

## Traditional Knowledge of the Bowhead Whale (*Balaena mysticetus*) around St. Lawrence Island, Alaska

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**ABSTRACT.** Despite considerable research on the bowhead whale (*Balaena mysticetus*) in Alaskan waters, relatively little has been conducted in the northern Bering Sea. To help fill this gap, we documented traditional knowledge of bowhead whales held by Yupik whalers of St. Lawrence Island, Alaska. Results include descriptions of the seasonal movements, distribution, and abundance of bowheads near St. Lawrence Island. The bowhead population appears to be increasing, as is the number of young whales seen. Changing environmental conditions are influencing distribution, leading to a somewhat earlier spring migration and a greater presence of whales near the island in winter. Hunters describe two bowhead migration paths near the island. It is unknown whether these two paths are used by two genetically different groups of whales, or whether the animals are simply responding differently to oceanographic conditions or geography. Our findings are consistent with studies of this bowhead population conducted elsewhere and suggest that additional research is needed to determine possible migratory (or genetic) differences between the two migrations of whales seen at St. Lawrence Island.

**Key words:** bowhead whale, *Balaena mysticetus*, St. Lawrence Island, Bering Sea, traditional knowledge, Yupik, Alaska

**RÉSUMÉ.** Bien que de nombreuses recherches aient été effectuées sur la baleine boréale (*Balaena mysticetus*) dans les eaux alaskiennes, peu de recherches ont été réalisées dans le nord de la mer de Béring. Afin de combler ce vide, nous avons pris note des connaissances traditionnelles des chasseurs de baleines yupik en matière de baleines boréales sur l'île Saint-Laurent, en Alaska. Les données obtenues prennent la forme de la description des mouvements saisonniers, de la répartition et de l'abondance des baleines boréales près de l'île Saint-Laurent. La population de baleines boréales semble augmenter, comme c'est aussi le cas du nombre de jeunes baleines. L'évolution des conditions environnementales a des effets sur la répartition des baleines et engendre une migration un peu plus hâtive au printemps de même qu'une plus grande présence de baleines près de l'île l'hiver. Les chasseurs décrivent deux chemins de migration pour les baleines boréales. Nous ne savons pas si ces deux chemins sont empruntés par deux groupes de baleines différents du point de vue génétique ou si les baleines réagissent simplement différemment aux conditions océanographiques ou géographiques. Nos constatations sont conformes aux études de cette population de baleines boréales réalisées ailleurs et laissent croire que des recherches plus poussées s'avèrent nécessaires pour déterminer les différences migratoires (ou génétiques) entre les deux migrations de baleines en évidence à l'île Saint-Laurent.

**Mots clés :** baleine boréale, *Balaena mysticetus*, île Saint-Laurent, mer de Béring, connaissances traditionnelles, Yupik, Alaska

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### INTRODUCTION

Considerable research on bowhead whales (*Balaena mysticetus*) has taken place in the Chukchi and Beaufort seas (e.g., Burns et al., 1993), but relatively little has been conducted in the northern Bering Sea (Brueggeman, 1982; Ljungblad et al., 1986; Burns et al., 1993). Research to determine population size and trend, reproductive rate, and other biological parameters has taken place mainly at

Barrow, Alaska. Management actions, including the harvest quota set by the International Whaling Commission (IWC), are based largely on these studies (Burns et al., 1993; George et al., 2004). At its May meeting in 2002, the IWC denied renewal of the five-year block hunting quota under which Alaska Eskimo whalers hunt, primarily because of concern that more than one stock might be present in the northern Bering Sea (IWC, 2003:18–22). The renewal was later accepted, however, at a special meeting held in October 2002.

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Although a quota was eventually negotiated at the later meeting, the IWC also recommended that a major stock structure research program be initiated.

In 2004, the United States launched a substantial program that includes, among other things, genetics, aerial photo-identification, traditional knowledge, satellite telemetry, and stable-carbon analysis of baleen (see Rugh et al., 2003, for more discussion about stock structure research for bowhead whales). Preliminary evidence of genetic differentiation between samples collected at Barrow and St. Lawrence Island (Givens et al., 2004) was considered inconclusive because of the small sample size (IWC, 2005). Extensive genetic sampling of recently harvested whales (LeDuc et al., 2006), baleen collection for isotope analysis, and the present study of traditional knowledge were considered key elements of the overall program (Moore and George, 2005).

