. Most of the streams are calcium bicarbonate/calcium bicarbonate-sulfate type water with the exception of two streams that are calcium sulfate and magnesium sulfate type water. Trace element concentrations of arsenic, chromium, and nickel in the bed sediments of 9 streams exceeded the TEC or the probable effect concentration (PEC). Seven streams exceeded the threshold value of the toxicity quotient. Analysis of trace element concentrations in bed sediment and basin characteristics for 16 watersheds by cluster and discriminant analysis techniques indicated that the watersheds could be separated into two groups based on their basin characteristics.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
  Stressor
  Physical Process
  Structural or Physical Changes
  Functional Response
Method

Ref ID: 316
Abstract: The Cook Inlet Basin study unit of the U.S. Geological Survey National Water-Quality Assessment Program comprises 39,325 square miles in south-central Alaska. Data were collected at eight fixed sites to provide baseline information in areas where no development has taken place, urbanization or logging have occurred, or the effects of recreation are increasing. Collection of water-quality, biology, and physical-habitat data began in October 1998 and ended in September 2001 (water years 1999-2001). The climate for the water years in the study may be categorized as slightly cool-wet (1999), slightly warm-wet (2000), and significantly warm-dry (2001). Total precipitation was near normal during the study period, and air temperatures ranged from modestly cool in water year 1999 to near normal in 2000, and to notably warm in 2001. Snowmelt runoff dominates the hydrology of streams in the Cook Inlet Basin. Average annual flows at the fixed sites were approximately the same as the long-term average annual flows, with the exception of those in glacier-fed basins, which had above-average flow in water year 2001. Water temperature of all streams studied in the Cook Inlet Basin remained at 0°C for about 6 months per year, and average annual water temperatures ranged from 3.3 to 6.2 degrees Celsius. Of the water-quality constituents sampled, all concentrations were less than drinking-water standards and only one constituent, the pesticide carbaryl, exceeded aquatic-life standards. Most of the stream waters of the Cook Inlet Basin were classified as calcium bicarbonate, which reflects the underlying geology. Streams in the Cook Inlet Basin draining areas with glaciers, rough mountainous terrain, and poorly developed soils have low concentrations of nitrogen, phosphorus, and dissolved organic carbon compared with concentrations of these same constituents in streams in lowland or urbanized areas. In streams draining relatively low-lying areas, most of the suspended sediment, nutrients, and dissolved organic carbon are transported in the spring from the melting snowpack. The urbanized stream, Chester Creek, had the highest concentrations of calcium, magnesium, chloride, and sodium, most likely because of the application of de-icing materials during the winter. Several volatile organic compounds and pesticides also were detected in samples from this stream. Aquatic communities in the Cook Inlet Basin are naturally different than similar sites in the contiguous United States because of the unique conditions of the northern latitudes where the Cook Inlet Basin is located, such as extreme diurnal cycles and long periods of ice cover. Blue-green algae was the dominant algae found at all sites although in some years green algae was the most dominant algae. Macroinvertebrate communities consist primarily of Diptera (true flies), Ephemeroptera (mayflies), and Plecoptera (stoneflies). Lowland areas have higher abundance of aquatic communities than glacier-fed basins. However, samples from the urbanized stream, Chester Creek, were dominated by oligochaetes, a class of worms. Most of the functional feeding groups were collector-gatherers. The number of taxa for both algae and macroinvertebrates were highest in water year 2001, which may be due to the relative mild winter of 2000–2001 and the above average air temperatures for this water year. The streams in the Cook Inlet Basin typically are low gradient. Bank substrates consist of silt, clay, or sand, and bed substrate consists of coarse gravel or cobbles. Vegetation is primarily shrubs and woodlands with spruce or cottonwood trees. Canopy angles vary with the size of the stream or river and are relatively low at the smaller streams and high at the larger streams. Suitable fish habitat, such as woody debris, pools, cobble substrate, and overhanging vegetation, is found at most sites. Of the human activities occurring in the fixed site basins — high recreational use, logging, and urbanization — based on the multiple lines of evidence used in the NAWQA program, only urbanization was noted to have measurably affected the water quality. High recreational use and logging may be affecting site-specific areas within the Kenai River and Ninilchik River basins, respectively, but these effects, if any, were not seen at the respective sampling sites.

Notes: Use in monitoring plan development:

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<th>Method</th>
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Ref ID: 338
Reprint: In File
Keywords: Petroleum/Water/Water quality/River/Monitoring
Abstract: From 2002 to 2006, the BLM collected streamflow, channel geometry and water quality data from the Judy and Fish Creek and Kalikpak and Ublutuoch River drainages in northeastern National Petroleum Reserve-Alaska (NPR-A). Supplemental stream surface water and sediment samples were collected and analyzed for petroleum hydrocarbons and heavy metals. This information was used to determine contaminant baselines in the watersheds related to airborne deposition, prior to oil and gas development within the area.

Notes: Use in monitoring plan development:

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<th>Method</th>
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<th>Structural or Physical Changes</th>
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Ref ID: 41
Reprint: In File
Keywords: Alaska/Environmental aspects/National Petroleum Reserve/National Petroleum Reserve (Alaska)/Oil spills/Oil well drilling/Petroleum/Monitoring
Abstract: This analysis of the risk of oil spills is based on available data on the frequency and size of spills and blowouts and estimates of the likely number of wells in NPR-A should discoveries be made.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref Type: Unpublished Work
Ref ID: 347
Keywords: Monitoring/River/Streams/Lakes/Lake/Habitat/Water
Reprint: In File
Abstract: Our rivers, streams, and lakes are in peril. Contaminants destroy aquatic habitats and endanger our own lives. To solve this problem, we must know how much pollution threatens our waterways. Scientists at the Columbia Environmental Research Center (CERC) have an effective method for determining the amount of contamination in water. This article explains our basic approach and also provides a Glossary of related technical terms.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 320
Reprint: In File
Keywords: Habitat/Water/Water quality/Alaska/River/Environmental conditions/Monitoring
Abstract: This report explains the concepts and field methods to be used by the U.S. Geological Survey’s National Water-Quality Assessment (NAWQA) Program for evaluating contaminants in tissues of biological organisms. Laboratory methods for analysis of these contaminants will be detailed in a future report. Part 1 explains the rationale for analyzing contaminants in tissues and gives an overview of the approach. Part 2 describes the tissue-contaminant strategies of other agencies and compares them to the strategy used in NAWQA. Part 3 details the approach for the use of tissue analysis as an aid to interpreting quality of water in NAWQA study units. Concentrations of contaminants in tissues will complement measures of water and sediment chemistry, and ecological surveys in NAWQA, providing multiple lines of evidence for water-quality assessments. Individual sections in Part 3 provide detailed discussions of target contaminants, target taxa, and field procedures. Suggestions for interpretation of data are presented to facilitate consistency among NAWQA study units.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 265
Reprint: In File
Keywords: River/Monitoring/Biological monitoring
Abstract: Three biomarkers of hydrocarbon exposure, liver 7-ethoxyresourfin-O-deethylase activity (EROD), fluorescent
hydrocarbon compounds (FACs) in bilis, and the liver antioxidant enzyme catalase (CAT) were examined in the autochthonous fish species Barbus meridionalis collected in the river Fluvià (NE Catalunya, Spain) after an oil spillage. Four different locations were sampled, including the impacted site, upstream and downstream sites and a reference site. Biomarker responses were compared with diatom and macroinvertebrate community assemblage metrics (Specific Pollution Sensitivity index - IPS, and Iberian Biological Monitoring Working Party - IBMWP, respectively). Chemical analyses denoted that polycyclic aromatic hydrocarbon levels in sediment were much higher at the impacted site than in downstream reaches. Four fold increase of EROD activity together with increased levels of biliary FACs in barbs collected at the spilled sited indicated exposure of inhabiting fish to the oil. Additionally, CAT activity was significantly depressed (fourfold) when compared to other stations, thus suggesting that fish collected from the impacted sites could be more susceptible to suffer oxidative stress. Biological indices (particularly that of the diatom community (IPS) showed slight significant effects between control and impacted sites, indicating that more tolerant taxa were favored because of the oil spillage. These results support the need to include biochemical responses measured in local species in monitoring programmes aimed to diagnose specific pollution effects in stressed river ecosystems.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
  - Stressor
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national consistency in collection techniques while allowing flexibility in habitat assessment within individual Study Units. Procedures are described for collecting habitat data at basin and segment scales; these procedures include use of geographic information system data bases, topographic maps, and aerial photographs. Data collected at the reach scale include channel, bank, and riparian characteristics.

Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 321
Reprint: In File
Keywords: Habitat/Water/Water quality/Alaska/River/Environmental conditions/Monitoring/water resources
Abstract: The miniaturization of sensors and other technological advances in electronics have resulted in water-quality instruments that house multiple sensors capable of simultaneous readings for various field measurements in environmental waters. With the use of these multiparameter instruments, field measurements can be determined with considerable reduction in the field work that generally is required when using multiple single-parameter instruments. This section addresses the short-term or discrete-measurement use of portable multiparameter instruments. Refer to Wagner and others (2006) for long-term or continuous-monitor deployment in surface water.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
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Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 240
Reprint: In File
Keywords: Arctic/Arctic tundra/Arctic grayling/Kuparuk/River/Monitoring
Abstract: Experimental additions of phosphorus or phosphorus plus nitrogen to Oksrukuyik Creek, an arctic tundra stream, stimulated production at all trophic levels relative to an unfertilized reach. Epilithic chlorophyll concentration, primary production, and respiration in the epilithic community increased in fertilized riffles, and biomass of diatoms and filamentous macroalgae increased considerably. Production and density of Baetis spp. and Orthocladius rivulorum, 2 key grazing larval insects, increased in the fertilized zone. Production and density of larval black flies, the major filter feeders in the Creek, were not affected significantly by enrichment. Fertilization increased summer growth of adult and young-of-the-year Arctic grayling Thymallus arcticus. Mean summer discharge was an important regulator of epilithic chlorophyll concentration, macroalgal biomass, Orthocladius production, and possibly fish growth. We compared our results to a similar fertilization experiment conducted in the Kuparuk River, a larger arctic tundra stream. In both systems, production increased at every trophic level, although responses of specific primary producers and insects differed, possibly because of differences in flow regimes.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 94
Reprint: In File
Keywords: Lakes/Monitoring/Arctic
Appendix D. Annotated Bibliography


Abstract: Using empirical data from 466 temperate to arctic lakes covering a total phosphorus (TP) gradient of 2-1036 µg L⁻¹, we describe how the relative contributions of resource supply, and predator control change along a nutrient gradient. We argue that (a) predator control on large-bodied zooplankton is unimodally related to TP and is highest in the most nutrient-rich and nutrient-poor lakes and generally higher in shallow than deep lakes, (b) the cascading effect of changes in predator control on phytoplankton decreases with increasing TP, and (c) these general patterns occur with significant variations that is, the predation pressure can be low or high at all nutrient levels. A quantile regression revealed that the median share of the predator-sensitive Daphnia to the total cladoceran biomass was significantly related unimodally to TP, while the 10% and 90% percentiles approached 0 and 100%, respectively, at all TP levels. Moreover, deep lakes (more than 6 m) had a higher percentage of Daphnia than shallow (less than 6 m) lakes. The median percentage of Daphnia peaked at 0.15 mg L⁻¹ in shallow lakes and 0.09 mg L⁻¹ in deep lakes. The assumption that fish are responsible for the unimodality was supported by data on the abundance of potential planktivorous fish (catch night gill nets with the different mesh sizes [CPUE]). To elucidate the potential cascading effect on phytoplankton, we examined the zooplankton phytoplankton biomass ratio. Even though this ratio was inversely related to CPUE at all TP levels, we found an overall higher ratio in oligotrophic lakes than in eutrophic lakes, despite similar predator control of large-bodied zooplankton. Accordingly, the phytoplankton yield, expressed as the chlorophyll a-TP ratio, did not relate to CPUE at low TP, but it increased significantly with CPUE at high TP. We conclude that the chances of implementing a successful restoration program using biomanipulation as a tool to reduce phytoplankton biomass increase progressively with increasing TP, but that success in the long term is most likely achieved at intermediate TP concentrations.

Notes: Use in monitoring plan development:
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Baseline Data
Model Development
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Structural or Physical Changes
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Abstract: Anthropogenic stressors are currently a major threat to marine fish populations. Marine fisheries are declining worldwide and, although overfishing is a major cause, habitat alteration and contaminants have also been implicated as contributing factors. As studies of the effects of stress move to higher levels of biological organization and toward higher environmental relevance, linking cause (stressor) to effect becomes more difficult. Consequently, while it is important to
develop more accurate techniques for establishing these linkages between cause and effect, it is also critical to have a clear understanding of the limitations of our understanding and methods of risk prediction if we are to manage our aquatic resources in a prudent manner.

Notes: Use in monitoring plan development:
- Not Used

Baseline Data
Model Development
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Physical Process
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Functional Response
Method

Ref ID: 272
Reprint: In File
Keywords: Lakes/Stream Crossings/Habitat/Streams/Fish Passage/Monitoring/Composition
Abstract: Within the period from 1989 to 1993, the impact of heavy metals and acid oxides on lakes, more than 100 km distant from the nearest source of pollution (enterprises of the copper-nickel industry), has been investigated. On the basis of complex investigations (chemical composition of snowpack and lake sediments, state of fish organisms and populations), it was discovered that there is intensive precipitation of heavy metals and acid oxides within the catchment of the lake Kochejavr. The catchment is characterized by a natural buffer capacity to neutralize acid precipitation. Active accumulation of heavy metals is observed in lake sediments. Metal accumulation causes subtoxic effects on the lake fish. The levels of precipitation of nickel and copper of 0.9 mg/m² per year over long periods was found to be dangerous for biological systems of freshwater catchments.
Notes: Use in monitoring plan development:
- Not Used

Baseline Data
Model Development
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Physical Process
Structural or Physical Changes
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Method

Ref ID: 177
Reprint: In File
Keywords: Human ecology/Ecology/Alaska/Monitoring/Wainwright
Abstract: Report incomplete. Sections included: (1) Fish, (2) Discussion, (3) Notes, (4) Glossary, (5) Bibliography. Figure 23: Fishing locations near Wainwright
Notes: Use in monitoring plan development:
- Not Used

Baseline Data
Model Development
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Physical Process
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Functional Response
Method

Ref ID: 318
Reprint: In File
Keywords: Habitat/Water/Water quality/Alaska/River/Environmental conditions/Monitoring
Abstract: During 2001-2002, the U.S. Geological Survey sampled streambed sediment at 23 sites, measured water quality at 26 sites, and assessed fish habitat for the entire length of Noyes Slough, a 5.6-mile slough of the Chena River in Fairbanks, Alaska. These studies were undertaken to document the environmental condition of the slough and to provide information to the public for consideration in plans to improve environmental conditions of the waterway. The availability of physical habitat for fish in the slough does not appear to be limited, although some beaver dams and shallow water may restrict movement, particularly during low flow. Elevated water temperatures in summer and low dissolved-oxygen concentrations are the principle factors adversely affecting water quality in Noyes Slough. Increased flow mitigated poor water-quality conditions and reduced the number of possible fish barriers. Flow appears to be the most prominent mechanism shaping water quality and fish habitat in Noyes Slough. Streambed sediment samples collected at 23 sites in 2001 were analyzed for 24 trace elements. Arsenic, lead, and zinc were the only trace elements detected in concentrations that exceed probable effect levels
for the protection of aquatic life. The background concentration for arsenic in Noyes Slough is naturally elevated because of significant concentrations of arsenic in local bedrock and ground water. Sources of the zinc and lead contamination are uncertain, however both lead and zinc are common urban contaminants. Streambed-sediment samples from 12 sites in 2002 were analyzed for organochlorine pesticides, polychlorinated biphenyls (PCBs), and semivolatile organic compounds (SVOCs). The concentration of bis(2-ethylhexyl)phthalate of 2,600 micrograms per kilogram (µg/kg) for one sample from the site above Aurora Drive approached the aquatic-life criterion of 2,650 µg/kg. Low concentrations of p-cresol, chrysene, and fluoranthene were detected in most of the sediment samples. The presence of these compounds in Noyes Slough sediment was expected because cresols are emitted to the atmosphere in the exhaust from motor vehicles and chrysene and fluoranthene are formed during the incomplete burning of coal, oil, gas, wood, garbage, or other organic substances. Low-level concentrations of DDT or its degradation products DDD and DDE were detected in all samples collected during 2002. However, total DDT (DDT+DDD+DDE) concentrations are less than the effects range median aquatic-life criterion of 46.1 µg/kg. In general, total DDT concentrations were less than 10 µg/kg, except for samples from two sites that have estimated concentrations of about 14 and 20 µg/kg.

