Novel Surface Feeding Tactics of Minke Whales, *Balaenoptera acutorostrata*, in the Saguenay-St. Lawrence National Marine Park

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Surface feeding behaviours of Minke Whales (*Balaenoptera acutorostrata*) in the mouth and fjord of the Saguenay River, Québec, were documented between June and October 2003. Several novel behaviours associated with gathering prey into dense, near-surface aggregations prior to a feeding strike were observed. To our knowledge, these behaviours have not been described in detail and may be exclusive to this area or to these individuals. A small number of known Minke Whales show strong site fidelity to the Saguenay region, providing an ideal opportunity for the study of foraging behaviour at the individual level.

Key Words: Minke Whale, *Balaenoptera acutorostrata*, St. Lawrence Estuary, foraging, surface feeding, specialization, behaviour.

The Minke Whale (*Balaenoptera acutorostrata*) is one of the smallest and most widely distributed baleen whales, averaging 7 to 10 m in length and weighing up to 9200 kg (Reeves et al. 2002). These whales generally undergo annual migrations between low latitude breeding grounds in the winter and high latitude feeding grounds in the summer. Like other balaenopterids, Minke Whales feed by swimming into a concentration of small fish or euphausiids mouth agape, then expelling a large quantity of water through their baleen while retaining and swallowing the prey.

A variety of foraging behaviours have been reported for this species. In the northeast Pacific, Hoelzel et al. (1989) reported two distinct foraging strategies: bird-association feeding, in which whales take advantage of aggregations of shoaling fish beneath feeding birds, and lunge feeding, in which whales actively gather prey prior to a strike that breaches the surface. In the St. Lawrence Estuary, Lynas and Sylvester (1988) distinguished between patch fishing and line fishing, two alternate feeding modes dependent on prey distribution. Gaskin (1982) and Edds and Macfarlane (1987) observed dynamic surface behaviours of Minke Whales in the Saguenay-St. Lawrence region but did not describe them in detail or address their function. Here, we describe and discuss the surface feeding behaviour of five well-known Minke Whales in the Saguenay Fjord, including several apparently novel manoeuvres.

Study Area and Methods

The Saguenay Fjord is a major tributary to the St. Lawrence Estuary, running 170 km southeast from Lac Saint-Jean to the north shore of the St. Lawrence River near Tadoussac, Québec. An 80 m deep sill located 18 km from the mouth of the fjord divides the Saguenay into distinct inner and outer basins, the outer reaching a maximum depth of 250 m (Schafer et al. 1990). Our study area (Figure 1) consisted of the outer basin and mouth of the fjord (48˚08'N, 69˚43'W), which lie within the boundaries of the Saguenay-St. Lawrence National Marine Park. Two cetacean species, Beluga Whales (*Delphinapterus leucas*) and Minke Whales, are regularly observed in the Saguenay. Larger baleen whales, including Fin (*Balaenoptera physalus*), Humpback (*Megaptera novaeangliae*) and Blue (*Balaenoptera musculus*), are occasionally seen at the river's mouth but tend to remain in the more open waters of the St. Lawrence Estuary.

Data were collected on the foraging behaviour of five known Minke Whales (individuals that were photographed regularly in the area for at least one full season prior to the study) using handheld voice recorders during 162 outings between June and October 2003. Research outings were conducted on a daily basis (weather permitting) aboard 1 to 3 small (5-7 m) rigid-hull inflatable vessels and lasted from 3 to 10 hours. Photographs were taken using SLR cameras equipped with 300 mm fixed focal lenses on 200 ISO slide film to allow identification of individuals based on dorsal fin markings and other acquired morphological traits. We focused on one identified whale at a time, documenting all surface behaviours and taking frequent Global Positioning System (GPS) positions. Duration of focal follows used in this study ranged from 15 minutes to several hours and depended largely on the continuity of feeding and on tracking conditions.

Results

A total of 32.8 hours of surface feeding data were collected from the five individuals (M1 – M5) (Figure 2) that showed strong site fidelity to the Saguenay mouth and fjord throughout the season. These whales were observed in the study area on 20, 26, 15, 47 and 31 days, respectively, from mid-June until mid-October. Opportunistic sightings data from the two previous seasons showed similar patterns of habitat use by these