Previously reported observations from Russian coastal communities along the Bering and Chukchi seas indicated that some bowhead whales from the northern Bering Sea may not migrate past Barrow (Bogoslovskaya, 2003; Melnikov et al., 2004). St. Lawrence Island residents had reported observations indicating the same conclusion (Conrad Oozeva, pers. comm. 1982), but no formal study of traditional knowledge in the region had been made. We conducted this study to document traditional knowledge held by Yupik whalers in the two communities of Gambell and Savoonga on St. Lawrence Island (Fig. 1). Our goal was to record local understanding of important and otherwise unavailable information about bowhead whales in the northern Bering Sea (IWC, 2005), including (a) the migratory patterns and seasonal distribution of bowhead whales near St. Lawrence Island, (b) the possibility of distinct stocks or sub-stocks in the area, and (c) changes over time in bowhead abundance and distribution. Additional observations on other biological and ecological parameters were gathered, but were not the primary focus of the study.

We use the term “traditional knowledge” to refer to the body of information and understanding developed over time, in this case, by the St. Lawrence Island Yupik. It is based on lessons and stories passed from generation to generation and personal experience and interaction with peers, including people from other communities (cf. Johannes, 1981; Huntington, 1998; Berkes, 1999). In the case of whaling, the Yupik have also interacted with and learned from outsiders: from commercial whalers and traders, starting in the mid-19th century (Bockstoce, 1986), and more recently, from biologists studying whales, whaling, and other marine mammals (e.g., Burns, 1993).

## METHODS

### *Acquisition and Transmission of Traditional Knowledge*

Traditional knowledge is built on experience, passed on through stories (e.g., Cruikshank, 1998) and practice, and

continually tested and refined by one’s own experience. When citing experiences of others, the Yupik will identify the source or sources of the information and the people through whom it has been transmitted. When a person’s own observations and experience confirm such information, then a person can describe it as a fact known to him or her. Many phenomena, such as the movements and dynamics of nearshore sea ice, are known from frequent observation, whereas other phenomena, such as offshore ocean currents, are known from extraordinary events, such as the stranding of hunters or travelers on moving pack ice.

Traditional knowledge is used for success and safety in hunting activities and while traveling and living on the land and sea. It is continually discussed in the community and while engaging in the activities that develop and require traditional knowledge, such as hunting, boating, or traveling over or amid sea ice (see Fig. 2). Children and youth are taught to remember stories and information accurately, to “put it into your body,” by techniques such as keeping one’s head still while listening. Songs may also be used to memorialize notable events. The Yupik language is a key element of knowledge transmission, with specific terms for a host of detailed phenomena (e.g., the 99 words for sea ice described in Oozeva et al., 2004) as well as rich associations of certain terms with detailed environmental conditions (e.g., Chester Noongwook’s observations of sea ice recorded in Oozeva et al., 2004).

While traditional knowledge is built on detailed observations of specific phenomena (see Huntington et al., 2004), its holders also recognize patterns and connections that define the environmental system of which they are part. For example, ice movements are understood as part of a larger system, driven by wind and current, and affecting the distribution of marine mammals and the ability of hunters to reach them. The understanding of the system that Yupik share allows them to convey detailed information in a few words, as speaker and audience recognize the implications of key variables such as wind direction and ice conditions (e.g., Krupnik, 2002). This understanding is part of the holistic view often ascribed to traditional knowledge, and which also includes spiritual associations beyond the biophysical realm (e.g., Kawagley, 1995).

The importance of traditional knowledge for safety and hunting success places a premium on care and honesty when conveying information. Lives may depend on a given piece of information. The accuracy of transmission of knowledge on St. Lawrence Island was demonstrated when Savoonga residents resumed whaling at Pugughileq in 1972 after a gap of many decades. The whalers who resumed the practice were descendants of Pugughileq residents who had left that area one or more generations earlier. When whaling resumed in 1972, the whalers successfully applied knowledge that had been passed down to them about the movements and behavior of whales in that area, as well as the local dynamics of sea ice, although no one with personal experience of whaling at Pugughileq was still alive.