Notes: Use in monitoring plan development:
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Baseline Data
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Structural or Physical Changes
Functional Response
Method

Ref ID: 273
Reprint: In File
Keywords: Arctic/Lakes/Monitoring/Water
Abstract: We studied Arctic char (Salvelinus alpinus) from five oligotrophic Alpine lakes in northern Tyrol, Austria, that differed in altitude (929 - 2796 m above sea level), pH (pH 5.4 - 8.3), and alkalinity (1.3 - 2750 µequiv·L⁻¹). Concentrations of Cd, Pb, Zn, and Cu were measured in the water and in the kidney of fish, allowing the calculation of metal bioconcentration factors between water and fish kidney. Despite relatively low Cd and Pb concentrations in the water (Cd, 0.1 µg·L⁻¹; Pb, 0.5 µg·L⁻¹; dissolved), metal concentrations in the kidneys of fish from the most acidic lake (Cd, 123 µg·L⁻¹; Pb, 19 µg·g⁻¹, dry weight) were comparable with those of fish from waters polluted by direct discharge of metals. Concentrations of Cd and Pb in the kidney were negatively correlated with the alkalinity of the lakes. Comparison with data from other studies confirms the predictive utility of water alkalinity for estimating Cd accumulation in fish from oligotrophic lakes. The correlation between bioconcentration factors and alkalinity was negative for Cd and Pb, positive for Zn, and nonsignificant for Cu.
Notes: Use in monitoring plan development:
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Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 274
Reprint: In File
Keywords: Arctic/Monitoring/Water
Abstract: Cd and Pb concentrations in the liver, kidney, and stomach contents of Arctic char (Salvelinus alpinus) from an oligotrophic high mountain lake (Schwarzsee ob Solden Tyrol, Austria) with low pH (4.8 to 6.4) and alkalinity (-8 to +8 µequiv·L⁻¹) were investigated over the course of 1 year. Peak concentrations of Cd and Pb in the water coincided with the drop of pH during snowmelt, whereas metal concentrations in liver and kidney were lowest at the end of winter and increased during summer. Furthermore, the Cd and Pb load of the food was considerably higher in winter than during summer. Thus, fluctuations in the metal levels in fish did not correlate with seasonal variations in the metal concentrations in lake water or in the diet. Rather, patterns of metal accumulation in the fish indicated that enhanced metal uptake was a consequence of increasing metabolic rates during summer. Thus, water temperature appeared to be the driving force of metal accumulation in fish from an oligotrophic lake. Concentrations of Cd and Pb in liver and kidney were positively correlated to age. A simple empirical model illustrates the ability of the fish to eliminate considerable amounts of accumulated metals.
Notes: Use in monitoring plan development:
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Structural or Physical Changes
Ref ID: 278
Reprint: In File
Keywords: River/Monitoring/Streams
Abstract: In response to a number of recommendations following the Northern Rivers Basin Studies (NRBS) contaminant program, the Northern Rivers Ecosystem Initiative (NREI) focused considerable attention on assessing contaminants from specific sources including pulp mill effluents, atmospheric transport of mercury and the Alberta oil sands operations. NRBS identified a number of major contaminants of concern including polychlorinated biphenyls, dioxins and furans, mercury and various hydrocarbons. Together, the NRBS and the NREI studies have demonstrated major declines in the levels of dioxins and furans over the last decade as pulp and paper mills have changed their process and treatment strategies in response to new Federal regulations. Polychlorinated biphenyls however, continue to be a concern for the region as their levels have not declined in fish and sediments over the course of these studies. Higher levels in sediments downstream of Grande Prairie and Hinton were identified, but the source of these contaminants remains unknown. Chlorinated pesticides were also investigated, and although toxaphene, DDT and other chlorinated organic pesticides were detected in fish tissue, they were present at very low levels. Studies on the oil sands industry in northern Alberta demonstrated limited impacts on the Athabasca River to date, although studies did identify slight to moderate impacts of natural oil seeps on fish and benthic communities in tributary streams. NREI studies also identified endocrine active compounds in the three pulp and paper mill effluents tested, but endocrine disruptive effects in wild fish were minimal. Municipal sewage effluents also contain endocrine active compounds and it is recommended that monitoring continue around these point sources.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 203
Reprint: In File
Keywords: fish communities/Monitoring/Lakes/Composition
Abstract: Knowledge of zooplankton size structure and measures of lake productivity can facilitate interpretation of data from fishery surveys. Our findings demonstrate that, for small warm-water lakes containing predominantly centrarchids and percids, the size composition of the zooplankton community and growth and size structure of the fish community are closely correlated. Spatial-temporal differences between lakes suggest the fishery manager can obtain a useful measure of zooplankton size by sampling at deeper, offshore sites in August. Measurement of zooplankton size as an index of predator-prey balance in the fish community offers a simple, yet economical, approach for assessing the status of a fish population and determining management options. Comparisons of Fee's productivity index, zooplankton biomass, and catches of fish in variable-mesh gill nets indicate that lakes with a high productivity index generally support a larger biomass of planktivorous fish. Finally, evaluation of fish communities through assessment of zooplankton populations and measures of lake productivity has sound potential for future investigations and provides a rational basis for developing fish-management strategies
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 279
Reprint: In File
Keywords: Arctic/Water/Monitoring/Arctic Region/Pollutants
Abstract: Based upon studies in the industrially developed Arctic region, Russian Kola, here we discuss the fate of metals in high latitude surface water. Mainly, attention is paid to the priority pollutants from copper-nickel smelters. The influence of accompanying processes, such as acidification and eutrophication, on metal behavior is considered. The dramatic situation for fauna of Arctic latitudes is illustrated: (i) during the snow-melt, due to the pulse of tonic metal forms; and (ii) during the long polar winter in lower water layers, due to the involvement of a wide spectrum of metals in the redox-cycle under
eutrophication and oxygen deficiency. Here we identify fish pathologies, which are related to the influence of metals. Generalizing the data on metal behavior, an original approach to define the integrated toxicity index for surface waters of the Russian Kola (based on the data for a 460-lake survey). As shown, there is a risk of fish diseases, due to both airborne contamination by metals and an indirect leaching by acid runoff over almost 30% of the area of the Russian Kola. For the Arctic region, polar winter stress syndrome will be repeatedly significant. During the polar night, as well as the spring, the vulnerability of the Arctic biota to toxic impact is higher. The accompaniment of water metal-pollution by two or more stressors would occur simultaneously, thereby multiplying the risk that it could develop.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
  - Physical Process
    - Structural or Physical Changes
  - Functional Response
- Method


Ref ID: 324
Reprint: In File
Keywords: Habitat/Water/Water quality/Alaska/River/Environmental conditions/Monitoring/Lakes/Water chemistry/fish communities/integrated assessment
Abstract: Algal, invertebrate, and fish communities are characterized as part of ecological studies in the U.S. Geological Survey's National Water-Quality Assessment Program. Information from these ecological studies, together with chemical and physical data, provide an integrated assessment of water quality at local, regional, and national scales. Analysis and interpretation of water-quality data at these various geographic scales require accurate and consistent application of sampling protocols and sample-processing procedures. This report revises and unifies into a single document the algal, invertebrate, and fish community sampling protocols used in the National Water-Quality Assessment Program.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
  - Physical Process
    - Structural or Physical Changes
  - Functional Response
- Method


Ref ID: 325
Reprint: In File
Keywords: Water quality/Monitoring
Abstract: The data-quality objectives of the National Water-Quality Assessment Program include estimating the extent to which contamination, matrix effects, and measurement variability affect interpretation of chemical analyses of surfacewater samples. The quality-control samples used to make these estimates include field blanks, field matrix spikes, and replicates. This report describes the design for collection of these quality-control samples in National Water-Quality Assessment Program studies and the data management needed to properly identify these samples in the U.S. Geological Survey's national data base.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
  - Physical Process
    - Structural or Physical Changes
  - Functional Response
- Method


Ref ID: 282
Reprint: In File
Keywords: River/Monitoring/Composition
Abstract: Phosphorus fertilization of a pristine tundra river for four consecutive summers dramatically changed biological
processes and populations at all trophic levels. At the primary producer level, both algal biomass and productivity increased and chlorophyll accumulated on the river bottom in the first two summers. Diatom community composition changed little in spite of large chlorophyll changes. However, an increase in grazing insects prevented chlorophyll buildup in the third and fourth summers. Some microbial processes were also stimulated by the increased photosynthesis caused by fertilization. Total respiration of the epilithon, acetate uptake, and decomposition of lignin monomers were all stimulated but only in light-grown epilithon. When epilithon was grown in the dark in the fertilized region of the river, there was no increased respiration. Also, phosphorus did not stimulate the decomposition of Carex litter. Although insects grew more rapidly in the fertilized section of the river, there were community interactions that kept total insect production from appreciable change. The four most abundant large insects did increase their growth rates in response to phosphorus addition and there were increases in populations of Baetis lapponicus and Brachycentrus americanus. These increases were offset by the decline in abundance of the dominant species, the black fly Prosimulium martini, perhaps caused by competition for space from Brachycentrus. Growth of both young-of-the-year and adult grayling (Thymallus arcticus) was strongly stimulated by phosphorus addition in years 3 and 4 (not tested in years 1 and 2). Carbon and nitrogen stable isotope tracers indicated that the measured increases in insect and fish growth were largely attributable to increases in the production of epilithic algae. Overall, the results indicate a strong "bottom-up" response of the riverine food web to additions of the limiting nutrient, phosphorus. The response was modified in later years, however, by a strong "top-down" feedback of insects grazing on epilithic algae and by competitive exclusion of black flies by caddisflies.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 287
Reprint: In File
Keywords: Arctic/Arctic tundra/Monitoring/River/Streams
Abstract: 1. As part of a whole-system study, the response of the heterotrophic microfaunal community colonizing artificial substrata (polyfoam units) to fertilization of an arctic tundra stream was followed for 6 weeks during the summer. 2. Dominant heterotrophic microfauna observed included amoebae (approximately 40% of colonizing biomass), rotifers (36% of biomass) and ciliates (25% of biomass). 3. Biomass of heterotrophic microfauna on artificial substrata was not significantly different in a control reach and an experimental reach fertilized with phosphorus (loading rate ten times ambient), but in a reach fertilized with both phosphorus and nitrogen (loading rates ten times ambient) biomass was double that of the control and phosphorus-fertilized reaches. The lack of response in the phosphorus reach was probably due to greater insect grazing as a result of previous phosphorus fertilization of this reach. 4. Abundance of microfauna on epilithic surfaces in the river was higher on rock from pools than on rocks from riffle areas, but abundance on the artificial substrata was higher than on the natural rocks. 5. The results suggest that microfauna of arctic tundra streams are regulated by grazers and that their importance in transfers among trophic levels is greater in pools than in riffles.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 336
Reprint: In File
Keywords: Monitoring/River
Abstract: This document describes procedures used by biologists to collect information, tissues, and fluids useful for determining the exposure of fish to environmental contaminants. Fish are to be captured and held alive (generally <1 h), then weighed, measured, and examined for grossly visible external lesions. A blood sample is collected by caudal veinipuncture. The fish is subdued, and its abdominal cavity is opened with a mid-ventral incision. The internal organs are dissected from the fish for examination. Selected organs are weighed, and tissues are collected for laboratory analyses. All remaining tissues and fluids are then returned to the carcass, which is prepared for chemical analysis. Individual fish are composited by station, species, and gender; frozen; and shipped to the analytical laboratory. Procedures are also described for record keeping; processing blood to obtain serum and plasma; flash-freezing samples; cleaning equipment; and preventing the transport of living organisms among waterways. A list of necessary equipment and supplies is also provided.
Notes: Use in monitoring plan development:
34. Shelton, L. R. and P. D. Capel. 1994. Guidelines for collecting and processing samples of stream bed sediment for analysis of trace elements and organic contaminants for the National Water-Quality Assessment program. Open-File Report 94-458. U.S. Geological Survey, National Water-Quality Assessment Program Unit, Sacramento, California. Ref ID: 328 Reprint: In File Keywords: Water quality/Streams/Monitoring Abstract: A major component of the U.S. Geological Survey's National Water-Quality Assessment program is to characterize the geographic and seasonal distributions of water-quality conditions in relation to major contaminant sources. For streams, the assessment of trace elements and organic contaminants is accomplished through two-phase assessment of stream bed sediments and tissues of aquatic organisms. The first phase of the strategy is to identify important constituents based on data collected from bed-sediment depositional zones. Fine-grained particles deposited in these zones are natural accumulators of trace elements and hydrophobic organic compounds. For the information to be comparable among studies in many different parts of the Nation, strategies for selecting stream sites and depositional zones are critical. Fine-grained surficial sediments are obtained from several depositional zones within a stream reach and composited to yield a sample representing average conditions. Sample collection and processing must be done consistently and by procedures specifically designed to separate the fine material into fractions that yield uncontaminated samples for trace-level analytes in the laboratory. Special coring samplers and other instruments made of Teflon are used for collection. Samples are processed through a 2.0-millimeter stainless-steel mesh sieve for organic contaminate analysis and a 63-micrometer nylon-cloth sieve for trace-element analysis. Quality assurance is maintained by strict collection and processing procedures, duplicate sampling, and a rigid cleaning procedure.

Notes: Use in monitoring plan development: Not Used Baseline Data Model Development Stressor Physical Process Structural or Physical Changes Functional Response Method

35. Shelton, L. R. 1994. Field guide for collecting and processing stream-water samples for the National Water-Quality Assessment Program. Open-File Report 94-455. U.S. Geological Survey, National Water-Quality Assessment Program Unit, Sacramento, California. Ref ID: 327 Reprint: In File Keywords: Habitat/Water/Water quality/Alaska/River/Environmental conditions/Monitoring/Lakes/Water chemistry/Streams Abstract: The U.S. Geological Survey's National Water-Quality Assessment program includes extensive data-collection efforts to assess the quality of the Nation's streams. These studies require analyses of stream samples for major ions, nutrients, sediments, and organic contaminants. For the information to be comparable among studies in different parts of the Nation, consistent procedures specifically designed to produce uncontaminated samples for trace analysis in the laboratory are critical. This field guide describes the standard procedures for collecting and processing samples for major ions, nutrients, organic contaminants, sediment, and field analyses of conductivity, pH, alkalinity, and dissolved oxygen. Samples are collected and processed using modified and newly designed equipment made of Teflon to avoid contamination, including nonmetallic samplers (D-77 and DH-81) and a Teflon sample splitter. Field solid-phase extraction procedures developed to process samples for organic constituent analyses produce an extracted sample with stabilized compounds for more accurate results. Improvements to standard operational procedures include the use of processing chambers and capsule filtering systems. A modified collecting and processing procedure for organic carbon is designed to avoid contamination from equipment cleaned with methanol. Quality assurance is maintained by strict collecting and processing procedures, replicate sampling, equipment blank samples, and a rigid cleaning procedure using detergent, hydrochloric acid, and methanol.

Notes: Use in monitoring plan development: Not Used Baseline Data Model Development Stressor Physical Process Structural or Physical Changes Functional Response Method
Ref ID: 329
Reprint: In File
Keywords: Habitat/Water/Water quality/Alaska/River/Environmental conditions/Monitoring/Lakes/Water chemistry
Abstract: For many years, stream samples for analysis of volatile organic compounds have been collected without specific guidelines or a sampler designed to avoid analyte loss. In 1996, the U.S. Geological Survey's National Water-Quality Assessment Program began aggressively monitoring urban stream-water for volatile organic compounds. To assure representative samples and consistency in collection procedures, a specific sampler was designed to collect samples for analysis of volatile organic compounds in stream water. This sampler, and the collection procedures, were tested in the laboratory and in the field for compound loss, contamination, sample reproducibility, and functional capabilities. This report describes that sampler and its use, and outlines field procedures specifically designed to provide contaminant-free, reproducible volatile organic compound data from stream-water samples. These guidelines and the equipment described represent a significant change in the U.S. Geological Survey instructions for collecting and processing stream-water samples for analysis of volatile organic compounds. They are intended to produce data that are both defensible and interpretable, particularly for concentrations below the microgram-per-liter level. The guidelines also contain detailed recommendations for quality-control samples.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 290
Reprint: In File
Keywords: Kuparuk/River/Monitoring/Arctic/North Slope/Alaska/Habitat/Composition/Arctic tundra
Abstract: A long-term stream fertilization experiment was performed to evaluate the potential eutrophication of an arctic stream ecosystem. During 16 years of summer phosphorus (H₃PO₄) fertilization, we observed a dramatic change in the community structure of the Kuparuk River on the North Slope of Alaska. A positive response to fertilization was observed at all trophic levels with increases in epilithic algal stocks, some insect densities, and fish growth rates. After approximately eight years of P fertilization, bryophytes (mosses) replaced epilithic diatoms as the dominant primary producers in the Kuparuk River. The moss impacted NH₄⁺ uptake rates, benthic gross primary production, habitat structure, and insect abundance and species composition. This study documents the long-term changes in arctic tundra stream in response to nutrient enrichment. Predicting stream ecosystem responses to chronic perturbation requires long-term observation and experiments.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 330
Reprint: In File
Keywords: Habitat/Water/Water quality/Alaska/River/Environmental conditions/Monitoring/Lakes/Water chemistry
Abstract: The National Field Manual for the Collection of Water-Quality Data (National Field Manual) describes protocols and provides guidelines for U.S. Geological Survey (USGS) personnel who collect data that are used to assess the quality of the Nation's surface-water and ground-water resources. This chapter addresses preparations and appropriate methods for the collection of surface-water, ground-water, and associated quality-control samples. Among the topics covered are considerations and procedures to prevent sample contamination; establishing site files; instructions for collecting depth-integrated isokinetic and nonisokinetic samples at flowing- and still-water sites; and guidelines for collecting formation water from wells having various types of construction and hydraulic and aquifer characteristics.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process

Ref ID: 331
Reprint: In File
Keywords: Habitat/Water/Water quality/Alaska/River/Environmental conditions/Monitoring/Lakes/Water chemistry/Turbidity/water resources
Abstract: The U.S. Geological Survey uses continuous water-quality monitors to assess the quality of the Nation's surface water. A common monitoring-system configuration for water-quality data collection is the four-parameter monitoring system, which collects temperature, specific conductance, dissolved oxygen, and pH data. Such systems also can be configured to measure other properties, such as turbidity or fluorescence. Data from sensors can be used in conjunction with chemical analyses of samples to estimate chemical loads. The sensors that are used to measure water-quality field parameters require careful field observation, cleaning, and calibration procedures, as well as thorough procedures for the computation and publication of final records. This report provides guidelines for site- and monitor-selection considerations; sensor inspection and calibration methods; field procedures; data evaluation, correction, and computation; and record-review and data-reporting processes, which supersede the guidelines presented previously in U.S. Geological Survey Water-Resources Investigations Report 00–4252. These procedures have evolved over the past three decades, and the process continues to evolve with newer technologies.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method


Ref ID: 131
Reprint: In File
Keywords: Monitoring
Abstract: In Canada, Environmental Effects Monitoring (EEM) programs exist within two regulations: the Pulp and Paper Effluent Regulations and the new Metal Mining Effluent Regulations under the Canadian Fisheries Act. EEM provides a biological, effects-based feedback loop to assess the effectiveness of technology-based regulations in protecting receiving environments. The promulgation of the Pulp and Paper Effluent Regulations, in 1992, represented a significant step forward in the Canadian regulatory approach by incorporating directly into a regulation a requirement to assess the effects of effluent discharges on receiving environments using proven scientific monitoring methodologies. Similarly, an assessment of the aquatic impacts of mines resulted in recommendations to amend the Metal Mining Effluent Regulations, recently promulgated in 2002, and includes an EEM program as a science-based feedback loop. As such, these regulations recognize the possibility that national, technology-based standards may not necessarily protect all receiving environments because of the diversity and variability of both discharges and receiving sites across the country. Since that time, EEM has improved its flexibility by considering both advances in science and the uniqueness of monitoring sites across Canada to allow the most appropriate and cost-effective monitoring approaches at each site while maintaining national consistency. This paper discusses the use of monitoring under two Canadian regulations to assess effects on aquatic ecosystems. As well, the National EEM approach to maintaining up-to-date scientific practices in a national regulatory program is discussed using examples.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method


Ref ID: 133
Reprint: In File
Keywords: Freshwater fishes/Fishes/Alaska/Monitoring/Water
Abstract: Small (1-5 C) changes in water temperatures may have consequential effects on fish, depending upon the time of year the changes occur, the magnitude and duration of the changes, and the fish species and life stage of the fish affected.
Changes in water temperature affect survival at all life stages, rates of egg development and growth, timing of smolting, and mortality rates during overwintering. Increases or decreases in water temperature may influence reproduction by changing the timing of the spawning run; influencing fish to seek other spawning areas, increasing egg mortality and the occurrence of deformed alevins, changing the time for egg development; or causing fish to avoid certain streams or stream reaches.

