Environmental Conservation **31** (3): 177–180 © 2004 Foundation for Environmental Conservation DOI:10.1017/S0376892904001559

COMMENT

Traditional knowledge and satellite tracking as complementary approaches to ecological understanding

The integration or co-application of traditional knowledge and scientific knowledge has been the subject of considerable research and discussion (see Johannes 1981; Johnson 1992; Stevenson 1996; McDonald *et al.* 1997; Huntington *et al.* 1999, 2002), with emphasis on various specific topics including environmental management and conservation (see Freeman & Carbyn 1988; Ferguson & Messier 1997; Ford & Martinez 2000; Usher 2000; Albert 2001). In most cases, examples of successful integration compare traditional and scientific observations at similar spatial scales to increase confidence in understanding or to fill gaps that appear from either perspective. We present a different approach to integration, emphasizing complementarity rather than concordance in spatial perspective, using two migratory species as examples.

The use of satellite transmitters in recent years has added to researchers' abilities to determine the large-scale (from 100 s to 1000 s of kilometres) movements of individual animals. At the same time, increased attention to traditional knowledge (also known as indigenous knowledge or similar) has shown the depth of detailed local information and understanding (< 1 to ~ 10 s km) that can be contributed by communities of resource users (for example hunters, fishers and indigenous peoples), based on their experiential observations and knowledge gained while interacting closely with their environments. Linking information across these scales provides a means of combining traditional and scientific knowledge to improve collective understanding of the natural history of certain species. We use two examples from our own research and other published materials in Alaska and neighbouring regions (Fig. 1), namely beluga whales (*Delphinapterus leucas*) and white-winged and surf scoters (*Melanitta fusca* and *M. perspicillata*).

Beluga whales

The eastern Chukchi Sea stock of beluga whales is found along north-western Alaska in early summer (O'Corry-Crowe *et al.* 1997). Harvests from this stock form a substantial portion of the annual subsistence harvest for the Iñupiat Eskimo village of Point Lay, Alaska (Suydam *et al.* 2001). As documented through interviews with hunters (Huntington *et al.* 1999), belugas typically arrive south of the village in late June. After congregating near Omalik Lagoon (approximately 50 km south of the village) for several days, they begin to move northward along the coast. Sea ice, wind, currents and the activities of hunters from Point Lay influence their movements, causing some interannual variation in the timing of the migration and the number of animals seen in a given year. Nonetheless, the overall migratory pattern has not changed appreciably within living memory. Residents of Point Lay regard the Omalik Lagoon area as critical for the belugas and highly productive for all forms of marine life.

After the belugas pass Point Lay on their northward journey, they typically move away from the coast and are not seen again until the following summer. While hunters provided extensive traditional knowledge of the ecology of belugas in the Point Lay area, they offered no information on subsequent movements of the animals. Indeed, hunters expressed great interest in acquiring this information from scientists (Huntington *et al.* 1999).

Using satellite telemetry in 1998, three Point Lay animals with transmitters sent signals for 2–3 months as they travelled 700 km into the pack ice, reaching 80°N, before heading south again into the Beaufort Sea (Suydam *et al.* 2001). Additional belugas tagged in 1999, 2001 and 2002 followed a similar pattern, with one animal continuing westwards into Russian waters (Robert S Suydam, unpublished data 1999, 2001, 2002). These findings were a surprise, as researchers had expected the belugas to stay near the ice edge in the Chukchi Sea, at approximately 72–74°N.

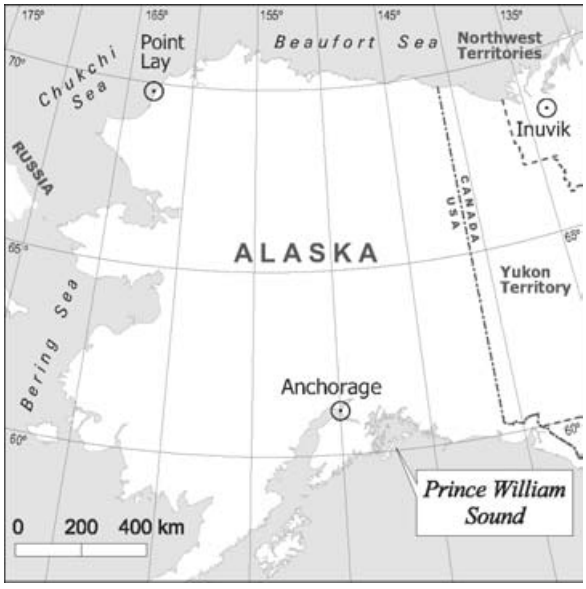

Figure 1 Location of major places mentioned in the text.

Scoters

Scoters comprise a significant portion of the waterfowl subsistence harvest in both coastal and interior Alaska (Wolfe *et al*. 1990). Despite their importance to subsistence lifestyles, scoters are among the least studied of North American waterfowl (Godfrey 1986; Savard & Lamothe 1991; Henny *et al*. 1995; Savard *et al*. 1998).

Fourteen surf scoters were tagged with satellite transmitters in Prince William Sound in 1998, 1999 and 2000. They migrated to breeding areas in Alaska and the Yukon and Northwest Territories before departing for Bering Sea moulting areas in western Alaska. Twenty-two white-winged scoters tagged with satellite transmitters in 1999 and 2000 showed similar patterns. Both species showed wide-ranging wintering, nesting and moulting areas (Rosenberg & Petrula 1999, 2000). In the area around Inuvik, Northwest Territories, Canada, the Gwich'in people noted a decline in scoters in 1995 (Gwich'in Elders 1997). No potential causes of this decline had been identified until satellite telemetry linked the Northwest Territories population with Prince William Sound, Alaska.

Combining traditional knowledge and telemetry

Taken together, information from satellite telemetry and traditional knowledge can illuminate connections between distant ecosystems and provide a more complete picture of a species or stock of wild animals. Traditional knowledge in Point Lay emphasized the potential threat from a proposed coal-loading causeway near Omalik Lagoon, whereas satellite telemetry has shown potential interactions of this beluga stock with proposed offshore oil exploration and development as well as activities in Russian waters. The combination of these sources and scales of information has provided a clearer picture of the movements and conservation needs of this particular stock of beluga whales.

Linking scoters in Prince William Sound to the Northwest Territories offered one potential explanation of the observed population decline. In 1993, the population of herring (*Clupea pallasi*) in Prince William Sound crashed because of a disease outbreak (Meyers *et al*. 1994). Scoters may congregate in Prince William Sound in spring in part to feed on the abundant herring spawn. While the herring crash cannot be confirmed as the cause of the scoter decline observed in the Northwest Territories, the timing and migratory connection are suggestive.

There has been much exhortation in recent years to use traditional knowledge and scientific knowledge together, but comparatively less discussion about the various ways that that goal can be reached. Comparing information from both sources, when available, is useful. Another, and

perhaps more powerful, approach is to recognize the strengths of each system and to use them to complement one another.

Acknowledgements

We thank the Alaska Beluga Whale Committee, the North Slope Borough, the Alaska Department of Fish and Game, the National Science Foundation, the US Fish and Wildlife Service, the *Exxon Valdez* Oil Spill Trustee Council, and the native villages of Point Lay and Tatitlek for support. The following individuals assisted our research and the preparation of this paper: Mike Petrula, Gerard Boere, Kathy Frost, Lloyd Lowry, Greg O'Corry-Crowe, Danny Pikok Jr, Celia Rozen, Hugh Short, and the editor and reviewers of this journal, for whose constructive comments we are grateful.

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