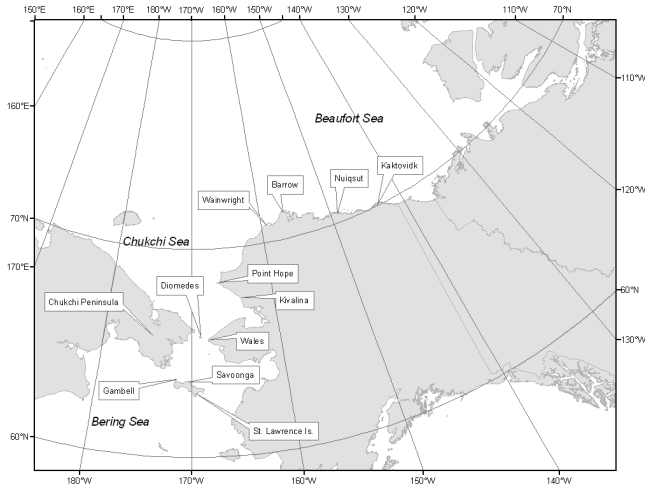


FIG. 1. Location of St. Lawrence Island, Alaska, and other Alaska whaling communities. (Courtesy of Kim Sheldon, National Marine Fisheries Service)

### *Documentation of Traditional Knowledge*

The acquisition and transmission of traditional knowledge create a body of knowledge within a community. The documentation of traditional knowledge is intended to help convey information beyond the community of its holders. Our study focused on ecological aspects of traditional knowledge (see Huntington, 2005). Although the removal of traditional knowledge information from its original context means that certain aspects and associations are lost (e.g., Cruikshank, 2001), we can distinguish between the ways that traditional knowledge is engaged within a community and how it can be usefully engaged with a wider audience (e.g., Ingold and Kurttila, 2000). Our approach allows St. Lawrence Island Yupik whalers to contribute to the broader scientific literature about bowhead whales, enhancing our collective understanding.

We used the semi-directive interview (Huntington, 1998), primarily in group settings, but supplemented with individual interviews and conversations. Our field research took place in Savoonga and Gambell during the last week of January 2006. In Savoonga, seven whaling captains and whalers (in addition to the lead author, who is a whaling captain himself) participated in some or all of the group sessions, which were held over the course of two days. In Gambell, nine whaling captains and whalers took part in a group session held one afternoon, with additional interviews that evening and the next morning and afternoon. In both cases, the individuals (who shall remain anonymous) were elders with considerable personal experience (dating back to the 1940s and earlier in some cases). They were selected by the local commissioner of the Alaska Eskimo Whaling Commission, with some additional recruitment through chain referral and word of mouth.

The research team included a local leader and whaling captain (George Noongwook), a biologist who has specialized in bowhead whale studies (John "Craig" George), and



FIG. 2. Spring whaling near Pugughileq, St. Lawrence Island, in a skin boat under sail, April 1976. (Courtesy of the Eskimo Heritage Program, Kawerak, Inc., Nome, Alaska)

a researcher with extensive experience in traditional knowledge studies (Henry Huntington). We were joined by two local videographers trained by the Eskimo Walrus Commission, Edwin Noongwook and Brian Rookok, Jr., who were recording footage for a program on best hunting practices. They recorded all of the group sessions and most of the individual interviews. The diversity of expertise in the research group provided several perspectives on the information we gathered and allowed us to pursue different lines of inquiry in follow-up questions and other interactions with the local whalers.

The group interview sessions were not simply a one-way flow of information. Instead, Craig George also shared information from bowhead studies conducted elsewhere, as well as photographs and information from previous visits to St. Lawrence Island. Comments from the local whalers indicate that they regarded this sharing of information as enjoyable and important, and that it helped create a sense of shared enterprise between the researchers and interview participants (e.g., Huntington et al., 2002).

Much of the discussion was in Yupik, recorded as video and also in notes by the lead author. Some discussion was in English, and the lead author or others provided English summaries from time to time for the benefit of the visiting researchers. Yupik is the language that the whalers use when discussing whales and whaling among themselves, and as noted in the previous section, it has specific terms to describe complex suites of environmental phenomena. While some of this richness is inevitably lost in the eventual translation to English, the group interview format allowed the whalers to discuss their observations and understanding in detail and then provide a consensus summary. The supplemental individual interviews (conducted largely in English, but also at times in Yupik) added some details, but they did not attain the depth of the group conversations, upon which most of our results are based.