Changes in temperature have been shown to affect the number of eggs that are successfully fertilized when fish are delayed in migrating to spawning areas. In Alaska, elevations in temperature may be particularly harmful to fishes that are adapted to coldwater conditions and rarely experience significant summer warming. Many of the studies that relate changes in temperature to effects on fish examine higher ranges than are usually experienced by fish in Alaska. Therefore, acceptable upper and lower temperature ranges from published literature are often not applicable to fish naturally occurring at higher latitudes. This report examines much of the published literature on coldwater species of fish that inhabit freshwater.

Summaries are given of the effects of changes on temperature on different life stages. The final section of this report presents recommendations for optimal temperatures for various fish life stages.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
  - Stressor
  - Physical Process
  - Structural or Physical Changes
  - Functional Response
- Method


Ref ID: 44
Reprint: In File
Keywords: Alaska/Effect of water pollution on/Fishes/National Petroleum Reserve (Alaska)/Pollutants/Monitoring/Petroleum/Colville River/River

Abstract: The BLM entered into a cooperative agreement with the FWS to undertake a fisheries contaminant investigation in NPR-A during 1981 to establish some baseline contaminant information. The purpose of this investigation was to determine background levels of environmental contaminants in fish in selected sites within NPR-A from where the lease areas were most likely to be chosen. This information would be necessary to evaluate post exploration and possible development of petroleum resources as it affected the availability of pollutants to the aquatic environment. Sampling was conducted at three locations with NPR-A. All three areas, Eastern Teshekpuk Lake, Liberator Lake, and the Colville River near Umiat.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
  - Stressor
  - Physical Process
  - Structural or Physical Changes
  - Functional Response
- Method


Ref ID: 219
Reprint: In File
Keywords: Monitoring/Prudhoe Bay/Water/Water quality/Arctic/Arctic tundra/Alaska/Turbidity

Abstract: We attempted to determine if water quality or the macroinvertebrate community of these ponds was being adversely affected by oil field operations. In particular, we examined the impacts of direct and indirect discharges of reserve pit fluids into tundra ponds. Results of simple linear regressions of chemical on biological data (pits excluded) were used to suggest water quality and contaminant variable indicative of adverse environmental impacts. Water quality characteristics that best predicted deteriorating biological conditions were alkalinity and hardness, and metals most indicative of biological change were arsenic and barium. In addition, chromium concentrations in reserve pits and ponds near drill sites may have exceeded chronic toxicity criteria for protection of aquatic life set by the U.S. Environmental Protection Agency (EPA), and high concentrations of chromium had obviously dispersed into distant ponds. Measurement of these variables should assist in more effectively screening reserve pit fluids before discharging to the tundra. June 1983 inspections at Prudhoe Bay, Alaska, revealed oil sheens at 52% of the reserve pits, and discharges of 61% to tundra and roads. Pits, adjacent, distant, and control ponds differed significantly (P<.05) in water quality and biological characteristics. Of the water quality characteristics, the primary discriminant function corresponded to a gradient in turbidity, and a second function reflected increases in alkalinity from control to receiving ponds. Among biological variables, total taxa accounted for 89% of the variance. Kruskal-Wallis tests showed that hardness, alkalinity, turbidity, chromium, barium, arsenic, and nickel were elevated in receiving versus control ponds (P<.05). Alkalinity, chromium, and aliphatic hydrocarbons were higher in distant ponds than in controls. Regressions showed that alkalinity, hardness, arsenic, and barium were the water quality and contaminant variables that best predicted deteriorating biological conditions. Chromium concentrations were also high, and considerable mobility occurred for this metal. Measurement of these variables could assist in screening proposed discharges to tundra wetlands.
Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method

**Fish Harvest**

   - Ref ID: 152
   - Reprint: On Request 03/20/08
   - Keywords: Monitoring
   - Abstract: Shows some (not all) fishing areas for some NPR-A communities. Note: Full report is available at ARLIS.
   - Notes: Use in monitoring plan development:
     - Not Used
     - Baseline Data
     - Model Development
     - Stressor
     - Physical Process
     - Structural or Physical Changes
     - Functional Response
     - Method

   - Ref ID: 154
   - Reprint: On Request 03/20/08
   - Keywords: Monitoring/North Slope/Alaska
   - Abstract: This bibliography includes keywords with a one-sentence description of the content of the study. It includes 665 documents. Note: Full report available at ARLIS.
   - Notes: Use in monitoring plan development:
     - Not Used
     - Baseline Data
     - Model Development
     - Stressor
     - Physical Process
     - Structural or Physical Changes
     - Functional Response
     - Method

   - Ref ID: 157
   - Reprint: Not in File
   - Keywords: Monitoring
   - Abstract: Shows some (not all) fishing areas for some NPR-A communities.
   - Notes: Use in monitoring plan development:
     - Not Used
     - Baseline Data
     - Model Development
     - Stressor
     - Physical Process
     - Structural or Physical Changes
     - Functional Response
     - Method

   - Ref ID: 162
   - Reprint: In File
   - Keywords: North Slope/Alaska/Monitoring/caribou/Waterfowl/Wildlife management
Abstract: This study is part of the North Slope Borough Subsistence Harvest Documentation Project. Caribou is the most important subsistence resource for this community. The harvest of 311 caribou is low compared to other years. The community also harvested sheep, various fish, waterfowl, and furbearers. Most of the subsistence resources were harvested outside of the coastal zone. The study focused on harvest locations rather than areas hunted or fished. Appendix 5 includes a map that illustrates some of the Nunmiut place names associated with caribou harvest locations in the 1990s. These areas include the coastal zone corridor around the Anaktuvuk River. The map includes only a 40-mile radius around the community of Anaktuvuk Pass.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 161
Reprint: Not in File
Keywords: Monitoring/North Slope/Alaska/Subsistence
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 160
Reprint: Not in File
Keywords: Alaska/Monitoring/North Slope
Abstract: [In press]-This should be available soon from the Borough.-SRB
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 164
Reprint: On Request 03/20/08
Keywords: Monitoring/Nuiqsut/Subsistence/caribou
Abstract: This document reflects the values important to the people of Nuiqsut, subsistence uses, historical sites, and chronicles the return to the community by residents that moved away earlier in the century. The document includes a map of intensive subsistence use areas, historical extended use areas, and other maps for furbearers, caribou, fish, moose, and seal. The document states that "seasonal locations for fishing and trapping are scattered over a vast territory". Conflicts between subsistence and hunting guide activities, noise from aircraft, and damage from seismic activities are documented. NOTE: Full report is available at ARLIS.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Ref ID: 40
Reprint: On Request 03/20/08
Keywords: Alaska/Economic aspects/Environmental aspects/National Petroleum Reserve/National Petroleum Reserve (Alaska)/Petroleum/Petroleum industry and trade/Subsistence economy/Monitoring
Abstract: Large overlay report available at ARLIS.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 165
Reprint: In File
Keywords: Fishes/Petroleum/Alaska/Monitoring/Subsistence/Barrow
Abstract: This workshop was held in conjunction with a project titled Development of Comprehensive Management Plans for Subsistence Use Animals Within NPR-A. The purpose of the project was to compile information about fish and wildlife resources in NPR-A, consideration of mitigation measures and recommendations for future studies. The workshop, held in Barrow October 1988, included both Inupiat elders and scientists. This workshop was convened because of the lack of information about fish in the NPR-A. The proceedings summarize group discussion on individual species.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 12
Reprint: In File
Keywords: Fishery management/Alaska/National Petroleum Reserve/Congresses/Fishes/National Petroleum Reserve (Alaska)/Economic conditions/20th century/Subsistence economy/Salmonidae/Habitat/Smelts/Pike/Petroleum/North Slope/Wildlife management/Monitoring/Subsistence/Arctic/Arctic cisco/Barrow
Abstract: This report deals with the fishes. There was virtually no published information about the fishes of NPR-A that are of importance to subsistence users, and relatively little about the fishes elsewhere on the North Slope, with the exception of arctic cisco. However, scientists have been involved with studies of the arctic fishes in question, mainly (but not entirely) in areas other than the North Slope. Of equal importance, local knowledge about fishes of the North Slope has been accumulated and passed down, as oral history, for generations by the Inupiat fishers of the region. As an important starting point it seemed prudent to convene a workshop to be attended by highly knowledgeable Inupiat elders as well as by active, recognized scientific experts engaged in study of the arctic fishes of interest to the NSB. The workshop was convened in Barrow during October 26 to 28, 1988. There were 25 attendees of which 12 were invited fishery scientists or managers, 4 were from the North Slope Borough Department of Wildlife Management, 7 were Inupiat experts, each from a different North Slope Community, and 1 was a resident commercial fisherman of the Colville Delta, as well as a biological technician.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method
Ref ID: 167
Ref Type: Journal (Full)
Keywords: Arctic/Atqasuk/Barrow/Kaktovik/Monitoring/Nuiqsut/Point Lay/Subsistence/Wainwright/Whitefish/Fishes/Anadromous
Abstract: Subsistence fisheries in the Alaskan Arctic provide an important food source for the coastal communities of Barrow, Point Lay, Wainwright, Atqasuk, Nuiqsut, and Kaktovik. The total annual harvest (villages combined) is roughly 210,000 pounds of fish, which in terms of utilizable weight almost equals the villages’ annual harvest of bowhead whales. The fisheries concentrate on anadromous species (whitefishes, ciscoes, char, salmon) although freshwater species (grayling) are also taken. The species caught at each village differ, as would be expected based on distribution patterns of fishes in the study area. The fisheries are fairly well described in terms of timing and location but not harvest quantity. In some cases, the only available information about harvest quantity consists of a rough estimate made 15 years ago.
Notes: Use in monitoring plan development:
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 306
Abstract: This supplemental technique addresses the use of gill nets targeting salmonids in the Pacific Northwest but can be used for other species as well.
Notes: Use in monitoring plan development:
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 169
Abstract: This report covers subsistence harvests for Anaktuvuk Pass, Atqasuk, Barrow, Kaktovik, Nuiqsut, Point Hope, Point Lay and Wainwright. Harvest estimates were made for all communities except Point Lay and Atqasuk (low response rates). For all villages, the average harvest was 389 pounds per person (range from 315 pounds in Anaktuvuk Pass to 787 pounds in Kaktovik). The number of species harvested ranged from 34 in Anaktuvuk Pass to 62 in Barrow. Marine mammals dominated the catch in coastal villages, and caribou were important for all villages. No bowhead whales were taken in Wainwright during 1992, although this species is very important to that community. The survey did not address the location of subsistence activities.
Notes: Use in monitoring plan development:
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 170
Reprint: On Request 03/20/08
Keywords: Monitoring/Alaska/Subsistence/Nuiqsut/Subsistence economy/Colville River Delta/caribou/Colville River/River

Abstract: The purpose of this study was to provide a baseline of social conditions from which to measure impacts of offshore oil and gas projects. Most residents left this area in the 1940s, other than seasonal subsistence use. The traditional community of Nuiqsut was resettled in 1973 by families with ties to the area. Archaeological studies have not be extensive in this area. "Fish and Game Advisory Boards and other groups that deal with subsistence resources have a long and checkered history. Nuiqsut Inupiat seem to lump them all together." Chapter V addresses the subsistence economy. The Colville River Delta historically was the location of the trade fair of Nigliq, and it is "the geographic buffer zone for several different subsistence areas . . ." It is not possible to predict where concentrations of caribou will be located in any given year due to variability of migration patterns. Figure 16 illustrates major food sources. The study recognized the dietary, nutritional, social and cultural importance of subsistence. "[T]he harvesting of subsistence resources is a central organizing principle in the world-view of Nuiqsut residents". "Information on the harvest of fish and game is difficult to obtain, and is often of questionable reliability". This study focused more on consumption of subsistence resources rather than where the harvests occurred. It found that about 50% of the food consumed in Nuiqsut was from subsistence resources. Full report available at ARLIS.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 84
Reprint: In File
Keywords: Broad Whitefish/Whitefish/Prudhoe Bay/Alaska/Monitoring/Ecology/Arctic

Abstract: A decade of monitoring size and age structure and catch per unit effort of broad whitefish Coregonus nasus in the Prudhoe Bay region of Alaska has begun to yield an understanding of the life history of this species and the factors, including the effects of offshore developments, that govern population levels. The Endicott Causeway was constructed in spring 1985, before breakup of sea ice. Before 1985, abundance levels were high and the population was dominated by juveniles, especially the 1979 year-class. The local population reached its lowest levels for the period of record in 1985-1987, and the size structure became markedly bimodal with the 1979 year-class constituting most of the fish in the large-size mode. When these fish reached maturity in 1988, they disappeared from the population. Population levels then increased rapidly to pre-1985 levels, and the size structure that emerged at the end of 1992 greatly resembled the size structure observed in 1982. Evidence is presented showing that changes in abundance and size structure do not appear to be attributable to a causeway effect and that a density-dependent life history strategy may be implicated. We question the appropriateness of steps that have been taken to mitigate the perceived causeway effects on broad whitefish.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 171
Reprint: In File
Keywords: Alaska/Monitoring/North Slope/Wildlife management/Colville River/River/Subsistence/Nuiqsut/Kuparuk

Abstract: In light of the prospect of industrial impacts to the fishery it seemed timely that an effort to document the nature of the fishery be initiated to gather baseline data. Recently, state lease sales have been offered in the Colville Delta and, if commercial finds are made, it is likely these will be developed as a logical extension of the Kuparuk oil field. Additional concerns to managers are the possible impacts due to fishing pressure, as little is known about harvest levels or the size of the populations fished. The objectives of the study were: a) To identify the major fishing areas and periods and collect catch per unit effort data (CPUE) at these sites. b) To identify the target species harvested in the fishery. c) To test and develop methods for quantifying subsistence harvests.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development

Reprint: In File
Keywords: Monitoring/North Slope/Wildlife management/Nuiqsut/Water/Subsistence
Abstract: From previous studies, it was evident that the Kupigruak Channel was the most important fall fishing area in the Colville Region. In view of the comprehensive treatment of the Entrix study, our study was directed at documenting the level of effort and gathering catch data from specific sites along the Kupigruak Channel of the Colville during the period October 9-19, 1985. The objectives were as follows: a) To document the number of fishing stations, the level of effort and the type of gear used in the Nuiqsut fall fishery in the Kupigruak Channel of the Colville (for the study period 9-19 October). b) To document the daily harvest as to species, fork length, and numbers taken (in regard to net mesh size) at specific sites on the Kupigruak Channel. c) To document the daily water temperature and salinity at a specific station on the Kupigruak Channel. d) To sample the smaller size classes and other species not captured in the subsistence harvest.
Notes: Use in monitoring plan development: Not Used


Reprint: In File
Keywords: Alaska/Broad Whitfish/Fish populations/Fish surveys/Fishes/Habitat/Humpback Whitefish/Lakes/Least Cisco/Monitoring/Stock Assessment/Water/Water chemistry/Whitefish Lake/Yukon Delta National Wildlife Refuge/Whitefish/Kuskokwim River/Broad Whitefish/Composition
Abstract: Whitefish Coregoninae spp. are an important subsistence fish harvested year-round in the Kuskokwim River drainage. Conservation concerns regarding reduced size and abundance of broad whitefish, Coregonus nasus, resulted in the 1992 creation of subsistence regulations for whitefish in Whitefish Lake. To understand the dynamics of whitefish utilizing Whitefish Lake, we used a flexible picket weir and deployed Floy tags to assess the abundance, age at length composition and migratory patterns of broad whitefish, humpback whitefish, C. pidschian, and least cisco, C. sardinella, between 2001 and 2003. Emigrations were highest in 2003 for broad whitefish with 254 leaving the lake. Humpback whitefish and least cisco emigrations were highest in 2002 with 31,985 and 26,195, respectively. Inter year tag returns indicated fidelity to the lake. Maximum ages were 20, 29, and 14 for broad and humpback whitefish and least cisco, respectively. Extensive migrations were indicated through the return of tagged whitefish harvested by subsistence fishers between the village of Tuluksak (rkm 192) and Medfra (rkm 863). Otolith chemical analysis indicated fish using Whitefish Lake are anadromous.
Notes: Use in monitoring plan development: Not Used


