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Belugas and Narwhals: Application of New Technology to Whale Science in the Arctic

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The beluga, or white whale (*Delphinapterus leucas*), is one of the best known of the toothed whales (Odontoceti). Along with its nearest living relative, the narwhal (*Monodon monoceros*), it has a long history of economic and cultural importance to the Inuit. For many decades, non-Native commercial whalers also exploited these whales in much of their range. The beluga was one of the first cetacean species brought into captivity, and captive belugas have been used for experimental research on acoustics, physiology, learning, and behaviour. Belugas have also become well known to the general public through oceanarium presentations and television documentaries. In recent years, both belugas and narwhals have been the subjects of field research using new technology. The findings of that research have challenged earlier thoughts about the animals' physiological capabilities, their diving and other behaviour, and the ways in which they use their dynamic Arctic environment. This special issue of *Arctic* is intended to demonstrate the value of new tools recently applied in studies of belugas and narwhals and to reveal some of the exciting insights gained through such applications.

In addition to thousands of journal articles and gray-literature reports, three monograph-type books on the beluga are available. Kleinenberg et al. (1969) is based mainly on samples taken from large-scale commercial hunts in the Russian Arctic between 1955 and 1960. Smith et al. (1990) is centred on studies in North America involving aerial surveys, land-based or sea-level observations, work with captive animals, and analyses of biological samples from whales killed for food by Inuit. It considers the subjects of evolution and taxonomic status, abundance, habitat use, acoustics, age estimation, energetics, hormone and immune function, and tissue contamination. Born et al. (1994) covers both belugas and narwhals, with a particular focus on the region from eastern Canada to Svalbard. It includes information on abundance and habitat use, life history, ecology, hormone levels, and contaminants.

Those previous works set the stage for this special issue of *Arctic*. Two major areas of scientific innovation—molecular genetic analyses and satellite telemetry—have had enormous influence on wildlife studies in recent years. Investigations have been completed on the genetic population structure and history of belugas (e.g., O'Corry-Crowe et al., 1997) and narwhals (Palsbøll et al., 1997), and much more work of this kind is underway. Similarly ground-breaking work on animal movements and diving behaviour, based on telemetry data, were published in the 1990s (e.g., beluga: Martin and Smith, 1992; Smith and Martin, 1994; Heide-Jørgensen et al., 1998; Martin et al., 1998; Richard et al., 1998; narwhal: Martin et al., 1994; Dietz and Heide-Jørgensen, 1995; Heide-Jørgensen and Dietz, 1995), and new reports on these topics appear in this special issue.

It has long been known that white whales congregate by the thousands in certain bays and estuaries along the coasts of Somerset Island (Sergeant and Brodie, 1975; Reeves and Mitchell, 1987). A series of observational studies in the clear, shallow waters of Cunningham Inlet, carried out by Tom Smith and his colleagues in the 1980s, illuminated many aspects of beluga behaviour during the period of estuarine occupation (Sjare and Smith, 1986; St. Aubin et al., 1990; Smith et al., 1994). However, it was not until Smith and Tony Martin began tagging and tracking the whales via satellite that the bigger picture of the animals' lives started to unfold. Belugas, once viewed as shallow-water creatures, were revealed to be regular summer visitors to deep trenches in Peel Sound (Richard et al., this issue: 207–222) and Viscount Melville Sound (Richard et al., this issue: 223–236). The whales are assumed to flock to both areas to acquire stores of fat before the autumn migration. Some of the belugas that congregate in late June and early July along the north coast of Alaska also move far offshore and into the heavy pack ice later in the season (Suydam et al., this issue). Thus, belugas rival narwhals in their ability to navigate thick pack ice and explore depths well in excess of 1000 m.

Questions of stock identity are critical for hunt management. Satellite tracking has shown that although narwhals tagged in Tremblay Sound and Melville Bay in the summer remain more or less stationary until the ice drives them offshore in the autumn, animals from both of these summering

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grounds converge in early November on a common wintering area in northern Davis Strait (Dietz et al., this issue). The relationship between the belugas using the summering grounds in Prince Regent Inlet and Barrow Strait and those using the wintering grounds along the central west coast of Greenland is a major uncertainty. It has long been assumed that a single population of whales migrates between the two areas. However, telemetry results suggest that things are far more complicated. Only one of the 39 animals tagged to date near Somerset Island or southeastern Devon Island moved into Greenland waters. The rest remained in the North Water, a polynya centred in northern Baffin Bay and Smith Sound, until their transmitters either dropped off or stopped functioning. The case is still not closed, but it is beginning to look as though a high proportion of the belugas that use the bays, sounds, and inlets of the eastern Canadian High Arctic in the summer end up spending the winter in the North Water rather than in the lanes of open water and loose pack ice off central West Greenland (Richard et al., this issue: 207–222). Similar concerns apply to the belugas in Hudson Bay and Hudson Strait, where population structure seems especially complicated (Brennin et al., 1997). Results from satellite tracking generally support previous assumptions. For example, some belugas appear to remain in waters between the Belcher Islands and the Quebec coast throughout the summer, then migrate northward in the autumn (Kingsley et al., this issue). At least some of the animals that congregate in western Hudson Bay remain in shallow coastal waters for the entire open-water season (Martin et al., this issue). Major questions remain in all areas, particularly in regard to the dark months after November, by which time most tagged belugas have lost their transmitters, even the ones applied late in the fall.