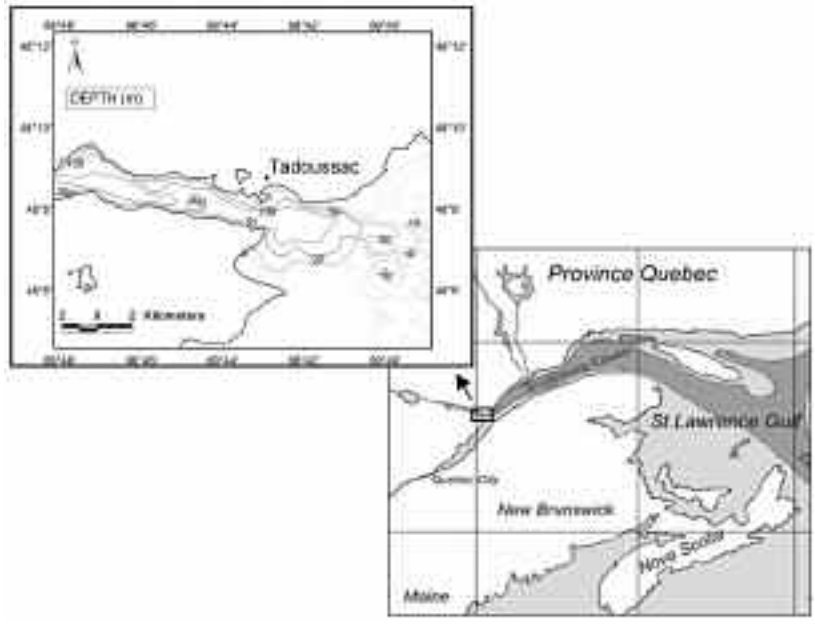

FIGURE 1. Map showing location of study site at the confluence of the Saguenay and St. Lawrence Rivers, Québec.

whales. Sightings of these individuals outside the study area were infrequent and occurred mostly near the study area boundary.

In 11 of 43 (25.6 %) focal follows, small fish (approximately 10-15 cm) were observed either (a) being displaced into the air by a feeding strike; (b) on the body surface of the whale during a feeding strike; (c) jumping at the surface of the water just prior to a feeding strike; or (d) being picked up by birds at the feeding site prior to or just after a strike. Due to extremely poor visibility in the Saguenay we were unable to identify the species. When conditions allowed us to approach the site of a recent feeding strike, the water was searched for scales or dead fish but these efforts proved unsuccessful. Prey were small shoaling fish but we can only speculate that they were most likely juvenile Capelin

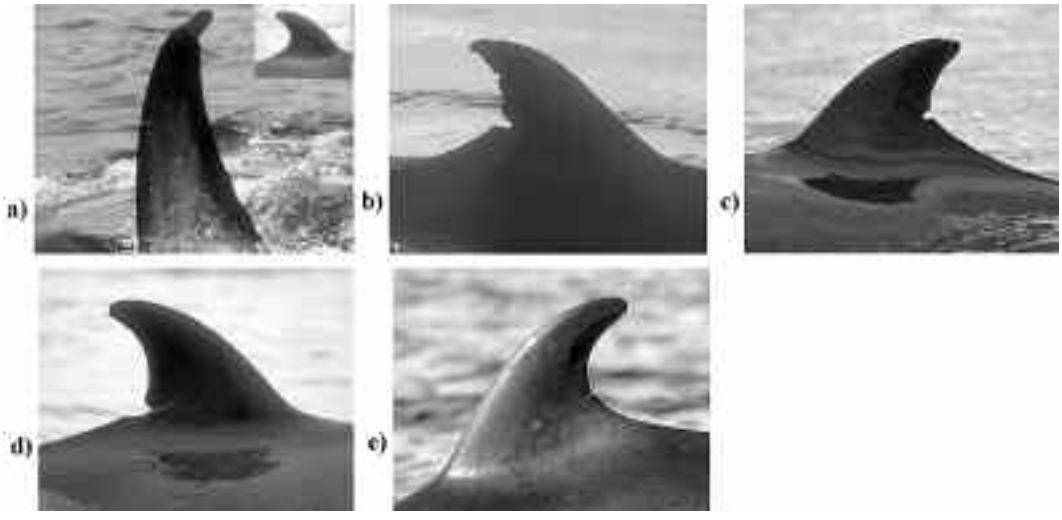

FIGURE 2. Identification photographs of the five individual Minke Whales: a) M1 (lacks dorsal fin markings but has distinct bent left fluke tip visible during lateral surface manoeuvres); b) M2; c) M3; d) M4; and e) M5.

(*Mallotus villosus*), which has been reported as the predominant prey species of Minke Whales in the Saguenay and in neighbouring areas of the St. Lawrence (Gaskin 1982; Simard et al. 2002). Sand Lance (*Ammodytes americanus*) has also been identified as prey of Minke Whales in the area (ORES unpublished data) and therefore cannot be ruled out.

The five focal whales used variations of the same foraging strategy, which involved actively gathering prey at the air/water interface using various combinations of multi-directional surface manoeuvres followed by a feeding strike at or near the surface. Pre-strike manoevures that were frequently observed included "head slaps", "chin-up blows" and "exhales on the dive". These behaviours were observed exclusively during bouts of surface feeding and were generally performed while the whale swam in a tight elliptical pattern followed by a strike at or near the centre of the ellipse.

Head Slap

Surfacing dorsal side up, the whale would slowly bring its head high out of the water at an angle of approximately 30 to 45˚. As much as one third of its body became visible above the surface with ventral grooves *not* expanded and no water seen being expelled from the mouth (Figure 3a). After taking a breath, the whale would then quickly and powerfully thrust its head toward the water, creating a large splash and an audible slap as it struck the surface. Head slaps were performed on several surfacings oriented in various directions prior to a feeding strike, often at the same spot. This manoeuvre was also occasionally performed oriented laterally with the whale's right side striking the surface. Head slaps were observed on 336 occasions (22 of which were lateral) from three whales during 27 focal follows. 99.4% of these were performed by M4 and M5 (Table 1).