Reprint: In File
Keywords: Alaska/Broad Whitefish/Humpback Whitefish/Kuskokwim River/Least Cisco/Monitoring/Water/Whitefish/River
Abstract: Passive Integrated Transponders (PIT) tags were surgically implanted in three broad whitefish Coregonus nasus, 84 least cisco C. sardinella, and 38 humpback whitefish C. pidschian to test their use for monitoring whitefish movements using flat panel antenna systems. Tagged fish were released between two antennas, located 200 m apart, and 78% of the tags were detected passing either upstream into the lake from the release location or downstream. An unexpected 17% of all tagged fish moved downstream and 13% were detected by both antennas. Of the 22% that were not detected, 37% were released the day before or the day of an equipment malfunction. The maximum read distance above the
antenna that a fish could be detected was 45 cm. Results indicate this technology is applicable to assess movements of individual whitefish in remote sites.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
  - Physical Process
  - Structural or Physical Changes
  - Functional Response
- Method

   Ref ID: 173
   Reprint: In File
   Keywords: Land use/Monitoring/North Slope/Nuiqsut/Subsistence
   Abstract: Nuiqsut was chosen for archeological and ethnohistorical work during the summer of 1977 primarily because the Traditional Land Use Inventory (T.L.U.I.) for that village had been completed and adopted. In a meeting held during the previous winter, the village had indicated which of the sites in the Nuiqsut area should be considered for National Register nomination. It was felt that many of these places could be visited during the summer, verifying their existence and clearly delineating the extent and nature of the resources. Research on the ethnohistory of the area would indicate the significance of the resources to local people and provide a valuable first step in understanding the culture history. This ethnohistory, when combined with the research on contemporary subsistence and archeology, would hopefully provide a picture of land use through time--a key to understanding of local values, present activities and future adaptations. Three work group members conducted research in Nuiqsut from early June until the end of August 1977. They were an archeologist, an ethnohistorian, and a subsistence worker. The archeologist and ethnohistorian conducted field research at sites near Nuiqsut which were chosen by the village residents from the T.L.U.I. Local Nuiqsut residents familiar with the sites were present on all field trips. The subsistence researcher spent most the summer season in the village, living with a local family. He talked with hunters throughout the village and made maps of land use areas with several of them.
   Notes: Use in monitoring plan development:
   - Not Used
   - Baseline Data
   - Model Development
   - Stressor
     - Physical Process
     - Structural or Physical Changes
     - Functional Response
   - Method

   Ref ID: 174
   Reprint: On Request 03/20/08
   Keywords: Monitoring/Nuiqsut
   Abstract: Background information on Nuiqsut. Full report available at ARLIS.
   Notes: Use in monitoring plan development:
   - Not Used
   - Baseline Data
   - Model Development
   - Stressor
     - Physical Process
     - Structural or Physical Changes
     - Functional Response
   - Method

   Ref ID: 176
   Reprint: On Request 03/20/08
   Keywords: Land use/Monitoring
   Abstract: Full report available at ARLIS.
   Notes: Use in monitoring plan development:
   - Not Used
   - Baseline Data
   - Model Development
   - Stressor
     - Physical Process
Ref ID: 308
Reprint: In File
Keywords: Lakes/Monitoring/salmonids/River
Abstract: The primary purpose of this book is to describe the great variety of field sampling protocols for determining the abundance, distribution, and productivity of salmonid populations, especially in stream and river networks. These protocols guide the field practitioner in the selection of appropriate methods to collect fish once the sampling locations have been determined. Equally important is the selection of the locations where fish are to be collected, especially when it is impractical to conduct a census by which all the fish are counted or when information is required for all locations on the stream network. Statisticians sometimes distinguish these two aspects as the sampling or survey design (Where should I collect the fish?) and the response design (How should I collect the fish?).
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 309
Reprint: In File
Keywords: Lakes/Monitoring/salmonids/River/Fish populations
Abstract: Hydroacoustic methods are typically used to assess abundance in migrating fish populations when other methods are not feasible (i.e., the river is too wide for weirs or too turbid for observation towers). In many instances, hydroacoustic systems may be preferable to more intrusive devices such as nets or traps. This protocol addresses the use of hydroacoustic systems in rivers from fixed, nearshore positions, although down-looking, mobile methods have also been used to assess migrating fish populations.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 181
Reprint: In File
Keywords: Monitoring/Colville River/River/Arctic/Arctic cisco/Least Cisco/Broad Whitefish/Whitefish/Humpback Whitefish/Subsistence/Nuiqsut/Prudhoe Bay
Abstract: The Colville River on the Alaskan Arctic Coastal Plain supports substantial populations of Arctic cisco (Coregonus autumnalis), least cisco (C. sardinella), broad whitefish (C. nasus), humpback whitefish (C. pidschian), and Dolly Varden char (Salvelinus malma) that have historically been harvested by native people. In contrast to the commercial fishery, for which there is an abundance of data, there is scant information on harvest levels for subsistence fisheries in the remainder of the Colville drainage. The harvest from the village fishery is retained for food, trade, or other subsistence uses. The primary objectives of this study were to (1) obtain estimates of the total effort and catch for the fall fishery in the delta, including harvests of both the village of Nuiqsut and the commercial fishery, and (2) evaluate the effects of these harvest levels on the stocks. The lack of information on harvest levels, coupled with concern for possible effects on the fish stocks from coastal developments around the Prudhoe Bay oilfields, prompted this effort to evaluate current harvest levels and develop recommendations for future management strategies.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Ref ID: 179
Reprint: In File
Keywords: Monitoring/Colville River/Colville River Delta/River/Arctic/Arctic cisco/Nuiqsut/Least Cisco/Bering cisco/Prudhoe Bay/Recruitment
Abstract: The objectives of the 200 study were to continue obtaining estimates of the total effort and catch for the fall gill net fishery in the Colville River delta, which targets arctic cisco, including harvests of both the village of Nuiqsut and the commercial fishery. Similar to previous years, a daily count was made of the nets fishing from mid October to late November. Fishers were interviewed as they tended their nets to obtain estimates of catch rate. The fishery began in early October, which is considered normal timing. Much of the early fishing was missed by the time monitoring began on October 15. Reports were that fishing was good during the early season, but decreased later in October. Because of the late start and uncertainty regarding the early catch patterns, the 2000 estimates should be viewed as minimum effort and harvest levels. The 2000 fishery was characterized by a low catch rate on arctic cisco throughout the season. Fishing effort was 22% under the 1989-1998 average, while the village harvest of arctic cisco was one of the lower harvests observed. The catch of least cisco, the primary by-catch species, was the lowest yet observed in fifteen years of monitoring. Catch rates of least cisco in the Nigliq Channel were low, and when combined with the low effort, resulted in the overall low total harvest. In the commercial fishery, effort was down 46% from that recorded in 1999 and, when combined with the low catch rates, resulted in the lowest arctic cisco catch yet recorded. Bering cisco, which had been unusually abundant in 1990, remained at an incidental level in 2000. The prediction for 2001 is for a continuing decrease in the arctic cisco CPUE. This prediction is based on the apparent abundance of age-0 fish in the Prudhoe Bay region during the initial recruitment year. The 2000 harvest was supported almost completely by the 1994 and 1995 year classes, which were quite weak, based on catches of age-0 fish in Prudhoe Bay. Most of the 2001 harvest will continue to be composed of these two year classes, since the 1996 year class appears to be essentially absent from the region. Catch rates after 2001 may increase somewhat as the 1997 and 1998 year classes recruit into the fishery. Neither of these year classes is particularly strong, however, so any increase in harvest rate is likely to be small and harvests will probably remain low until 5 years after another major recruitment.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 180
Reprint: In File
Keywords: Monitoring/Colville River/Colville River Delta/River/Arctic/Arctic cisco/Nuiqsut/Least Cisco/Subsistence/Prudhoe Bay/Fisheries
Abstract: The objectives of the 2004 study were to continue obtaining estimates of the total effort and catch for the fall gill net fishery in the Colville River delta, which targets qaaqtaq (Arctic cisco), including harvests of both the village of Nuiqsut and the commercial fishery. Similar to previous years, a daily count was made of the nets fishing from mid October to late November. The fishery began around October 9, which is considered a normal start date. The 2004 fishery was characterized by high catch rates of qaaqtaq (Arctic cisco) throughout the season, ending up with the fourth highest catch rate recorded in the 20 years of monitoring. The catch of iqalussaq (least cisco), the primary by-catch species, was the highest yet recorded in the Nigliq Channel. The catch rate of qaaktaq (Arctic cisco) in 2005 is likely to decrease from that seen in 2004, but should still be able to meet subsistence needs. This prediction is based on the abundance of fish from the 1998 and 1999 as recorded in the Prudhoe Bay region during summer 2004. The 2004 harvest was supported by the 1998 year class and larger fish of the 1997 year class. Catches in fyke nets from summer studies in Prudhoe Bay indicate there continues to be a moderate number of fish from the 1998 and 1999 year classes that will be available for harvest by fall 2005. Fish caught in 2005 should be of similar size to those in 2004 because of growth in the 1998 and 1999 year classes that will comprise the catch. Catch rates of qaaktaq (Arctic cisco) in 2006 will likely decline to a low level as the 1998 and 1999 year classes mature and leave the area.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method
Reprint: In File
Keywords: Arctic/Arctic cisco/Broad Whitefish/Habitat/Lake/Lakes/Monitoring/Subsistence/Whitefish/Colville River/North Slope/Wildlife management
Abstract: Harvest rates for broad whitefish and burbot in the Colville River between April 5 and May 5, 2006. Changes in the age structure of the harvested population can reveal effects related to changes in fishing pressure. Age data were not collected in 2006, but samples from 2005 were collected by the North Slope Borough Department of Wildlife Management. The age structure from fish harvested in 2005 was not substantially different than that from 1985. In both years, most harvested fish were between 10 and 26 years of age. The small sample size and uncertainty about how well the 2005 data represent the delta-wide harvest preclude detailed analysis of the age distributions.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Reprint: In File
Keywords: Arctic/Arctic cisco/Broad Whitefish/Habitat/Lake/Lakes/Monitoring/Subsistence/Whitefish
Abstract: A considerable amount of effort has been expended in identifying important fish habitats within the Colville Delta. These efforts have identified tapped lakes as being important rearing areas for a variety of fish species, with broad whitefish being especially abundant in these habitats. Broad whitefish is the most important subsistence fish species that feeds within the delta; the other favorite fish, Arctic cisco, uses the delta primary for wintering, not feeding. Most studies in recent years use fyke nets for sampling fish. These nets provide an index of fish abundance, but there remains a question as to how many fish are represented by these catch rates. In addition, available information does not provide information on fish density or production rates. Such information is useful for estimating the production capacity of tapped lakes, which can be used when evaluating harvest guidelines. The objective of this study is to evaluate methods to estimate the number of broad whitefish using selected tapped lakes during the summer feeding period and begin to assess the production potential for broad whitefish from such lakes.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Reprint: In File
Keywords: Fisheries/Lakes/Methods/Monitoring/River/salmonids/Sampling/Planning/Habitat/Fishes
Abstract: This text represents a complete revision of the popular first edition of Fisheries Techniques. Written as an introduction to the ways in which fisheries data are collected, primarily intended for graduate and advanced undergraduate courses in fisheries curricula, but is written so that students with little or no previous exposure to fisheries techniques can use it. Intended to serve as a basic reference for practicing fisheries professionals. Chapters include: 1 Planning for Sampling; 2 Data Management and Statistical Techniques; 3 Safety in Fisheries Work; 4 Aquatic Habitat Measurements; 5 Care and Handling of Sampled Organisms; 6 Passive Capture Techniques; 7 Active Fish Capture Methods; 8 Electrofishing; 9 Collection, Preservation, and Identification of Fish Eggs and Larvae; 10 Sampling with Toxicants; 11 Invertebrates; 12 Tagging and Marking; 13 Acoustic Assessment of Fish Abundance and Distribution; 14 Field Examination of Fishes; 15 Length, Weight, and Associated Structural Indices; 16 Determination of Age and Growth; 17 Quantitative Description of the Diet; 18 Underwater Observation; 19 Advances in Underwater Biotelemetry; 20 Sampling the Recreational Creel; 21 Commercial Fisheries Surveys; 22 Measuring the Human Dimensions of Recreational Fisheries.
Notes: Use in monitoring plan development: Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes


major reasons why fishing effort by residents of Barrow (110 km west) and Nuiqsut (60 km east) is low. Basic biology and life history information on the Teshekpuk Lake fish will be needed for management and will serve for further comparison to determine the effects, if any, from increased harvest. The lake is located within the National Petroleum Reserve in Alaska and is therefore in an area of potential oil and gas exploration and development. A program to collect long-term, in-depth, biological and harvest information is needed to properly manage anadromous and freshwater fish in the Barrow to Teshekpuk Lake area. From 1988 through 1990, we conducted a study of anadromous fish in the Dease Inlet/Admiralty Bay area as a contribution to such a program. Our 1990-1992 studies were conducted as an extension of that program to include anadromous and freshwater fish in the Teshekpuk Lake.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 159
Reprint: On Request 03/20/08
Keywords: Monitoring/North Slope/Subsistence
Abstract: The objectives for this study were to collect and analyze harvest data and to map subsistence usage. The study focused on successful harvest locations rather than the subsistence use ranges (area hunted); therefore the maps do not illustrate the total area hunted. The data reflect 2 years and not longer term trends. Subsistence success is affected by fluctuations in populations, variations in seasonal migrations, ice and storm conditions, summer rainfall and winter snow cover. Availability of cash and constraints of employment also affect subsistence. The first year collected data for 107 households and the second year for 100 households. The study reports the seasonal use of subsistence resources by month. The categories of use include marine mammals (70%), terrestrial mammals (24%), fish (5%) and birds (2%). Detailed subsistence harvest data 1988, and 1989, including fish. Note: Full report available at ARLIS.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 158
Reprint: On Request 03/20/08
Keywords: North Slope/Monitoring/Wainwright/Subsistence/Barrow
Abstract: This 3-year study, sponsored by the Minerals Management Service, was associated with the study of Wainwright described below. Its purpose was to collect and analyze harvest data and to map where subsistence use took place. The maps represent harvest sites rather than the areas hunted; therefore the maps do not illustrate the total area hunted. The data reflect 3 years and not longer term trends. 101 of the 937 households in Barrow were interviewed. The study describes a month-by-month subsistence description. Marine mammals represent 55% of the usable pounds, terrestrial mammals (30%), fish (11%) and birds (4%). Detailed subsistence harvest data 1987, 1988, and 1989, including fish. Note: Full report available at ARLIS.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 311
Reprint: In File
Keywords: Lakes/Monitoring/salmonids/River/Fish populations

Abstract: This chapter provides a small amount of balance across these two critical parts of developing a program to monitor salmonid populations by describing some important components of survey designs relevant to the estimation of the abundance, distribution, and productivity of salmonid populations. A variety of statistical books cover many of the aspects of survey designs in great detail. Some information on environmental sampling is provided. Discusses technical issues that arise with response designs when conducting a survey in environmental settings.

Notes: Use in monitoring plan development:
- Not Used
  - Baseline Data
  - Model Development
  - Stressor
  - Physical Process
  - Structural or Physical Changes
  - Functional Response
  - Method


Abstract: This chapter has been written in two parts. Part I covers field collection and emphasizes working with local-scale, observation-based data; it frames key data concepts and structures that allow local data to be connected subsequently with larger, distributed regional data systems. Part II deals with regional data sharing and focuses on the features of an effective network of regional data centers; the function of these centers is the generation, repository, and dissemination of data as a resource to people and organization interested in regionwide, national, international, and global natural resource issues.

Notes: Use in monitoring plan development:
- Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

BACKGROUND


Ref ID: 251
Reprint: In File
Keywords: biological indicators/Monitoring/Fishes


Notes: Use in monitoring plan development:
- Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method


Ref ID: 75
Reprint: In File
Keywords: aging of fish/fresh water fish monitoring/gill-net sensitivity/intercalibration/Intermordic/Monitoring/multi-mesh gillnets/Arctic/Whitefish/Pollutants

Abstract: The awareness of the effects of transboundary pollution has increased the necessity to use comparable methods and to initiate joint studies between countries in environmental monitoring. In freshwater fish monitoring a number of different methods have been used, strongly reducing the possibilities to comparative assessments between countries. In 1990, a workshop on freshwater fish sampling was initiated in order to develop and intercalibrate methods used in freshwater fish studies in the Nordic countries. During a three year period, a new type of multi-mesh gillnet to be used for fish monitoring in Norway, Finland and Sweden have been developed. Comparative studies and gillnet-selectivity assessments show that these new multi-mesh gillnets better describe the actual population structure of European perch (Perca fluviatilis), roach (Rutilus rutilus) and Arctic char (Salvelinus alpinus) than do the traditional gillnet series used in the Nordic countries. Ageing of fish is central in most environmental studies, however, the comparability of analyses performed at different laboratories may be low. Comparative age analyses between the three countries have been performed for a number of fish species. The results of ageing E. perch, whitefish (Coregonus sp.) and roach indicate that differences between laboratories can be reduced by intercalibration. In the future, the workgroup will be focused on a further development of joint methods within studies of freshwater fish and on joint intemordic assessments on species distribution, abundance and life history characteristics in relation to airborne pollutants and liming.