Other management-related issues revolve around abundance estimation. How many whales are present in a given area, and how large is a particular stock or population? Again, telemetry is helping to refine the way we interpret the results of aerial surveys. Abundance of both belugas and narwhals is generally estimated from visual or photographic data obtained during aerial surveys. To produce meaningful abundance estimates, however, surveys must sample the complete range of the study population. Telemetry data on the movements of belugas tagged in the Mackenzie Delta have necessitated a major reinterpretation of previous survey results. These animals are now known to cycle through the delta, with some heading far offshore to areas outside the survey tracts. Thus, there are considerably more animals in the aggregate population than previously calculated (Richard et al., this issue: 223–236).

Anyone who has maintained watch during an aerial survey for cetaceans realizes that some animals are missed because they are submerged as the aircraft passes overhead. This problem applies to photographic surveys as well, although it is not necessarily appropriate to use the same expansion factors to “correct” visual and photographic survey data. Several papers in this issue contain data on diving behaviour and thus provide a basis for developing correction factors. Kingsley et al. (this issue) suggest that 85% should be added to counts in eastern Hudson Bay to account for missed belugas. Martin et al. (this issue) make no attempt to estimate correction factors, but their data from western Hudson Bay suggest that surveys of river mouths would find the belugas to be within a few metres of the surface 85% of the time. Heide-Jørgensen et al. (this issue) analyzed large samples of dive data from both narwhals and belugas in the High Arctic. They found that the proportion of time spent at the surface or in the upper few metres of the water column declines in autumn as the animals move offshore toward their wintering areas. Both narwhals and belugas apparently spend at least 20% of their time in surface waters, regardless of season or activity.

More belugas than any other cetacean species have been instrumented with satellite-linked transmitters. The techniques of capturing them safely and efficiently have become almost routine (Orr et al., this issue). Great progress has been made in the development of effective attachment methods and the design of transmitters. The availability of huge volumes of data on whale locations makes it possible to contemplate statistical analyses of integrated databases. For example, Barber et al. (this issue) used a geographic information system to explore the relationships among belugas, bathymetry, and sea ice conditions. The live-capture and release efforts themselves have had valuable spinoffs. Blood collected during the tagging operations has provided a wealth of baseline information on 55 whales. This information, when combined with data from another 128 individuals sampled in other studies, constitutes the largest published database for a free-ranging cetacean (St. Aubin et al., this volume). This database provides a unique opportunity to consider how factors such as age, sex, season, and stock might influence physiological indices measured in the circulation. Samples of tissue taken from the temporarily restrained animals are also being used for genetic and contaminant analyses.

Lest anyone be awestruck by the microprocessor revolution, it is important to consider some of its limitations. Several years ago, a team of scientists involved in the early development of satellite tracking technology called attention to the importance of ground-truth observations of tagged whales:

> Nothing can give one a 'feel' for how an animal lives better than…dogging its flukeprints continuously for periods of days or weeks. On-the-spot interpretations of behavior…allow the field biologist to develop a sense for what is important in the day-to-day life of the animal. Regular observations of the tagged animal allow the researcher to judge whether the data being received are accurate and whether the behavior of the animal is normal. (Scott et al., 1990:507)

In the course of the research reported in this issue, there have been few observations of tagged whales after release, and this may be unavoidable, given the remoteness, harshness, and darkness of Arctic field conditions. However, on those occasions when there has been follow-up, the results have been informative and useful. For example, observations of scarred tissue on the backs of previously tagged white whales appeared to confirm the supposition that tagging has no lingering effect on animal health or behaviour (Orr et al., 1998). Changes in blood constituents of animals recaptured within a few weeks after tagging (St. Aubin et al., this issue) are about what one would expect, given that some tissue damage and stress are inevitably associated with capture and tagging procedures. In future studies, it might be worth the extra cost of incorporating opportunities to find tagged animals and "dog their fluke-prints" for a few days or weeks. More physiological monitoring of whales at the time of capture and at later intervals would also be useful.

The ten studies published in this special issue are pieces of a much larger puzzle. Stock- and even site-specific studies have been typical for beluga research, largely because of management concerns. Findings, therefore, are often reported in what seems like a fragmentary manner, and this is reflected in the somewhat miscellaneous nature of the present compilation as well. Eventually, we expect a unified picture to emerge for both the beluga and the narwhal. Until it does, this collection of papers should be seen as one more in a series of benchmarks, each of which helps to elucidate what is known about the whales, the tools available for studying them, and questions that remain to be addressed.

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