After this trip, the research team prepared a draft manuscript, which was circulated among us for review and then

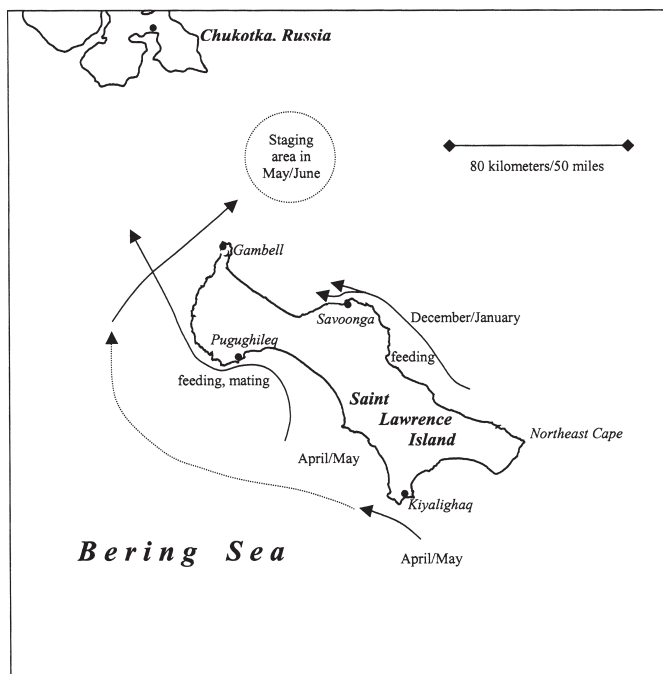


FIG. 3. The movements of whales near St. Lawrence Island. Savoonga whalers hunt near Pugughileq in spring and near Savoonga in fall/winter. Gambell whalers hunt near Gambell in both seasons. In winter, bowhead whales are generally southwest of the island, though some may remain near the coast of Chukotka or north of Gambell.

distributed to the participants in the interviews, the tribal councils of both Gambell and Savoonga, and the Alaska Eskimo Whaling Commission. This review allowed for correction of errors, addition of material that had subsequently occurred to participants, and the deletion of information incidental to the study results that the participants, the tribal councils, or the AEWC felt might be harmful to their interests. These steps were in keeping with prior practice (e.g., Huntington et al., 1999) and ethical principles (e.g., IARPC, 1992). During this time, the lead author also confirmed or clarified a number of details with other whalers, adding this information to the paper.

The summary of results presented below reports the substance of discussions and interviews rather than interpreting them. The whalers, however, did at times interpret the significance of their own observations. For example, observed changes to sea ice were discussed in the context of global climate change, and more frequent sightings of whales were regarded as the result of an increased population. Interpretation by the authors is confined to the Discussion and Conclusions sections.

## RESULTS

### *Movements, Distribution, and Abundance in Spring and Summer*

In spring, bowhead whales follow two paths past St. Lawrence Island (Fig. 3). One path goes westward past

Kiyalighaq (Southeast Cape), remains offshore of Pugughileq (Southwest Cape), and then is seen again at Gambell (Northwest Cape) heading to the northeast. The other path comes near land to the east of Pugughileq, follows the coast past Southwest Cape, but then turns offshore in a northwestward direction towards the coast of Chukotka. The existence of these two paths has been known for many generations and is confirmed by recent observations of Gambell and Savoonga whalers. When whales are seen at Pugughileq, no corresponding pulse is seen at Gambell, and vice versa. Furthermore, Gambell whalers hunting to the southwest of the village distinguish “northeast-heading” and “northwest-heading” whales, using this characteristic to indicate which direction to follow when pursuing a whale. Few whales go past the east end of the island, although the presence of bowhead bones in archeological sites (with which local residents are very familiar) suggests that at least some whales, at some time of the year, have traveled that way in the past.

Both groups are segregated by size as they travel. First come the smaller whales—*ingutuk* in both Yupik and Iñupiaq, referring to small whales with thick blubber, probably yearling whales (Braham et al., 1980)—then the mid-sized whales, and finally the largest whales. Mothers with calves travel as part of the large-whale group and are seen as early as April, but with greatest frequency in mid-May. Calves may be born as late as June. Hunters say they are harvesting pregnant females more frequently now than years ago, which is consistent with observations of increasing numbers of whales and particularly small whales.