Notes: Use in monitoring plan development:
- Not Used

Baseline Data
Model Development
Stressor
Physical Process

Abstract: The aim of the present paper is to describe a standardised method for sampling fish in lakes, using multi-mesh gillnets. The method provides a whole-lake estimate for species occurrence, quantitative relative abundance and biomass expressed as catch per unit effort (CPUE), and size structure of fish assemblages in temperate lakes. It also provides estimates comparable over time within a lake, and estimates comparable between lakes. By further development, the method also will form the basis for estimating actual fish biomass in lakes in the future. The method is based on a development that has been going on for several decades at the Institute of Freshwater Research, Drottningholm. The method is commonly used in national and regional fish sampling programmes in Sweden. The basic ideas for the method was initialised in 1983, and in its present form being applied in Swedish national and regional environmental monitoring programmes since 1994. It has an earlier form also been adapted to African reservoirs. An extensive co-operation within a joint Nordic workshop (Nordic Freshwater Fish Group) has facilitates the development of the NORDIC gillnets.

Notes: Use in monitoring plan development: Not Used


Abstract: Accounting for natural differences in flow variability among rivers, and understanding the importance of this for the protection of freshwater biodiversity and maintenance of goods and services that rivers provide, is a great challenge for water managers and scientists. Nevertheless, despite considerable progress in understanding how flow variability sustains river ecosystems, there is a growing temptation to ignore natural system complexity in favor of simplistic, static, environmental flow "rules" to resolve pressing river management issues. We argue that such approaches are misguided and will ultimately contribute to further degradation of river ecosystems. In the absence of detailed empirical information of environmental flow requirements for rivers, we propose a generic approach that incorporates essential aspects of natural flow variability shared across particular classes of rivers that can be validated with empirical biological data and other information in a calibration process. We argue that this approach can bridge the gap between simple hydrological "rules of thumb" and more comprehensive environmental flow assessments and experimental flow restoration projects.

Notes: Use in monitoring plan development: Not Used


Abstract: Community-level analysis is one of the most popular methods used to assess the effect of stressors on aquatic ecosystems. The community is viewed as not only an integrative multispecies indicator of stressors acting as a range of lower levels of organization but also the most ecologically relevant indicator because effects can be directly extrapolated to the ecosystem.

Notes: Use in monitoring plan development: Not Used
Reprint: In File
Keywords: biological indicators/Monitoring/Fishes/Fish populations
Abstract: Long-term exposure to environmental stressors is a concern to biologists and managers because of the possible detrimental effects on important fish performance features such as metabolism and growth, disease resistance, reproductive capacity, and, ultimately, the health, condition, and survival of fish populations.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Reprint: In File
Keywords: climate change/Habitat/Monitoring/Planning/Hydrology/Streams
Abstract: Throughout the world, efforts are under way to restore watersheds, but restoration planning rarely accounts for future climate change. Using a series of linked models of climate, land cover, hydrology, and salmon population dynamics, we investigated the impacts of climate change on the effectiveness of proposed habitat restoration efforts designed to recover depleted Chinook salmon populations in a Pacific Northwest river basin. Model results indicate a large negative impact of climate change on freshwater salmon habitat. Habitat restoration and protection can help to mitigate these effects and may allow populations to increase in the face of climate change. The habitat deterioration associated with climate change will, however, make salmon recovery targets much more difficult to attain. Because the negative impacts of climate change in this basin are projected to be most pronounced in relatively pristine, high-elevation streams where little restoration is possible, climate change and habitat restoration together are likely to cause a spatial shift in salmon abundance. River basins that span the current snow line appear especially vulnerable to climate change, and salmon recovery plans that enhance lower-elevation habitats are likely to be more successful over the next 50 years than those that target the higher-elevation basins likely to experience the greatest snow-rain transition.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Reprint: In File
Keywords: Arctic/Monitoring/Water/Fishes/Lakes/Streams/River/Least Cisco/lake trout/Broad Whitefish/Whitefish/Habitat
Abstract: This report presents information on the distribution of fresh water fishes in a 6,500 sq mi section of the central Arctic coastal plain. Gill net surveys were conducted on 62 lakes and at 26 sites in eight stream drainages within the region. Twelve species of freshwater fish and two marine species were captured in coastal plain streams. Ten species of freshwater fish were found in the Ikpikpuk River while seven species were found in the Fish Creek Drainage. Thirteen species of fish inhabit lakes within the study area. In the lakes that supported populations of fish, least cisco, lake trout and broad whitefish were the most frequently occurring species. Teshekpuk Lake had the greatest species diversity of the lakes surveyed. Information on the lengths, weights, ages and food habitats of the principal species encountered is presented. The presence of lake trout in coastal plain waters extends the previously reported range for this species.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 155
Reprint: In File
Keywords: Monitoring/Planning/Petroleum/Lakes/Streams/Colville River/River
Abstract: This report briefly summarizes baseline fishery assessments of 101 lakes and 14 streams in NE NPR-A during 1968 through 1986. They documented 10 families and 20 species of fish inhabiting the coastal plain between the Ikpikpuk and Colville Rivers.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref Type: Journal (Full)
Ref ID: 231
Keywords: Alaska/Anadromous/Arctic/Arctic cisco/Colville River/Fish populations/Genetics/Beaufort Sea Coast/River/Water/Barrow/Sagavanirktok/Habitat/Colville River Delta/Streams/Bering cisco/Monitoring
Reprint: In File
Abstract: This study is a genetic test of the hypothesis that all arctic cisco that occur along the Canadian and Alaskan Beaufort Sea coast originate from a spawning stock (or stocks) associated with the Mackenzie River. Late summer samples of fish were obtained from coastal waters near Point Barrow, the Sagavanirktok River, and Phillips Bay, each of which can be considered coastal feeding habitat. Samples were also obtained in autumn from the Colville river delta, and two spawning site samples were taken from the Peel and Arctic Red Rivers, tributaries to the Mackenzie River. Genetic data indicated that the coastal and Colville River delta samples were composed of fish from multiple breeding sites, the spawning site populations were genetically uniform, and the spawning sites were genetically different from one another. These data are consistent with the "Mackenzie hypothesis" and do not provide evidence for a differentiated Alaskan stock. Furthermore, the data suggest that the Arctic cisco, like other anadromous fish such as salmon, show fidelity to their natal streams for spawning but disperse in the Beaufort Sea and at overwintering sites. The arctic cisco possibly originated as recently as 10,000 years ago when the Wisconsin glacier that covered the Mackenzie River receded. The Yukon River Bering cisco population, which is only slightly different genetically, possibly gave rise to the Mackenzie River arctic cisco population either as a result of stream capture or chance migration. This explains the difficulty for fisheries biologists to easily identify individual fish to species but also suggests that genetic approaches to species and stock identification are useful.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 76
Reprint: In File
Keywords: Alaska/Arctic cisco/Beaufort Sea Coast/Bering cisco/Colville River Delta/Ecology/Arctic/Monitoring/Colville River/River
Abstract: Arctic ciscoes Coregonus autumnalis and Bering ciscoes C. laurettae were obtained from the Colville River delta during fall 1990 to assess the degree of morphological and genetic differentiation of these two forms. Specimens initially were identified to species based on external features. Subsequently, gill raker counts were found to be distinctly bimodal, with Bering ciscoes having 21-24 and Arctic ciscoes having 24-30 gill rakers. Mitochondrial DNA (mtDNA) haplotypes were also different between the two species. All Bering ciscoes had the BB haplotype as defined by Dde I and Hinf I restriction patterns of the 16S and NADH dehydrogenase-1 (NDH-1) regions of the mtDNA. Arctic ciscoes had the AA, BA, or CA haplotype, except for two specimens that had the BB haplotype characteristic of Bering ciscoes. The two BB Arctic ciscoes
had gill raker counts of 26 and 28, which are characteristic of Bering ciscoes. Arctic and Bering ciscoes were also assayed electrophoretically for the glycerol-3-phosphate dehydrogenase (G3PDH-1) locus. Four alleles were identified, of which two showed strong frequency differences between the two species. One of the two Arctic ciscoes with the BB mtDNA haplotype had a G3PDH-1 genotype common to Arctic ciscoes and the other had a genotype found at low frequency in both species. It is concluded that Arctic and Bering ciscoes possess diagnostic morphological characters that allow for their accurate separation in the fishery. Moreover, only a low level of apparent introgression of mtDNA, from Bering ciscoes into Arctic ciscoes, was detected. Our results confirm that these taxa represent distinct species as currently recognized.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 163
Reprint: In File
Keywords: Monitoring/Planning/Petroleum/North Slope/Alaska/caribou/Subsistence
Abstract: This study is part of the North Slope Borough Subsistence Harvest Documentation Project. 82 of the 83 households were surveyed, and 60% of the households harvested wildlife resources during this period. Caribou provided 58% of the edible pounds, fish 30%, moose 5%, birds 5%, and marine mammals 2%. Because no bowhead whales were harvested during this period, the percentage of edible pounds for marine mammals was low. The caribou harvest was low, and hunters had to travel great distances for it. Sharing of the harvest was important, and all households reported sharing some of the resources. Maps of the extent of subsistence activities were not developed, but a map of some harvest locations was included in Appendix 7.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 191
Reprint: In File
Keywords: Fish populations/Alaska/Streams/Monitoring
Abstract: Passive capture methods, such as minnow traps, are commonly used to capture fish for mark-recapture population estimates; however, they have not been used for removal methods. Minnow traps set for 90-min periods during three or four sequential capture occasions during the summer of 1996 were used to capture coho salmon Oncorhynchus kisutch fry and parr, Dolly Varden Salvelinus malma, cutthroat trout O. clarki, and juvenile steelhead O. mykiss to estimate population size with the Zippin or generalized removal method. More than 45% of the total catch was obtained during the first capture occasion, and in most cases, the catch during the fourth occasion was less than 15% of the total catch. In most pools, the probability of capture was greater than 0.4 but was lower for coho salmon fry than for coho salmon parr and other species. Mean population estimates for coho salmon parr made with concurrent mark-recapture and removal methods differed significantly in small streams. Estimates from mark-recapture and removal methods were not significantly different for coho salmon fry and Dolly Varden, but mark-recapture estimates were higher than removal estimates in most cases. My results show that removal estimates can be obtained with minnow traps if sampling procedures conform to the assumptions required for the method.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Appendix D. Annotated Bibliography


Ref ID: 115
Reprint: In File

Keywords: Petroleum/Monitoring/Water/Water quality/water resources

Abstract: The Northwest NPR-A IAP/EIS will determine appropriate multiple-use management of 8.8 million acres of public lands in the NPR-A consistent with statutory direction. This final document puts forward five alternatives. The alternatives offer a range of options that would make lands available for oil and gas leasing. The alternatives range from making no lands available for leasing to making all lands available for leasing. The EIS evaluates the potential effects to Air Quality; Birds; Coastal Zone Management; Cultural Resources; Economy; Endangered and Threatened Species (Bowhead Whales and Spectacled and Steller's eiders); Estuarine Water Quality; Environmental Justice; Fish Resources (Anadromous and Amphidromous); Freshwater Quality; Marine and Terrestrial Mammals; Paleontological Resources; Recreation and Wilderness; Sociocultural Systems; Soils; Subsistence-Harvest Patterns; Vegetation and Wetlands; Water Resources; Wild and Scenic Rivers. The alternatives include land allocations as well as stipulations and required operating procedures to mitigate impacts to resources and the uses.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method


Ref ID: 17
Reprint: In File

Keywords: Alaska/Environmental aspects/Environmental conditions/Environmental impact statements/Gas industry/Monitoring/National Petroleum Reserve/National Petroleum Reserve (Alaska)/Natural gas reserves/Petroleum industry and trade/Petroleum reserves/Petroleum

Abstract: This document finalizes the Bureau of Land Management's plan for managing 8.8 million acres of public land in the Northwest portion of the National Petroleum Reserve-Alaska. The decision by Secretary of the Interior Gale Norton as documented slightly modifies the BLM's preferred management alternative, which the Bureau described in a final Environmental Impact Statement on the management plan. Summary -- Decision -- Alternatives -- Management considerations -- ANILCA: Section 810 summary -- Mitigation and monitoring -- Public involvement -- Appendix A: Modifications and clarifications -- Appendix B: Stipulations and required operating procedures -- Appendix C: Final endangered and threatened species documentation

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method
   Ref ID: 137
   Reprint: In File
   Keywords: National Petroleum Reserve/Petroleum/Alaska/Water/water resources/Monitoring
   Abstract: The BLM is proposing to amend its 1998 Northeast National Petroleum Reserve - Alaska IAP/EIS to 1) consider leasing portions of lands currently unavailable or under a No Surface Activity restriction to oil and gas leasing in the Northeast National Petroleum Reserve - Alaska, and 2) consider developing performance-based lease stipulations and Required Operating Procedures (ROPs) to provide the BLM with greater flexibility in protecting important surface resources from the impacts of oil and gas activities, similar to those developed for the Northwest National Petroleum Reserve - Alaska. This document considers four alternatives, including the final Preferred Alternative. The alternatives offer a range of options for the amount of lands that would be made available for oil and gas leasing, from 87 percent to 100 percent of the approximately 4.6 million acres in the Northeast National Petroleum Reserve - Alaska. In addition, the alternatives offer two types of mitigation for impacts to resources prescriptive-based and performance-based. The EIS evaluates the potential effects to air quality, paleontological resources, soil, water resources, vegetation, wetlands and floodplains, fish, wildlife, threatened and endangered species, cultural and subsistence resources, sociocultural systems, environmental justice, coastal zone management, recreation, and the economy. The alternatives propose a range of land allocations as well as stipulations and required operating procedures to mitigate impacts to resources and their uses.
   Notes: Use in monitoring plan development:
   Not Used
   Baseline Data
   Model Development
   Stressor
   Functional Response
   Physical Process
   Structural or Physical Changes
   Method

   Ref ID: 149
   Reprint: In File
   Keywords: National Petroleum Reserve/Petroleum/Alaska/Water/water resources/Monitoring
   Abstract: The BLM is proposing to amend its 1998 Northeast National Petroleum Reserve - Alaska IAP/EIS to 1) consider leasing portions of lands currently unavailable or under a No Surface Activity restriction to oil and gas leasing in the Northeast National Petroleum Reserve - Alaska, and 2) consider developing performance-based lease stipulations and Required Operating Procedures (ROPs) to provide the BLM with greater flexibility in protecting important surface resources from the impacts of oil and gas activities, similar to those developed for the Northwest National Petroleum Reserve - Alaska. This document considers four alternatives, including the final Preferred Alternative. The alternatives offer a range of options for the amount of lands that would be made available for oil and gas leasing, from 87 percent to 100 percent of the approximately 4.6 million acres in the Northeast National Petroleum Reserve - Alaska. In addition, the alternatives offer two types of mitigation for impacts to resources prescriptive-based and performance-based. The EIS evaluates the potential effects to air quality, paleontological resources, soil, water resources, vegetation, wetlands and floodplains, fish, wildlife, threatened and endangered species, cultural and subsistence resources, sociocultural systems, environmental justice, coastal zone management, recreation, and the economy. The alternatives propose a range of land allocations as well as stipulations and required operating procedures to mitigate impacts to resources and their uses.
   Notes: Use in monitoring plan development:
   Not Used
   Baseline Data
   Model Development
   Stressor
   Functional Response
   Physical Process
   Structural or Physical Changes
   Method

   Ref ID: 139
   Reprint: In File
   Keywords: Petroleum/Planning/Monitoring/Environmental Assessment
   Abstract: This EA tiers from EA: AK-023-06-003, prepared last year for proposed FEX exploration drilling in the same area, with a Finding of No Significant (FONSI) issued in December 2006. This EA focuses on new project elements, with proposed activities evaluated on the basis of relevant site-specific terms and conditions. This includes a new access corridor totaling about 62 miles from Cape Simpson to nine new exploration ice drill pads (and one previously authorized drill site) and 34 new water supply lakes in the FEX exploration prospects in the Northwest (NW) NPR-A. Also, proposed access using

Appendix D. Annotated Bibliography 149
previously authorized Rights of Way (ROW) in the NPR-A. Specific locations are identified in the case files and project plans.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
  - Stressor
  - Physical Process
  - Structural or Physical Changes
  - Functional Response
- Method


Reprint: In File
Keywords: Petroleum/Alaska/Monitoring/Environmental Assessment
Abstract: This EA is the most recent in a series of NEPA assessments prepared by the BLM in evaluating potential and proposed oil exploration and development in the NPR-A. This EA is tiered from and incorporates relevant portions of the 1998 NE IAP/EIS, the 2003 NW IAP/EIS, and NPR-A Exploration EAs described in more detail in this document. The scope of this EA includes analysis of the effects of the proposed exploration activity and alternatives for a new access corridor totaling about 110 miles, to improve and shorten the existing authorized Right-of-Way (ROW) from Kuparuk to Barrow, as well a continued use of authorized ROW in the NPR-A. Also proposed are 4 new ice airstrip locations, 11 new drill sites and 9 new water supply lakes in the NE NPR-A. Specific locations are identified in the project plans.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
  - Stressor
  - Physical Process
  - Structural or Physical Changes
  - Functional Response
- Method