Chin-up Blow

Chin-up blows appeared similar to regular surfacings but were more vigorous and performed at a steeper angle than regular breaths. As the whale began to surface, it would raise its head high out of the water, breathe, and submerge in a continuous motion without a slap on the surface. This behaviour was observed frequently and was performed while oriented dorsoventrally or laterally (Figure 3b). This manoeuvre was observed on 495 occasions (219 of which were lateral) from all five individuals during 40 focal follows. Chin-up blows were the predominant pre-strike surface manoeuvre used by M1, M2 and M3 (Table 1).

Exhale on the Dive

Following a respiration, the whale would exhale as its blowholes submerged resulting in the displacement of a large volume of water into the air (Figure 3c). This manoeuvre was typically preceded by a regular blow or a chin-up blow and occasionally by a head slap. Exhales on the dive were observed on 56 occasions and were performed by only M1 and M5 during 11 focal follows (Table 1).

Discussion

The foraging behaviour of the five known Minke Whales in the Saguenay is markedly different from that observed in adjacent areas of the St. Lawrence River. For example, in the Laurentian Channel Head (LCH) located approximately 8 km east of the Saguenay mouth, Capelin are the primary prey of Minke Whales (Simard et al. 2002) and the surface manoeuvres described here were not observed in the study period. In the LCH, strong tidal currents, a stratified water column and bottom topography combine to create large areas of upwelling in which prey are forced to the surface (Simard et al. 2002). In contrast, the water in the outer Saguenay basin and mouth is well-mixed (Schafer et al. 1990), the tidal influence is lower and it appears that these whales expend a significant amount of energy gathering fish near the surface prior to a strike.

It is likely that the function of the behaviours described here is to increase prey density at the time of a strike. Precisely how this is achieved, however, is unclear and warrants further investigation. It is possible that head slaps and exhales on the dive have a combination of acoustic, mechanical and visual properties intended to stimulate an aggregation response in the prey. Aggregation has been documented as a common response of shoaling fish to "frightening" visual stimuli (Radakov 1973; Tegeder and Krause 1995), however, it has not been investigated as a response to mechanical or percussive acoustic cues such as those produced by the Minke Whales in this study.

Alternatively, it is possible that these behaviours temporarily confuse or stun the fish, restricting their movement while the whale dives to corral them by circling beneath the surface. Weinrich et al. (1992) proposed this function for lobtail feeding in Humpback Whales in the Gulf of Maine. In lobtail feeding, whales preying on Sand Lance slap the surface of the water with their flukes one to several times while diving and follow with the underwater release of bubbles leading up to a feeding strike. The response of fish to the release of bubbles was examined by Sharpe and Dill (1996), who demonstrated that bubbles can be effective in manipulating (restricting the movement) of groups of Pacific Herring (*Clupea harengus*).

TABLE 1. Pre-strike surface manoeuvres used by five known Minke Whales in the Saguenay mouth and fjord.

Individual	Surface Manoeuvre		
	Chin-up blow	Head slap	Exhale on the dive
M1	53	0	14
M2	58	0	0
M3	180	2	0
M4	19	154	0
M5	185	180	42
Total	495	336	56

FIGURE 3. Photographs of surface manoeuvres performed prior to a feeding strike: (a) head slap; (b) lateral chin-up blow; and c) exhale on the dive. Refer to text for description of these behaviours.

Other cetacean species have also been observed using surface slaps while foraging. For example, Bottlenose Dolphins (*Tursiops* sp.) have been reported using fluke slaps while foraging for single fish (Connor et al. 2000) and Dusky Dolphins (*Lagenorhynchus obscurus*) have been reported using them while feeding on shoaling fish (Würsig and Würsig 1980).

Individual Minke Whales in the Saguenay appeared to specialize in certain types of feeding strikes (for example, strikes oriented laterally or ventral side up) and surface behaviours prior to a strike. The five focal whales were often observed feeding in close proximity to other whales, each using their individual surface feeding technique, showing no signs of competition or displacement. This consistent variation made it possible on many occasions to identify individuals in the field by their "signature feeding technique" prior to obtaining an identification photograph. Lynas and Sylvestre (1988; Minke Whales) and Weinrich et al. (1992; Humpback Whales) have also reported consistent individual variation within a single foraging strategy. These studies allude to an individually learned component of foraging behaviour, which may result in the development of specialized feeding "styles".

Recently, increasing emphasis has been placed on the importance of individuality and culture in studies of behaviour and ecology (see Bolnick et al. 2003 and Rendell and Whitehead 2001). Continued studies of known Minke Whales in the Saguenay region should contribute further valuable insight on these topics. Particularly, data collected across seasons on the fidelity of these whales to the study area and on the frequency and spread of novel behaviours are of interest. Ongoing observation of these individuals should lead to an increased understanding of Minke Whale feeding behaviour and habitat use in the Saguenay, which could have important management implications for the Saguenay-St. Lawrence National Marine Park.

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