The whales that travel past Pugughileq often linger along the coast to both east and west, apparently feeding in the shallows and also mating. The spring migration coincides with the northward movement of polar bears (*Ursus maritimus*), an example of the connections recognized in traditional knowledge. However, the timing of the spring migration has advanced, in response to recent changes in ice conditions. Whereas bowheads used to migrate past the island in April and May, they now arrive in March and most have left before May. The migration is also less predictable than formerly, a result of changing weather and ice conditions.

In recent years, Savoonga whalers have had to end their whaling season earlier because deteriorating snow conditions have forced them to return overland from Pugughileq sooner than used to be necessary. Gambell whalers, in turn, have been hampered by generally poor weather conditions in spring, a recent change from patterns that used to include more good hunting weather. Additionally, sea ice has recently been thinner and has contained little or no ‘polar ice’ (*kulusik*; Oozeva et al., 2004:36), large multi-year ice floes that drift south to the island in fall and early winter. Thinner ice crumples more easily in wind and current, creating rougher ice conditions less favorable for transporting boats over the ice. These changes in timing and ice conditions are of great concern, particularly as they are seen as effects of global climate change. As such, these

conditions are what may be expected in future years, rather than a temporary change.

While present conditions may not favor traditional hunting, the whalers believe that bowhead whales are healthy as individuals and as a population. In the mid-20th century, Gambell whalers might stay out on the water or ice all day hoping to see one whale, but today, whales are seen frequently even if conditions prevent the whalers from reaching them. In the mid-20th century, most bowheads observed were large, whereas today many *ingutuks* are seen. At Pugughileq, there has been a general increase in the number of whales seen, especially young whales, though the numbers vary from year to year. In some years, large pulses of whales go past Pugughileq, whereas in other years, the whales trickle by. Beginning in the 1960s, the numbers of whales seen started to increase and included a greater number of small (i.e., young) whales. The frequency of pregnant females is also higher in recent years than it was in the 1950s.

After the main spring migration, some bowhead whales remain in the vicinity of the island. In May and June, bowheads and gray whales (*Eschrichtius robustus*) are seen in the same areas. In June, when most of the ice is gone, bowhead whales have been seen in an area about 40 km north of Gambell. From here, they typically head to the coast of Chukotka. After the ice is gone, there can be large aggregations of walrus and bearded seals moving through the area, a pattern known as *qavreq*. On occasion, large bowhead whales that are not migrating are seen in the waters north of the island after the ice is gone. Recently, two bowhead whales were seen very close to Savoonga in July.

#### *Movements, Distribution, and Abundance in Fall and Winter*

In fall, the whales arrive from the north in the opposite order from spring. The largest whales come first and the *ingutuks* last, which is consistent with the fall migration pattern near Barrow, Alaska (Suydam and George, 2004). Many, perhaps most, of the bowheads pass to the west of the island. Some bowheads, however, stay along the north shore through December, feeding along the edge of the shorefast ice. Eventually, these whales move westward past Gambell. In fact, Gambell whalers expect to see whales in their area approximately two days after they are seen in Savoonga.

The predominant fall movement of bowhead whales is westward, though a few bowheads may travel to the east. Whales are seen in the vicinity of Gambell during December, January, and February. A whale was harvested there during February 1992, and more have been harvested in the winter months since then. In years with little *kulusik* ('multiyear ice'), bowhead whales may remain north of the island during winter. From Yupik residents of the Chukotka coast, St. Lawrence Islanders are aware that bowhead whales are seen in polynyas during winter near Sireniki and other Chukotkan villages northwest of Gambell.

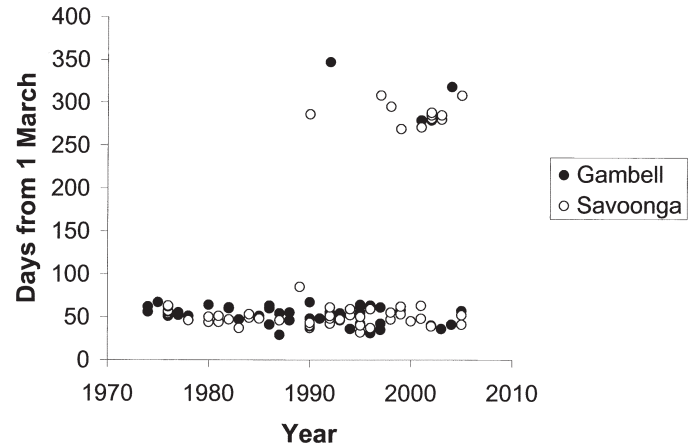


FIG. 4. Timing of bowhead whale harvests (days from 1 March) for the years 1974 to present at Gambell and Savoonga. Note that late fall and winter harvests began in 1990.