Reprint: In File
Keywords: National Petroleum Reserve/Petroleum/Alaska/Water/water resources/Monitoring
Abstract: The Bureau of Land Management is proposing to supplement its 2005 Northeast National Petroleum Reserve-Alaska (NPR-A) Amended Integrated Activity Plan/Environmental Impact Statement (IAP/EIS). The Amended IAP/EIS and this supplement are designed to address the Nation’s need for production of more oil and gas through leasing lands in the Northeast NPR-A in addition to those lands made available to leasing by the 1998 Record of Decision for the Northeast NPR-A IAP/EIS. This supplement considers four alternatives. The alternatives offer a range of options for the amount of lands that would be made available for oil and gas leasing, from 87 percent to 100 percent of the approximately 4.6 million acres in the Northeast NPR-A. In addition, the alternatives offer two types of mitigation for impacts to resources: prescriptive and performance-based. The IAP/EIS evaluates the potential effects to air quality, paleontological resources, soil, water resources, vegetation, wetlands and floodplains, fish, wildlife, threatened and endangered species, cultural and subsistence resources, sociocultural systems, environmental justice, coastal zone management, recreation, visual resources, public health, and the economy. The alternatives propose a range of land allocations as well as stipulations and required operating procedures to mitigate impacts to resources and their uses.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
  - Stressor
  - Physical Process
  - Structural or Physical Changes
  - Functional Response
- Method


Reprint: In File
Keywords: Petroleum/Monitoring
Abstract: The Supplemental IAP/EIS addressed the concerns of the District Court and updated the analysis. The analysis
provides the basis for the decisions in this ROD, including land allocation decisions, stipulations and ROPs, and studies and monitoring requirements.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 77
Reprint: In File
Keywords: Alaska/lake trout/Lakes/Monitoring/Ecology/Arctic
Abstract: Growth of lake trout *Salvelinus namaycush* in 11 Alaskan lakes was characterized and compared with that of other North American populations. Asymptotic length varied from 517 to 984 mm and was positively correlated with length at 50% maturity (LM50), lake surface area, and fish species richness. Incremental growth of subadults was correlated with LM50 only. Estimates of density of adult lake trout from 7 of the 11 lakes varied from 3.1 to 31.9 fish/ha. Adult density was inversely related to lake surface area and to fish species richness. The complexity of the fish community, which is strongly related to lake surface area, is an important factor influencing maximum size, maturity schedules, and population density in these lake trout populations.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref Type: Journal (Full)
Ref ID: 166
Keywords: Alaska/Arctic/Ecology/Fishes/Monitoring/Habitat/Water/stream habitat/Anadromous/River
Reprint: In File
Abstract: The arctic environment of western North America imposes a set of harsh physical and biological constraints upon anadromous fishes. These conditions are not unique to the Arctic, but their severity is extreme: (1) arctic aquatic habitats are very cold, with annual averages of only 1°C in coastal waters, and 2.5°C in large rivers, (2) winter freezing reduces stream habitat available to fish by some 95 percent, (3) fish must accumulate most of their year’s food reserves during the brief 3-month summer period, and (4) densities of fish prey in arctic rivers are very low. Despite these constraints, several salmonid species are well adapted for life in the Arctic, for several reasons. The fish have had over 200,000 years at their present location since Pleistocene glaciation to adjust genetically to the specifics of the arctic environment. Key environmental variables, such as the seasonal availability of food and habitat, fluctuate predictably on an annual cycle, thereby facilitating adaptation to them. The fish are also able, through migration, to select the most favorable conditions available (e.g., warmest water temperatures and the relatively abundant food supply in coastal waters). Further, as K-strategists, the fish are resilient to short-term adversity.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 341
Reprint: In File
Keywords: Colville River/River/Monitoring
Abstract: There are two main parts to the study: the Fishery Assessment and the Biological Study. This volume presents the results of the first year of study.
Notes: Use in monitoring plan development:

Ref ID: 225
Reprint: In File

Keywords: Habitat/Monitoring/climate change

Abstract: This study investigates the potential impact of sea-level rise on key coastal habitats in the Pacific Northwest. In addition to raising awareness of the threat, the results of the study will assist coastal managers and other relevant decision-makers identify and implement strategies to minimize the risks. We used the Sea Level Affecting Marshes Model (SLAMM), which simulates the dominant processes involved in wetland conversions and shoreline modifications during long-term sea-level rise. This model was applied to 11 different sites in Puget Sound and along the Pacific Coast in southwestern Washington and northwestern Oregon. Our analysis looked at a range of Intergovernmental Panel on Climate Change (IPCC) sea-level rise scenarios, from a 0.08 meter (3.0 inch) rise in global average sea level by 2025 to a 0.69 meter (27.3 inch) rise by 2100. We also modeled a rise of up to 2 meters (78.7 inches) by 2100 to accommodate for recent studies that suggest sea-level rise will occur much more rapidly during this century than the IPCC models have projected. Results for each study site are based on relative sea level rise for the given region, taking into consideration regional changes in land elevation due to geological factors, such as subsidence and uplift, and ecological factors such as sedimentation and marsh accretion. Full model results are available from the National Wildlife Federation.

Notes: Use in monitoring plan development:
Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method


Ref ID: 253
Reprint: In File

Keywords: biological indicators/Monitoring/Fishes/Fish populations

Abstract: Reproduction is arguably the most significant life function of fish affected by environmental stress, providing a crucial linkage between the effects of xenobiotics and other stressors on individual fish (through altered fecundity, increased mortality) and consequences at the population and community levels (population crashes, degraded communities). From a broad perspective, therefore, any stressor that alters the reproductive life span, impedes expected reproductive output, or interferes with the development of juveniles to sexually active adults could be considered a reproductive hazard.

Notes: Use in monitoring plan development:
Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method


Ref ID: 332
Reprint: In File

Keywords: North Slope/Subsistence/Atqasuk/Alaska/Monitoring/caribou/Land use

Abstract: Since the NSB wants to be more involved in management decisions regarding wildlife resources, the Borough initiated a comprehensive subsistence harvest documentation project. These harvest data will be used by the NSB in helping make management decisions with state and federal wildlife agencies. This report describes the NSB project as conducted in Atqasuk. The objectives of the Subsistence Harvest Documentation Project are listed below. 1) To document the level of subsistence harvested animals (caribou, seals, etc.) required by each village in the North Slope Borough to meet its nutritional and cultural needs. 2) To obtain the harvest and land use data that will: (a) allow greater local participation in the management of wildlife resources within the North Slope Borough, and (b) help the North Slope Borough to better represent
the people of the North Slope, when dealing with state and federal regulatory agencies that may wish to establish unreasonable harvest quotas or other restrictive harvest guidelines.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

29. Herlugson, C. J. 1997. Circumpolar perspective on the importance of fish resources within the arctic ecosystem and environmental changes that could affect these resources. Pages 1-3 in J. B. Reynolds, editor. Fish ecology in Arctic North America. American Fisheries Society, Symposium 19, Bethesda, Maryland.
Ref ID: 91
Reprint: In File
Keywords: Broad Whitefish/Whitefish/Prudhoe Bay/Alaska/Monitoring/Arctic cisco/Habitat/Ecology/Arctic/climate change/Overwintering Habitat/Anadromous
Abstract: The next century holds many new challenges for research and resource management in the Arctic. We know that the Arctic is an incredible laboratory where one can observe and thereby learn about the biological, chemical, and physical components and cycles of the ecosystem. But if you look into the future, you see applied research, because the arctic ecosystem is faced with a myriad of environmental issues. Increases in greenhouse gas emissions could result in climate change and temperature fluctuations. This issue could potentially change the very fabric of the arctic ecosystem. Depletion of the ozone layer is another major environmental issue, with continuing speculation on the associated risks of skin cancer for northern residents or even the possibility of genetic mutations in other species. Arctic haze is another concern in challenging the ecosystem. Acid rain and heavy-metal deposition from outside the Arctic also have the potential to influence arctic systems and lifestyles. The Arctic, with its changing physical characteristics, is the best example of the universality of the natural world, the concept of transboundary pollution—not just because the problems may have either international beginnings or international ramifications, but because the biological resources themselves are international: Arctic cisco Coregonus autumnalis, polar bear Ursus maritimus, bowhead whale Balaena mysticetus, beluga (white whale) Delphinapterus leucas, Arctic char Salvelinus alpinus, and Arctic cod Boreogadus saida. The environmental impacts of developments are being evaluated to see if there have been biological benefits, not just biological impacts. Research has shown that gravel mine sites, because of their depth, are now used as overwintering habitat for anadromous fish. Research is being conducted in the Beaufort Sea to evaluate the migration patterns of Arctic ciscoes across international boundaries and the effects of temperature fluctuations on growth potential and body condition. In the future, arctic biological research cannot afford to be isolated.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 260
Reprint: In File
Keywords: biological indicators/Monitoring/Fishes/Fish populations/Habitat
Abstract: This final chapter will discuss why we are interested in biomarkers and bioindicators, what their relative value and state of development are, which measures are ready to be applied in a systematic way, which are still at the research stage, and what research needs emerge from the current state of the art.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 92
Reprint: In File
Keywords: Monitoring/Alaska/Lakes/Water/Arctic/River/Streams
Abstract: The arctic coastal plain of northern Alaska covers an area of about 71,000 km$^2$ north of the foothills of the Brooks Range. The area of oil development, which lies between the Colville and Canning rivers, typifies coastal plain landscapes in that it is generally flat with a few small streams and rivers and thousands of ponds and small lakes. The area is underlain by permafrost hundreds of meters thick, which sustains the ponds and lakes by preventing downward percolation of water. Ponds and lakes freeze in winter to depths of about 1.7 m, thaw in June and July, and begin to freeze again in September. The short arctic summer is the period of intensive biological activity for the flora and fauna, and during this time fish and migratory birds feed extensively on invertebrates in tundra water bodies. This chapter focuses on the aquatic invertebrates that serve as principal prey for these fish and birds.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method


Ref ID: 80
Reprint: In File
Keywords: Monitoring
Abstract: Dolly Varden (Salvelinus malma) exist in two forms-anadromous and resident. Most often the resident form is found upstream of natural barriers (e.g., falls, dams) that prevent upstream movement of the anadromous form. Consecutive year capture studies show resident Dolly Varden do not move much (other than spawning and seasonal movements) within the stream system available as they are often captured in the same area (i.e., survey site) year after year. Survival and population size is determined by available spawning areas.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method


Ref ID: 175
Reprint: On Request 03/20/08
Keywords: Monitoring/Point Lay
Abstract: Full report available at ARLIS.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method


Ref ID: 93
Reprint: In File
Keywords: artificial intelligence/decision support systems/ecosystem health/expert systems/Habitat/knowledge base/Monitoring/watershed analysis/watershed conditions
Abstract: The Ecosystem Management Decision Support (EMDS) system is an application framework for knowledge-based decision support of ecological assessments. EMDS integrated geographic information system and knowledge base system technologies to provide an analytical tool for environmental assessment and monitoring. The basic objective of EMDS is to improve the quality and completeness of environmental assessments and the efficiency with which they are performed. The USDA Forest Service and the U.S. Environmental Protection Agency have cooperatively developed an EMDS knowledge base for watershed condition assessment. Specifically, this knowledge base evaluates watershed processes, patterns,
general effects of human activity, and fisheries habitat suitability. Such assessments are based on spatially explicit input
data concerning current conditions and reference conditions which are subsequently interpreted by user-defined "fuzzy"
membership functions. In this paper we describe basic components of our knowledge base for assessing watershed
condition and illustrate its application within northern Idaho and northwestern Montana.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Barrett. 2001. Inventory and monitoring of salmon habitat in the Pacific Northwest - Directory and synthesis of protocols for
management/research and volunteers in Washington, Oregon, Idaho, Montana, and British Columbia. Final Data Report 15
October 2001. Washington Department of Fish and Wildlife, Olympia, WA.
Ref ID: 197
Reprint: In File
Keywords: Monitoring/Habitat/Streams
Abstract: This document reflects an effort to establish a consistent format for the collection of salmonid habitat data across
the Pacific Northwest. More specifically, our objectives were to: 1) provide a synthesis of the salmon habitat protocols
applicable to the Pacific Northwest, 2) recommend a subset of these protocols for use by volunteers and
management/research personnel across the region, 3) link these protocols with specific types of habitat projects, 4) establish
a Quality Assurance/Quality Control framework for the data derived from the use of these protocols, and 5) to the degree
possible, identify the format and destination where the data is routinely sent. Following a detailed review of the protocols, we
used selection criteria combined with a scientific peer-review process to recommend a subset of protocols for use across the
Pacific Northwest. Protocols were evaluated in terms of: 1) a review of the protocol elements; 2) the accessibility and
practicability to workers with diverse training; 3) applicability across the different environments of the region, so that data and
analysis are comparable; 4) listing of tools and implements needed; and 5) kinds of data generated. We were not able to
assess implementation costs, as budgetary information was seldom included in the protocols. We ultimately identified 68
protocols for use by volunteers, and 93 protocols for use by management/research personnel across the Pacific Northwest.
The data collected through the protocols recommended in this publication will aid in providing a consistent foundation for
plans to restore and protect the health and biological capacity of salmon bearing streams and nearshore marine areas in the
Pacific Northwest. Likewise, the data will be an important basis for determining whether completed projects and related
conservation actions are achieving their intended goals. To the extent possible, we have identified the type of format the
data is stored in, as well as the agencies or entities that are the recipients and caretakers of this data. Local and regional
data management is an area in urgent need of funding investments. Important advancements in data handling, accessibility,
and analysis capability will stem from the overall efforts in monitoring in the region.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

36. Johnson, J. and E. Weiss. 2007. Catalog of waters important for spawning, rearing, or migration of anadromous fishes-Arctic
region, effective June 1, 2007. Special Publication No. 07-03, March 2007. Alaska Department of Fish and Game, Division of
Sport Fish, Research and Technical Services, Anchorage, Alaska.
Ref ID: 126
Reprint: In File
Keywords: Water/Alaska/Lakes/Fishes/Monitoring
Abstract: Alaska Statute 41.14.870(a) requires the ADNR to specify the various rivers, lakes, and streams, or parts of them,
that are important for spawning, rearing, or migration of anadromous fishes. Adopted by reference under 11 AAC 195.010 of
the Alaska Administrative Code, the Catalog of Waters Important for Spawning, Rearing or Migration of Anadromous Fishes
(referred to as the "Catalog") and the Atlas to the Catalog of Waters Important for Spawning, Rearing or Migration of
Anadromous Fishes (referred to as the "Atlas") are used to make this specification. The Catalog is a numerically-ordered list
of the water bodies with documented use by anadromous fish for these purposes. The Atlas shows cartographically the
location, name, and number of these specified water bodies, the anadromous fish species using these water bodies, and the
fish life history phases for which the water bodies are used (to the extent known).
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Ref ID: 96
Reprint: In File
Keywords: Biological monitoring/Environmental assessments/fish communities/indicator species/Monitoring/water resources/Habitat/Environmental Assessment
Abstract: Direct biological monitoring is essential for effective assessment efforts. Past approaches to biomonitoring are too simplistic (for example, toxicity testing, indicator species) or conceptually invalid (diversity indexes). Assessments that use ecological guilds use ecological principles in a more integrative fashion. The best long-term approach is development of suites of metrics, like those used in the index of biotic integrity (IBI), to reflect individual, population, community, and ecosystem attributes in an integrative framework. Efforts to use the conceptual content of IBI in a wider diversity of habitats should be encouraged and followed up with effective control actions.
Notes: Use in monitoring plan development:
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 97
Reprint: In File
Keywords: Biological monitoring/fish communities/Index of Biotic Integrity/indexes of degradation/Monitoring/Water/water pollution/water resources
Abstract: Water of sufficient quality and quantity is critical to all life. Increasing human population and growth of technology require human society to devote more and more attention to protection of adequate supplies of water. Although perception of biological degradation stimulated current state and federal legislation on the quality of water resources, that biological focus was lost in the search for easily measured physical and chemical surrogates. The "fishable and swimmable" goal of the Water Pollution Control Act of 1972 (PL 92-500) and its charge to "restore and maintain" biotic integrity illustrate that law's biological underpinning. Further, the need for operational definitions of terms like "biological integrity" and "unreasonable degradation" and for ecologically sound tools to measure divergence from society goals have increased interest in biological monitoring. Assessment of water resource quality by sampling biological communities in the field (ambient biological monitoring) is a promising approach that requires expanded use of ecological expertise. One such approach, the Index of Biotic Integrity (IBI), provides a broadly based, multiparameter tool for the assessment of biotic integrity in running waters. IBI based on fish community attributes has now been applied widely in North America. The success of IBI has stimulated the development of similar approaches using other aquatic taxa. Expanded use of ecological expertise in ambient biological monitoring is essential to the protection of water resources. Ecologists have the expertise to contribute significantly to those programs.
Notes: Use in monitoring plan development:
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 337
Reprint: In File
Keywords: Biological monitoring/fish communities/Index of Biotic Integrity/indexes of degradation/Monitoring/Water/water pollution/water resources
Abstract: This chapter discusses ecological integrity and ecological health. They are central roles in the decision about consumer goods and development technologies, including when, where, and how to supply technology.
Notes: Use in monitoring plan development:
Baseline Data
Model Development
Stressor
Ref ID: 317
Reprint: In File
Keywords: water resources/Monitoring
Abstract: This manual establishes the surveying procedures for (1) setting gages at a streamflow gaging station to datum and (2) checking the gages periodically for errors caused by vertical movement of the structures that support them. Surveying terms and concepts are explained, and procedures for testing, adjusting, and operating the instruments are described in detail. Notekeeping, adjusting level circuits, checking gages, summarizing results, locating the nearest National Geodetic Vertical Datum of 1929 bench mark, and relating the gage datum to the national datum are also described.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 98
Reprint: In File
Keywords: biocriteria/biological indicators/impact assessment/Monitoring
Abstract: The Canadian Environmental Assessment Act (CEAA) defines the federal environmental assessment (EA) process for evaluating the likelihood that development projects (e.g., roads, buildings, factories) will have impacts on the environment. Environmental effects monitoring (EEM) programs for mining and pulp and paper mills under the Federal Fisheries Act, define the process that is to be used to evaluate existing effects caused by liquid effluents discharged by operating facilities. The EA process occurs before a project is approved, and involves predicting whether the project is going to cause significant environmental impacts. The EEM process occurs after a project is operational, and involves determining whether an existing project has had or is continuing to have significant impacts on the environment. Ideally, the processes are complimentary, with the EA process identifying environmental attributes considered important, and the EEM process demonstrating whether predicted or unpredicted impacts occurred. The two processes are usually done in isolation so potential synergies are lost. The point of this manuscript is to justify bridging the two processes. We use the aquatic environment as the example, and briefly describe the EEM process, aquatic environment indicators, experimental designs, and typical environmental thresholds, to illustrate how the EEM and EA processes link.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 255
Reprint: In File
Keywords: biological indicators/Monitoring/Fishes/Fish populations/Habitat
Abstract: Behavior of aquatic organisms is a sequence of quantifiable actions that operate through the central and peripheral nervous system. These patterns are the culmination of genetic, biochemical, and physiological processes and, as such, are sensitive to alterations in the steady state of the organism. Behavioral responses are important for survival because they are necessary to perform essential life functions such as habitat selection, competition, predator avoidance, prey selection, and reproduction.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
43. Lovett, G. M., D. A. Burns, C. T. Driscoll, J. C. Jenkins, M. J. Mitchell, L. Rustad, J. B. Shanley, G. E. Likens, and R. Haeuber. 2007. Who needs environmental monitoring? Frontiers in Ecology and the Environment 5(5): 253-260. Ref ID: 202 Reprint: In File Keywords: Monitoring Abstract: Environmental monitoring is often criticized as being unscientific, too expensive, and wasteful. While some monitoring studies do suffer from these problems, there are also many highly successful long-term monitoring programs that have provided important scientific advances and crucial information for environmental policy. Here, we discuss the characteristics of effective monitoring programs, and contend that monitoring should be considered a fundamental component of environmental science and policy. We urge scientists who develop monitoring programs to plan in advance to ensure high data quality, accessibility, and cost-effectiveness, and we urge government agencies and other funding institutions to make greater commitments to increasing the amount and long-term stability of funding for environmental monitoring programs. Notes: Use in monitoring plan development: Not Used Baseline Data Model Development Stressor Physical Process Structural or Physical Changes Functional Response Method

44. McDonald, M. E., S. G. Paulsen, R. Blair, J. Dlugosz, S. Hale, S. Hedtke, D. Heggem, L. Jackson, K. B. Jones, B. Levinson, A. R. Olsen, J. Stoddard, K. Summers, and G. Veith. 2002. Research strategy: Environmental monitoring and assessment program. EPA 620/R-02/002, July 2002. U.S Environmental Protection Agency Office of Research and Development National Health and Environmental Effects Research Laboratory, Research Triangle Park, North Carolina. Ref ID: 81 Reprint: In File Keywords: Monitoring/biological indicators Abstract: The U.S. Environmental Protection Agency's (EPA's) Environmental Monitoring and Assessment Program (EMAP) is a long-term research effort to enable status and trend assessments of aquatic ecosystems across the U.S. with a known statistical confidence. The EMAP statistical (or probability) sampling design provides the framework for unbiased, representative monitoring for condition of an aquatic resource with a known confidence level. Monitoring with this approach through time allows statistical detection of change (and subsequently trends) in condition. EMAP primarily uses biological indicators to integrate all the different stressors acting on an ecosystem. We are demonstrating the framework for a consistent, state-based, probabilistic monitoring framework in the 24 marine coastal states and Puerto Rico. This effort will produce the first national assessment of the condition of the U.S. marine estuaries, and will be the baseline for future measures. Future EMAP work will provide the science necessary for determining the condition of other critical aquatic resources and will be necessary for the full implementation of GPRA. Notes: Use in monitoring plan development: Not Used Baseline Data Model Development Stressor Physical Process Structural or Physical Changes Functional Response Method

45. Mellor, J. C. 1987. A statistical analysis and summary of radar-interpreted Arctic lake depth: an addendum to 12 map products. BLM-Alaska Technical Report 11, December 1987. U.S. Department of the Interior, Bureau of Land Management, Alaska State Office, Anchorage, Alaska. Ref ID: 343 Reprint: In File Keywords: Alaska/Arctic/Lake/National Petroleum Reserve/Overwintering Habitat/Petroleum/Monitoring/Lakes Abstract: All resolvable (>10 ha) lakes on 12 U.S. Geological Survey 1:250,000 scale quadrangles covering the National Petroleum Reserve in Alaska have been mapped to depict three depth ranges. The ranges were mapped by delineating the ~1.6 m and ~4 m radar-interpreted isobaths. After a well-trained individual interpreted depths on all 12 quadrangles, fathometer transects were acquired on 157 field verification lakes for statistical comparison with radar-interpreted lake depths. Lakes depicting the ~1.6 m radar-interpreted isobath were verified in 99 percent of the 109 test lakes sounded by fathometer. Mean horizontal displacement of the confirmed ~1.6 m radar isolabs from the fathometer-determined 1.6 m depth was 62 m (predominantly shoreward). Lakes with interpreted depths >4 m were verified in only 63 percent of the 27 test lakes sounded by fathometer. Mean horizontal displacement of the confirmed >4 m radar-interpreted isolabs from the fathometer-determined 4 m depth was 147 m. Notes: Use in monitoring plan development:
Ref ID: 187
Reprint: In File
Keywords: North Slope/Lakes/Monitoring
Abstract: This report has been prepared to consolidate and present the results of a number of investigations into lake volume estimation methods and survey procedures for North Slope Lakes. This report provides an introduction (Section 1), a summary of lake volume estimation methods (Section 2), recommended lake volume estimation methods (Section 3), and field survey procedures (Section 4).
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 110
Reprint: In File
Keywords: Alaska/Arctic cisco/climate change/Habitat/Humpback Whitefish/Monitoring/Whitefish/Ecology/Arctic
Abstract: Least ciscoes Coregonus sardinella and humpback whitefish C. pidschian were collected from Dease Inlet, Alaska, during 1988-1990 for baseline data (length, weight, sex, maturity, fecundity, and age) on the reproductive cycle of these two lightly exploited species. Gonadosomatic indexes ranged from 4.1 to 13.8% of body weight in least ciscoes (mean - 8.3%) and 2.9 to 8.7% in humpback whitefish (mean = 5.7%). Fecundity was highly correlated with body weight in both species; it ranged from 12,206 to 100,939 in least ciscoes, with an average of 95 eggs/g somatic weight and from 10,824 to 44,387 in humpback whitefish, with an average of 45 eggs/g somatic weight. Fecundities were higher than those reported for populations of the same species in the Chatanika River, Alaska, and in the Canadian Arctic. Approximately half of the least ciscoes and humpback whitefish spawned each year. The mature portion of both populations was dominated by older fish (>10 years).
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 322
Reprint: In File
Keywords: Habitat/Water/Water quality/Alaska/River/Environmental conditions/Monitoring/Lakes/Water chemistry/Lake
Abstract: Objectives of the study were to document fish presence and habitat use in lakes for lakes that may be used to support exploration activities in association with drilling operations or to support ice road construction between drill sites. The objectives of the survey were to: 1) obtain lake bathymetry in lakes within the study area that appear suitable for water withdrawal, 2) inventory fish species in lakes within the study project area, and 3) measure water chemistry parameters to assess suitability of water for potential uses. The 2005 field effort is the first survey of lakes in the northwest region of NPRA since surveys conducted since the late 1970s and mid 1980s.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Ref ID: 334
Reprint: In File
Keywords: Monitoring/Anadromous/Lake/River/Broad Whitefish/Whitefish
Abstract: This field manual is designed to provide field personnel with information necessary to carry out their required assignments with the least number of difficulties. The first section explains the reason for the study and the study objectives. The second section details sampling gear required to conduct the program and safety equipment required for safe boat operation. The rest of the manual deals with how to set a fyke net, how to sample and process fish, and how to fill out all data forms. The primary goal of this research is to determine the extent of wintertime use by anadromous and resident fish in Teshekpuk Lake. Secondly, fisheries information collected during this study will allow for comparison with past and future data collected in the area to examine trends in fisheries Wintertime use by fish in Teshekpuk Lake. Finally, fisheries information collected during this study will allow for comparison with past and future data collected in the area to examine trends in fisheries Wintertime use by fish in Teshekpuk Lake.
Notes: Use in monitoring plan development:

Ref ID: 323
Reprint: In File
Keywords: Habitat/Water/Water quality/Alaska/River/Environmental conditions/Monitoring/Lakes/Water chemistry/Lake
Abstract: This 2007 survey samples 24 lakes for potential use as water sources during winter exploration. Six of the lakes in the 2007 study were initially surveyed from 1999 to 2001 using older survey methods. This study updates previous estimates using more accurate survey techniques developed in 2002. Objectives of the study were to conduct initial surveys, of re-survey selected lakes, to estimate the volume of water available for use, and to document fish presence and habitat use in lakes for lakes that may be used to support exploration activities. The objectives of the survey were to: 1) obtain up-dated lake bathymetry for selected lakes, 2) conducted initial surveys on lakes identified as being desirable water sources, 3) evaluate fish species in lakes within the project study area, and 4) measure water chemistry parameters to assess suitability of water for potential uses.
Notes: Use in monitoring plan development:

Ref ID: 335
Reprint: In File
Keywords: North Slope/Subsistence/Atqasuk/Alaska/Monitoring/caribou/Land use/Broad Whitefish/Whitefish/Lakes/Water/Water chemistry/Lake
Abstract: This field manual is designed to provide field personnel with information necessary to carry out their required assignments with the least number of difficulties. The first section explains the reason for the study and the study objectives. The second section details sampling gear required to conduct the program and safety equipment required for safe boat operation. The rest of the manual deals with how to set a fyke net, how to sample and process fish, and how to fill out all data forms. The objectives of the survey will be to: 1) obtain data to estimate the numbers of broad whitefish using selected tapped lakes within the Colville Delta, 2) obtain information on relative abundance of species in different water bodies sampled, especially from lakes that may be crossed by roads or used for water withdrawal during exploration and field development, 3) obtain basic descriptive population data for the species captured, 4) obtain bathymetric (i.e. depth) data to estimate lake volumes, and 5) obtain water chemistry measurements to assess suitability of water for potential uses.
Notes: Use in monitoring plan development:
Ref ID: 86
Reprint: In File
Keywords: adaptive management/conceptual model/ecological monitoring/effectiveness monitoring/Habitat/habitat basis/interpretive report/Monitoring/Northwest Forest Plan/predictive model/regional scale
Abstract: This report describes the logic and design of an effectiveness monitoring program for the Northwest Forest Plan. The program is prospective, providing an early warning of environmental change before irreversible loss has occurred. Monitoring is focused at two resource levels: individual species and specific ecosystem types. Selection of prospective indicators for the status of species or ecosystems is based on the development of conceptual models relating resource change to reliable, early warning signals of change. Ecosystems, such as late seral stage forest communities, are monitored on the basis of critical structural and compositional elements that reflect the state of underlying ecological processes. The assumption is that systems retain their ecological integrity to the extent that key biotic and physical processes are sustained. For species of concern, the design integrates animal populations with their necessary habitat and projects changes in population status by monitoring significant changes in habitat at several spatial scales. Anticipatory forecasting of changes in population status assumes habitat to be a reliable surrogate for direct population measures. A surrogate-based approach requires an active period of model building that relates population to habitat variation to develop robust wildlife relation models. Essential components needed for program implementation, such as data collection, information management, report preparation, and feedback to management, are discussed. This discussion includes recommendations for staffing, funding, and establishing a long-term commitment for a large, interagency monitoring program.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 58
Reprint: On Request 03/20/08
Keywords: Alaska/Handbooks,manuals,etc/Land use/National Petroleum Reserve/Planning/Monitoring
Abstract: NPRA 105(c) study guidelines describing how data should/will be collected and analyzed. Contains no data, just data collection procedures. Full report is available at ARLIS.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 210
Reprint: In File
Keywords: National Petroleum Reserve/Petroleum/Alaska/Monitoring/Land use/Natural resources/Planning/Arctic
Abstract: The Ecological Profile is one of a series of six Study Reports published by the National Petroleum Reserve in Alaska 105(c) Land Use Study. The series taken as a whole describes the physical, ecological and socioeconomic characteristics of the study area and presents information about the current status and potential use of the natural resources (excluding petroleum). The Planning Area Analysis, Study Report 6, examines the material in the report series from the points of view of demand, potential, and relation to land use planning. Readers can gain a comprehensive view of the
Reserve by consulting all reports in the series. This report describes the ecological systems of the National Petroleum Reserve in Alaska (NPR-A) at a level sufficient to provide a basis for broad management and land use decisions. Numerous references are cited which will lead the interested reader to further details. The Ecological Profile begins where the National Petroleum Reserve in Alaska Task Force Study Report 1 (1978a), hereafter referred to as the Physical Profile, left off. Thus the emphasis is on the biotic elements, plant and animal, even though the physical factors ultimately control the ecological systems of the region. In the Environmental Overview (this report) the ecological attributes and types in the NPR-A are placed in perspective with the Alaskan Arctic which includes the entire Arctic within the boundaries of the United States of America.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
  - Stressor
    - Physical Process
    - Structural or Physical Changes
  - Functional Response
- Method

Reprint: In File
Keywords: Alaska/Human ecology/Land use/National Petroleum Reserve/National Petroleum Reserve (Alaska)/Natural resources/Petroleum/Wildlife conservation/Monitoring
Abstract: This report provides a comprehensive statistical and analytical profile of the regional and state socioeconomic environment based on a synthesis of readily available information. No original research was conducted. NOTE: File contains preface and table of contents. The full report is available at ARLIS.
Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
  - Stressor
    - Physical Process
    - Structural or Physical Changes
  - Functional Response
- Method

Reprint: In File
Keywords: Alaska/Human ecology/Land use/National Petroleum Reserve/National Petroleum Reserve (Alaska)/Natural resources/Petroleum/Wildlife conservation/Monitoring
Abstract: These reports are summary documents based on recent field work and literature search. The reports are limited in geographic scope to the Reserve area, but in some instances consider regional aspects of a resource or value. Many Values and Resource Analysis report topics do not have complete data bases; these reports identify some specific inventory or analysis needs. The sections have been written in two parts. The first describes the present situation with regard to the individual value or resource. The second part of each report presents potential or opportunities for best use of a value or resource. Note: Full report is available at ARLIS.
Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
  - Stressor
    - Physical Process
    - Structural or Physical Changes
  - Functional Response
- Method

Reprint: In File
Keywords: Alaska/Earth sciences/National Petroleum Reserve/National Petroleum Reserve (Alaska)/Petroleum/Physical geography/Monitoring/Hydrology/Water/water resources
Abstract: Physical profile describing physical attributes or characteristics of NPR-A. Covering physiography, bedrock and surficial geology, soils, slopes and scarps, permafrost, surface- and ground-water hydrology and water resources, climate, as well as limiting factors such as erosion and seismicity. Contains 4 maps: (1) Distribution of Slope Zone and Scarps, (2) Distribution of Pre-quartenary Geologic Units, (3) Surficial Deposits, (4) Erosion Potential and Coastal Erosion Rates. Note:
Ref ID: 48  
Reprint: In File  
Keywords: Alaska/Human ecology/Land use/National Petroleum Reserve/National Petroleum Reserve (Alaska)/Natural resources/Petroleum/Petroleum reserves/Regional planning/Wildlife conservation/Arctic/Monitoring/Wainwright/Point Lay/Nuiqsut/Barrow  
Notes: Use in monitoring plan development:  
Not Used  
Baseline Data  
Model Development  
Stressor  
Physical Process  
Structural or Physical Changes  
Functional Response  
Method

Ref ID: 47  
Reprint: In File  
Keywords: Alaska/Land use/National Petroleum Reserve/National Petroleum Reserve (Alaska)/Natural resources/Petroleum/Planning/Regional planning/Monitoring  
Abstract: Planning Area Analysis is the focal point where all aspects of the planning—economic, social, resource and environmental values, intergovernmental relationships and the public concerns and issues related to planning—for the National Petroleum Reserve in Alaska are examined together prior to development of the land use options. Note: Full report is available at ARLIS.  
Notes: Use in monitoring plan development:  
Not Used  
Baseline Data  
Model Development  
Stressor  
Physical Process  
Structural or Physical Changes  
Functional Response  
Method