In fall, the movements of walrus and bearded seals mirror the spring pattern. These animals may arrive ahead of the ice. This movement is known as *anleghaq* or, if the movement involves large numbers of animals traveling together, as *unegyuuq* or *qiighqaghshiiq* ('like an island') because the group is so large.

Near Savoonga, walrus hunters traveling on sea ice have observed whales during December at least since 1962. Whales are seen in open water areas during winter. For example, bowheads were seen on the north side of the island in 1962, 1968, 1972, and 1978, years with significant mid-winter thaws or otherwise notably warm winters. In December 1998, whalers noted hundreds of *ingutuks* (but no large whales) near Kintanga Bay. In December 1990, a Savoonga captain harvested a whale northwest of the village, and whales have been seen in this area every subsequent winter. Whales have become more abundant around St. Lawrence Island in winter, and winter whaling has become common at both Savoonga and Gambell in recent years (see Fig. 4). In fact, in the last decade (1995–2005), roughly 40% of the whales harvested at St. Lawrence Island have been taken in winter rather than in spring.

#### *Other Information*

Bowhead whales are long-lived animals. A dead bowhead washed up on the island in 1939 or so ("some years before I was married in 1947"), and the *mangtak* ('skin and blubber') was still edible. While cutting into a piece of *mangtak*, a family discovered an ivory harpoon head in the blubber, with no notable wound or scarring on the skin's surface. The family was surprised not only to find a harpoon head, but also that it was made of ivory, which local whalers had stopped using in the late 19th century in preference for metal harpoons.

Bowhead whales are sensitive to noise when traveling alone or in small groups. Whalers on St. Lawrence Island use sails to power their boats when hunting bowheads.

When large numbers of whales are present, however, their sensitivity to noise decreases. Bowheads also have good lateral vision, so whalers must approach them from the front or from behind rather than from the side. Whales have been known to stay next to a whaling boat under sail for up to an hour, often positioning themselves near each “seat position” in the boat as though sizing up the crew members. While swimming alongside the boat, a whale may remain in sight even when submerged. At times, it may even touch the boat on the left side, where it is inaccessible to the harpooner. (Note: the harpoon equipment is always set up on the right side in a whaling boat and cannot be transferred because of the mast, lines, and seats.) When surfacing to breathe, these whales surface on the side of the boat opposite the harpooner, thus remaining out of reach for the whalers. This phenomenon is known as *angyi* (from the Yupik root *ang-*, which refers to giving something), meaning that the whale is considering giving itself to the whalers. (The same root is found in the Yupik word *angyaq* (‘skin boat’), referring to its use in pursuing the gift of the whale. The word *angyi* also means ‘the construction of an *angyaq*.’) The behavior is part of the relationship between the *angyalek* (‘whaling captain’) and the *aghveq* (‘bowhead whale’). Eventually, the whale may surface where it can be struck by the harpooner.

Yupik values concern many aspects of the environment. Speaking in part to the community and to posterity through the video recording, several whaling captains addressed various topics they thought should be emphasized. One captain discussed *yaayasitkegpenaan*, a term describing the appropriate treatment of animals and all life surrounding the Yupik. Proper behavior includes harvesting no more than one needs, not killing an animal that cannot be retrieved, and keeping the environment clean both for the animals and for future generations of islanders.

One whaling captain described the impact of moving away from *yaayasitkegpenaan*, sometimes because external regulatory regimes have been imposed. The early harvest quota on bowhead whales in the late 1970s and early 1980s was very restrictive for St. Lawrence Island and other whaling villages. Whalers were unable to hunt according to their needs, but had to regulate their harvest to match the quota restriction. This regulatory system created stress, diminished happiness, and created distrust and anxiety not only towards the government, but also among islanders. The conflict between traditional values and modern regulations, though currently eased by a larger harvest quota, still remains (as is the case throughout rural Alaska; see Huntington, 1992).