Ref ID: 339  
Reprint: In File  
Keywords: Monitoring/Water  
Abstract: EPA's Environmental Monitoring and Assessment Program (EMAP) was established to provide a comprehensive report card on the condition of the nation's ecological resources and to detect trends in the condition of those resources. At EPA's request, the National Research Council's Board on Environmental Studies and Toxicology and Water Science and Technology Board established the Committee to Review EPA's Environmental Monitoring and Assessment Program. This fourth and final report is the committee's overall evaluation of the program.  
Notes: Use in monitoring plan development:  
Not Used  
Baseline Data  
Model Development  
Stressor
Ref ID: 111
Reprint: In File
Keywords: Monitoring/sustainability/indigenous communities
Abstract: Complex environmental and ecological problems require collaborative, interdisciplinary efforts. A common approach to integrating disciplinary perspectives on these problems is to develop simulation models in which the linkages between system components are explicitly represented. There is, however, little guidance in the literature on how such models should be developed through collaborative teamwork. In this paper, we offer a set of heuristics (rules of thumb) that address a range of challenges associated with this enterprise, including the selection of team members, negotiating a consensus view of the research problem, prototyping and refining models, the role of sensitivity analysis, and the importance of team communication. These heuristics arose from a comparison of our experiences with several interdisciplinary modeling projects. We use one such experience—a project in which natural scientists, social scientists, and local residents came together to investigate the sustainability of small indigenous communities in the Arctic—to illustrate the heuristics.
Notes: Use in monitoring plan development:
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 114
Reprint: In File
Keywords: North Slope/Monitoring
Abstract: Directory listing.
Notes: Use in monitoring plan development:
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref Type: Data File
Ref ID: 235
Keywords: North Slope/Monitoring
Reprint: In File
Abstract: Excel spreadsheet of aquatic and fisheries research conducted on the North Slope for the 2005 fiscal year.
Notes: Use in monitoring plan development:
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 121
Reprint: In File
Keywords: Ecology/Monitoring/Environmental conditions/Habitat/Water/Fishes/salmonids/Arctic regions/Arctic Region/Alaska/Arctic
Abstract: Aquatic environments in the Arctic offer some protection against the extremes of the climate. The fish fauna is low in diversity because arctic ecosystems are still in the early stages of establishment, and environmental conditions are unsuitable for many species. Temperatures are low, with a narrow range, especially in marine habitats. The extreme
seasonal variation in light affects primary production and energy supply. There is a marked pulse in freshwater discharge, sediment, and nutrient export from rivers, but there are long periods of stability in all aquatic environments. Ice is a significant component of the environment, particularly in marine, shallow lake, and riverine waters. The arctic environment still retains the remains of a colder past in the form of permafrost, which greatly influences freshwater habitats. Arctic fishes have many morphological, behavioral, and physiological adaptations for survival. Morphological adaptations can involve sensory organs, coloration, and metamerism. Species must tolerate long periods of low light and temperature, and their seasonal patterns of activity, growth, and reproduction must be matched to the seasons. Anadromy is common among salmonids and advantageous for energy accumulation. Migrations and movements must be precise and timed so that fishes arrive where they can best exploit the productive potential of their environment and avoid its worst hazards. Physiological adaptations, such as increases in metabolic rate, may not occur in arctic fishes but species are adapted to low temperatures. Many species have evolved antifreeze proteins; others live in undercooled states in deeper marine waters. These mechanisms may have evolved separately in arctic and arctic regions, with a possible south-to-north transfer in one or more families. The arctic fish resource has been used by people for subsistence since their arrival in arctic regions. Harvests vary greatly between groups but today may average 60 kg per capita per year in arctic North America. Harvests are substantial compared with sport and commercial catches, and maintaining them is a priority. Slow growth, longevity, and iteroparity of arctic fish stocks may be adaptive but lead to low sustainable yields in fisheries. The fragmenting of freshwater and anadromous species into small, reproductively isolated stocks has implications for survival, stock genetics, and conservation. In North America most recent information on arctic fishes has been obtained as a necessary adjunct to development. Little attention has been paid to marine species of no economic or cultural importance. Many questions remain to be answered about the ability of arctic fishes to tolerate exploitation and industrial intrusions into their habitat. Threats to their environment originating in the south and global change pose other problems that could affect their longer-term survival. Much work remains to be done to fully understand and appreciate the ecology of arctic fishes. 

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Method

Ref ID: 120
Reprint: In File
Keywords: Monitoring
Abstract: The majority of environmental effects monitoring (EEM) frameworks that have been proposed compare selected indicator variables as a means of assessing whether significant changes in stressed ecosystems have occurred. Most are deterministic in nature and do not appropriately account for the natural variability and dynamics within the systems being compared. This suggests that the comparative procedures should be statistically based and immediately raises the issue of how the selected comparative procedures are to be used as decision-making tools or conclusive procedures. Conclusive procedures require a significant body of evidence before rejecting the postulated null hypothesis. The costs and time involved in environmental data collection accordingly bias action toward the maintenance of a status quo approach to environmental management. If, however, EEM is treated as a decision-making procedure, risk functions that include consideration of type I and II statistical error may be developed and combined with costs to select a minimum expected loss strategy for environmental management. Examples of the interpretative difficulties and conclusion reversal phenomena caused when EEM is used as a conclusive procedure are presented. In addition, risk functions appropriate for environmental management within an EEM context are constructed and applied. Only when such tools are fully developed and applied can EEM expect to have significant impacts on minimizing environmental degradation.

Notes: Use in monitoring plan development:
- Not Used
- Baseline Data
- Model Development
- Stressor
- Physical Process
- Structural or Physical Changes
- Functional Response
- Methods

Ref ID: 254
Reprint: In File
Keywords: biological indicators/Monitoring/Fishes/Fish populations
Abstract: The advent of environmental risk assessment has shifted much of the emphasis in applied ecological research from measurement and discussion of individual-level effects to estimation and discussion of population- and community-level effects. Although population-level endpoints have been promoted and recognized as being more ecologically relevant than individual-based measurements, individual assessment endpoints still dominate in the scientific literature and regulatory requirements.
Ref ID: 72
Reprint: In File
Keywords: Alaska/Arctic/Ecology/Monitoring
Abstract: This chapter contains various presentations on fisheries and fish ecology.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 233
Reprint: In File
Keywords: Arctic/Carbon 14/Food Chain/Primary Biological Productivity/Colville River/River/Anadromous/Fishes/Water/Composition/Least Cisco/Broad Whitefish/Whitefish/Fish populations/Monitoring
Abstract: The inputs of organic carbon from the Colville River and from shoreline erosion to Harrison Bay dominate the energy input to this system. This large input of allochthonous carbon is utilized by microorganisms and the secondary production is sampled from Harrison Bay during November, based on the carbon-14 content of the amphipods. The anadromous fishes entering marine waters attain an isotopic composition typical of marine fishes by late summer. Upon entering the freshwater system, however, the foodweb dependencies shift drastically and by spring, the anadromous fishes sampled (least cisco, broad whitefish) were almost completely derived from peat as indicated by a large depression in C-14 content. These data indicate critical facts regarding anadromous fish populations.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 27
Reprint: In File
Keywords: Alaska/Arctic Region/Arctic regions/Economic conditions/Environmental aspects/Environmental conditions/Habitat/National Petroleum Reserve/National Petroleum Reserve (Alaska)/Nature conservation/Petroleum/Prospecting/Subsistence economy/Arctic/Monitoring
Abstract: From the Colville River west to the Chukchi Sea, Alaska's western Arctic represents a vast landscape that remains largely unchanged in character from the lands inhabited by Inupiat Natives during the last millennia. Approximately two-thirds of the western Arctic lies within the National Petroleum Reserve-Alaska (NPR-A), the largest single unit of public land in the nation ... This report also summarizes information on industrial potential, subsistence and wilderness values, and key information gaps. Ch. 1. Introduction -- Ch. 2. Selected wildlife and fish species -- Ch. 3. Selected wildland values -- Ch. 4. Special areas -- Ch. 5. Industrial potential -- Ch. 6. Summary and synthesis
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Ref ID: 319
Reprint: In File
Keywords: Monitoring/Colville River/River/Subsistence/Nuiqsut/Alaska/Arctic/Arctic cisco/Anadromous
Abstract: The fall subsistence fishery conducted in the Colville River by the residents of Nuiqsut, Alaska has been monitored annually since 1985 (no data were collected in 1999) by contractors on behalf of ConocoPhillips Alaska, Inc. (CPAI), and its predecessors. The focus of the monitoring program has been on Arctic cisco (qaaktaq; Coregonus autumnalis), which are a staple in the diet of Nuiqsut residents. The impetus for the monitoring program primarily has been concern that oil and gas exploration and development in the nearshore marine environment and, more recently, on the Colville delta could adversely affect these anadromous fish. The main goal of the monitoring program has been to obtain estimates of the total fishing effort and catch and to predict future harvest. Hence, the objectives of the monitoring program in 2007 were to: * Develop stakeholder engagement and monitoring plans (Appendix A) in conjunction with key stakeholders; * Monitor the harvest of Arctic cisco throughout the fishing season using the agreed upon protocols; * Estimate the magnitude of the subsistence fishery harvest; * Collect biological data (e.g., length and weight) for as many fish as possible; * Measure salinity in primary fishing areas; and * Compare the 2007 results with those of previous years.
Notes: Use in monitoring plan development:

Ref ID: 214
Reprint: In File
Keywords: Habitat/Monitoring/Alaska/North Slope
Abstract: This Habitat Evaluation was prepared in cooperation with the U.S. Fish and Wildlife Service, the State of Alaska, and the North Slope Borough, and other interested individuals (Appendix I). The HE provides maps and analyses of habitat values for comparison with potential oil and gas values mapped and analyzed in a separate Mineral Evaluation. These analyses will enable the best possible decisions for management of all values within the Teshekpuk Lake Special Area (TLSA).
Notes: Use in monitoring plan development:

Ref ID: 79
Reprint: In File
Keywords: Monitoring/Water
Abstract: The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) Nearshore Science Team (NST) has developed a Conceptual Model framework to aid in assessing restoration and preservation measures for nearshore ecosystems in Puget Sound, Washington. This framework was designed primarily as a synthesis tool to better understand nearshore ecosystem processes and the response of nearshore ecosystems to different stressors or, alternatively, restoration actions. It may also serve as a tool to plan and guide the scientific elements of the restoration project. The overall goal of the NST for this Conceptual Model is to build a synthetic, ecosystem-process-based understanding about how Puget Sound's nearshore ecosystems "work." Essentially, the Conceptual Model is designed to identify how nearshore ecosystem processes linking air, water, sediment, and biology components influence ecosystem structure.
Notes: Use in monitoring plan development:
Ref Type: Journal (Full)
Ref ID: 227
Keywords: Alaska/Arctic/Database/Ecology/Fishes/Habitat/Monitoring/stream habitat/Water
Abstract: A search of documents reporting on arctic anadromous fish investigations conducted as early as 1771 and through the year 1985 yielded 280 references relevant to the ecology of arctic anadromous fish, mostly in the form of unpublished research reports and some supporting computer tapes of original data. These are referred to as the database. Of these, 96 individual studies were found to contain or be supported by sufficiently detailed research protocols that original data sets could be extracted and entered into a computerized Databank for Arctic anadromous Fishes (DAAF-85). The content and organization of DAAF-85 are described in this paper, and the annotated list of references in the database is appended. Notes: Use in monitoring plan development:
Not Used
Baseline Data

Ref ID: 259
Keywords: biological indicators/Monitoring/Fishes/Fish populations/Habitat
Abstract: Environmental stress information can be in the form of physical, chemical, biological, as well as social data. Because of the multivariate nature of this information, it is often necessary to try to summarize the data in terms of a single measure, and biomarkers represent one method for this summarization. There are many possible biomarkers that may be selected and measured in a given experimental study. To be useful in environmental studies, they must meet criteria of statistical acceptability. In this chapter, statistical criteria are explored, first from the view of development of markers to serve as early warning signals of stress and, second, in a comparative context. Notes: Use in monitoring plan development:
Not Used
Baseline Data

Ref ID: 129
Keywords: Broad Whitefish/Whitefish/Monitoring/Arctic regions/Arctic Region/Alaska/Ecology/Arctic
Abstract: I analyzed data on length at age of broad whitefish Coregonus nasus from 23 locations in the arctic regions of Canada, Alaska, and Siberia to determine the effects on growth rate of age, climate, dispersion (over a geographical range), and distance from the sea. A multiple-regression analysis combining the effects of age, climate of resting area, latitude of spawning area, and dispersion and their interactions on fork length was significant ($P < 0.001, R^2 = 0.90$). Age, climate, spawning latitude, and dispersion all had significant effects on length; distance from the sea did not. Climate and distance from the sea exhibited multicolinearity. Inclusion of a quadratic term to account for a curvilinear relationship between the age and length while removing interactions resulted in only a slight increase in significance ($R^2 = 0.91$); a reduced model using climate, spawning latitude, and a square-root transformation of age gave the same result. Growth in Alaska appears to be more rapid than in Canada and Siberia. This effect is probably attributable to climatic moderation of Alaskan rivers entering the Pacific Ocean. The same effects were compared in an analysis using the von Bertalanffy growth function. All effects had a significant influence on growth rate ($P < 0.001$), with age and climate being the most important. Notes: Use in monitoring plan development:
Not Used

Ref ID: 215
Reprint: In File
Keywords: Monitoring/Ecology

Abstract: The purpose of this paper is to review existing information on eelgrass restoration and potential effects of multiple stressors on the success of eelgrass restoration projects in Puget Sound. Although an earlier review found that less than 60% of the eelgrass restoration projects on the West Coast were successful, it was concluded that by careful site selection and planting, eelgrass could be restored. A recent, comprehensive, nation-wide review of seagrass restoration efforts by the National Marine Fisheries Service and ongoing tracking of eelgrass mitigation projects in California verify these findings. Projects we have conducted in Puget Sound and other northwest estuaries have had variable success. Through our research conducted at restoration sites and through several eelgrass ecology projects, we have learned that eelgrass restoration remains difficult but possible. To improve the probability of eelgrass restoration success, we have conducted a series of experiments to further refine the growth requirements of eelgrass. In these experiments, we have made observations and gathered data at transplant and eelgrass research sites that have helped us better understand the multitude of factors that can affect the success of an eelgrass restoration project. Two of our key findings are that eelgrass performance goals may be unrealistic and that random natural and human-induced stressors can play a major role in affecting the success of restoration projects. We present here some of our information along with a summary of the latest reviews. We also describe some of our findings relative to factors affecting the success of eelgrass restoration in the Pacific Northwest.

Notes: Use in monitoring plan development:
Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method


Ref ID: 216
Reprint: In File
Keywords: conceptual model/Habitat/Monitoring

Abstract: The City of Bainbridge Island is conducting a seminal nearshore characterization and assessment project funded through the Salmon Recovery Funding Board. The primary objective of this effort is to provide baseline data upon which to develop and implement nearshore management strategies (including restoration and preservation) and measure management success. A science-based conceptual framework was used to characterize the status of shoreline ecological functions based upon systematic evaluations of shoreline modifications, controlling factors, habitat structure, and habitat processes. Approximately 48.5 miles of shoreline was broken down into nine management units (based on drift cell knowledge) and each unit was analyzed by reach (based on the WADNR ShoreZone Inventory). Digital data, including the Bainbridge Island Nearshore Structure Inventory, was quantified using GIS which was in turn used to conduct a qualitative (3-tier) assessment using defensible, systematic matrices. The qualified measures were based on quantified parameters derived from the literature, current and historical shoreline photos, and expert opinion. This information was synthesized to determine human impacts, locating critical areas for protection or restoration, and identifying nearshore ecosystems most at risk to cumulative impacts. Based on readily available or easily collectable data, this approach could provide a useful framework for similar assessments in Puget Sound.

Notes: Use in monitoring plan development:
Not Used

Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Abstract: The regional-scale importance of an aquatic stressor depends both on its regional extent (i.e., how widespread it is) and on the severity of its effects in ecosystems where it is found. Sample surveys, such as those developed by the U.S. Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP), are designed to estimate and compare the extents, throughout a large region, of elevated conditions for various aquatic stressors. In this article, we propose relative risk as a complementary measure of the severity of each stressor's effect on a response variable that characterizes aquatic ecological condition. Specifically, relative risk measures the strength of association between stressor and response variables that can be classified as either "good" (i.e., reference) or "poor" (i.e., different from reference). We present formulae for estimating relative risk and its confidence interval, adapted for the unequal sample inclusion probabilities employed in EMAP surveys. For a recent EMAP survey of streams in five Mid-Atlantic states, we estimated the relative extents of eight stressors as well as their relative risks to aquatic macroinvertebrate assemblages, with assemblage condition measured by an index of biotic integrity (IBI). For example, a measure of excess sedimentation had a relative risk of 1.60 for macroinvertebrate IBI, with the meaning that poor IBI conditions were 1.6 times more likely to be found in streams having poor conditions of sedimentation than in streams having good sedimentation conditions. We show how stressor extent and relative risk estimates, viewed together, offer a compact and comprehensive assessment of the relative importance of multiple stressors.

Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 217
Reprint: In File
Keywords: Monitoring/conceptual model/Ecology/adaptive management/Habitat/Water/Water quality
Abstract: This document describes the sample collection, shipment, and analysis procedures used by the Washington State Department of Ecology, Environmental Monitoring and Trends Section staff to collect water quality information at long-term stream monitoring stations. Although it is intended as a guidance manual for staff doing the field sampling, it may also be useful to individuals who would like to know more about Ecology protocols. The goals of the program are to provide: (1) Water quality information that can be used to characterize past and current conditions. (2) Data that can be used to refine and verify total maximum daily load (TMDL) models or help evaluate other site-specific water quality issues. (3) Data from a representative sample of rivers and stream segments for the evaluation of impairment of beneficial uses and the detection of violations of state water quality standards.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 224
Reprint: In File
Keywords: Habitat/Monitoring/Planning
Abstract: The City of Bainbridge Island (COBI) is in need of a tool to inventory and assess the conditions of its marine shorelines. Current data gaps point to a need for a comprehensive assessment of shoreline conditions before decision-making under planning and regulatory programs may proceed effectively. Ultimately, this information will allow planners to assess levels of development impact and resource quality over discrete shoreline management areas (MAs), which will assist with permitting issues and prioritization of areas for conservation and restoration.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Method

Ref ID: 136
Reprint: In File
Keywords: Monitoring
Abstract: Environmental assessment and monitoring is not limited to measuring quantities of some substances that threaten our existence. At present the greatest challenge is not to gain another decimal point in assaying a certain noxious chemical. As far as technical aspects of monitoring are concerned, we witness a steady progress. Our conceptual development is less tangible. At the same time it is more urgent. We are directed to assess and monitor novel characteristics such as biodiversity and ecosystem health. They are considered to be the basis of modern, ecosystem management. Specialists in wildlife, fisheries, soil scientists, agronomists, and foresters are revising the established tenets of their disciplines to pursue maximum biodiversity. This could be done only if we know what biodiversity and ecosystem health are. This paper assesses the state of our knowledge of these concepts.
Notes: Use in monitoring plan development:
Not Used
Baseline Data
Model Development
Stressor
Physical Process
Structural or Physical Changes
Functional Response
Methods