## DISCUSSION

The results reported here are consistent with and extend the findings of other bowhead whale studies in the northern Bering Sea, along the coast of Chukotka, and along the Alaska coasts of the Chukchi and Beaufort seas. An analy-

sis of the logbooks of commercial whalers from 1848 to 1914 indicates that bowheads were not taken east of St. Lawrence Island, although active whaling ships sailed in those waters (Bockstoce and Botkin, 1983). Aerial surveys conducted near St. Lawrence Island from 1979 to 1984 did not observe bowhead whales east of the island (Ljungblad et al., 1986). Aerial surveys conducted in the northern Bering Sea during April 2005 found a concentration of bowheads approximately 40 km north of Gambell (Koski et al., 2004), in the same location Yupik whalers indicated as a staging area used after the retreat of spring ice.

The description of two distinct groups of whales moving past the island is broadly consistent with other observations about bowhead migratory behavior. Melnikov et al. (2004) found that in spring, bowhead whales migrating along the Chukotka coast do so later than those that migrate past Point Barrow. Commercial whaling records indicate that substantial numbers of bowheads were found in the northern Bering Sea during early to mid summer; however, animals summering in this area were largely extirpated in the early years of the commercial hunt (Bockstoce and Botkin, 1983). Whether separate migratory patterns now or in the past indicate distinct stocks or sub-stocks requires further research, as discussed below.

The size segregation pattern of the seasonal migrations, with small whales traveling north first in spring and traveling south last in fall, is consistent with observations at Barrow (Suydam and George, 2004; Koski et al., 2004). Additionally, pregnancy rates measured in harvested whales at Barrow appear to be increasing, and this increase is also consistent with the observations of Yupik whalers. The overall bowhead population increase documented by ice-based surveys conducted during spring at Barrow (George et al., 2004) is consistent with the observations of whalers elsewhere (e.g., Albert, 1988) as well as those reported here. It is important to note that more whales are now seen along both spring migratory paths past the island.

Specific patterns of behavior, such as feeding and mating and the details of local movements near St. Lawrence Island, have not been reported previously. Shifts in seasonal distribution, while apparent from changes in harvest dates, have not been described previously. Descriptions of longevity (George et al., 1999) and sensitivity to noise (Richardson et al., 1995) are also consistent with previous findings from other locations in Alaska and elsewhere. Discussion about whale behavior in relation to whalers and about the implications of regulations for that behavior are consistent with views of hunters reported elsewhere (e.g., Fienup-Riordan, 1999), though perhaps contrary to scientific understanding or outside the usual realm of scientific study.

We recognize that our study was not an exhaustive survey of the entire whale-hunting community of St. Lawrence Island, nor did our interviews cover all the knowledge and observations held by the individuals who took part. Nonetheless, the results obtained were remarkably consistent between villages and between hunters, giving us confidence in the basic information presented here.

## CONCLUSIONS AND FUTURE STUDIES

In the eyes of St. Lawrence Island Yupik whalers, bowhead whales are thriving in the northern Bering Sea. Although environmental change has caused shifts in distribution, timing, and availability to whalers, the bowhead whales appear healthy and the population appears to be increasing, with more young whales than in the past. This information supports current understanding of bowhead whale population trends for the Bering Sea stock (also known as the Western Arctic stock), and it applies to both migratory groups recognized by Yupik whalers.

The presence of two groups of bowheads, following intersecting but distinct migratory paths in spring, suggests a need for further studies to determine stock structure (e.g., Rugh et al., 2003), some of which are currently planned or underway as part of the overall research program for the northern Bering Sea, as noted in the Introduction. Genetic analysis of tissues from harvested whales (underway) and biopsy samples of free-ranging whales (underway elsewhere, proposed for the northern Bering Sea) can help determine the degree to which the two groups are reproductively isolated. Genetic analysis of bones from previous harvests, including archeological remains where possible, may indicate previous distributions of bowheads, as well as island harvest patterns. Data from satellite transmitters deployed on both groups of whales during the spring migration (expected to begin soon) can provide movement information about each bowhead group after it leaves the island area. Tagging at different times during the spring and fall migration (under consideration) would provide additional information regarding differences in routes and also the distribution and eventual destination(s) of small and large whales. Aerial photo-identification (underway) would also allow tracking of many individual whales during the seasonal migration and over the course of many years (Rugh, 1990), indicating the degree to which individual whales follow the same patterns from year to year. Shore-based surveys (from high sea bluffs) of the spring migration at St. Lawrence Island, for one or both groups, may provide valuable data on timing, relative abundance, and age-class composition, though is not without logistical challenges.

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