

Note

Sighting rates and prey of Minke Whales (*Balaenoptera acutorostrata*) and other cetaceans off Cormorant Island, British Columbia

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Abstract

From June to August 2012, we conducted over 500 h of visual surveys from Cormorant Island, British Columbia, to determine behaviour and habitat use patterns of nearby cetaceans. Seven species were documented, but Minke Whales (*Balaenoptera acutorostrata*) were by far the most common and were observed lunge feeding at the surface on 15 occasions. In addition, this species was documented surface lunge feeding on Pacific Herring (*Clupea pallasii*) and Pacific Sand Lance (*Ammodytes personatus*) on 32 occasions during vessel-based cetacean surveys around Cormorant Island between 2010 and 2014. Although Minke Whales are relatively uncommon in British Columbia, these results indicate that they can regularly be found in specific feeding areas during the summer.

Key words: Minke Whale; *Balaenoptera acutorostrata*; habitat use; feeding ground; Pacific Herring; *Clupea pallasii*; Pacific Sand Lance; *Ammodytes personatus*; Cormorant Island; British Columbia

The coastal waters of the eastern North Pacific are home to several species of cetaceans. Many have been exploited by humans and conservation concerns have made them the focus of extensive field studies in recent decades (Ford 2014). Important foraging habitats considered critical for recovery have been identified for depleted populations of Killer Whale (*Orcinus orca*), Humpback Whale (*Megaptera novaeangliae*), and Fin Whale (*Balaenoptera physalus*), and some populations of these species have become increasingly abundant and widespread in coastal waters in recent years (Ford *et al.* 2009, 2013, 2017; Nichol *et al.* 2018; Towers *et al.* 2015, 2018, 2019). Although the distribution and behaviour of less common cetacean species have been recorded (Ford 2014), the foraging ecology and habitat use patterns of some, such as Minke Whale (*Balaenoptera acutorostrata*), remain poorly understood.

Minke Whale is a small, migratory baleen whale that normally occurs in coastal waters of the eastern North Pacific between spring and fall (Towers *et al.* 2013). Despite a lack of human exploitation history in

these waters, Minke Whales are relatively rare along the west coast of North America. Ship-based cetacean surveys between California and Washington have documented Minke Whales 18 times between 1991 and 2008 (Barlow and Forney 2007; Barlow 2010). Further north, in the coastal waters of British Columbia, surveys conducted by Williams and Thomas (2007) and Ford *et al.* (2010) detected only a combined total of 35 Minke Whales during 34 290 km of survey effort.

Directed photo-identification research on Minke Whales in British Columbia and Washington has also documented relatively few unique individuals with totals of only 38 identified between 1977 and 1987 (Dorsey *et al.* 1990) and 44 between 2005 and 2012 (Towers *et al.* 2013). Photo-identification data have not been compared between these periods, but at least one individual identified in the 1980s was also documented in the 2010s (J.R.T. unpubl. data). Several other individuals documented on more than one occasion show high degrees of inter- and intra-annual fidelity to certain coastal areas over long periods (Dorsey *et al.* 1990; Towers *et al.* 2013).

The feeding behaviour of Minke Whales can be difficult to determine because most of it occurs below the water surface. However, in Washington, Minke Whales have been reported surface feeding on Pacific Herring (*Clupea pallasii*) and Pacific Sand Lance (*Ammodytes personatus*) on 10 and two occasions, respectively (Hoelzel *et al.* 1989). Few data on Minke Whale prey have been reported in western Canada, but Minke Whales have also been observed lunge feeding at the surface around Cormorant Island off northeastern Vancouver Island (Towers *et al.* 2013).

The waters around Cormorant Island are relatively shallow compared to depths of other nearby waterways and the substrate is made up of glaciofluvial gravels and sand. Large tidal fluctuations (5 m) and varied bathymetry in this area result in strong currents (<10 km/h = <5 kts with anything over 2 kts generally considered to have an impact on the movements and behaviour of most commercial and recreational vessel traffic as well as most fish and marine mammals) and upwellings. These environmental variables combine to create favourable habitat for an array of marine species, including several cetaceans in addition to Minke Whales.

To study the behaviour and occurrence of these species non-invasively, we conducted systematic shore-based cetacean observations from Cormorant Island in the summer of 2012 while making concurrent underwater acoustic recordings. This note presents the visual results of this study combined with data from surface predation events by Minke Whales that were opportunistically documented from small research vessels around Cormorant Island from 2010 to 2014. The acoustic results of this study are reported in Nikolich and Towers (2018).

Visual observations of cetaceans were made from the north shore of Cormorant Island at 50°36.140'N, 126°56.820'W (Figure 1). Observers used naked eyes and 15 × 80 binoculars (Steiner, Greeley, Colorado, USA) with built in magnetic (M) compass and reticle bar mounted on a leveled tripod (Velbon, Tokyo, Japan) to detect cetaceans over an arc of 160° (272°M–072°M). Visual surveys were conducted by two or more alternating observers for up to 13 h/day when Beaufort sea state levels were ≤2 (see http://www.wdcs.org/submissions_bin/WDCS_Shore_watch_Seastate.pdf for explanation of Beaufort sea

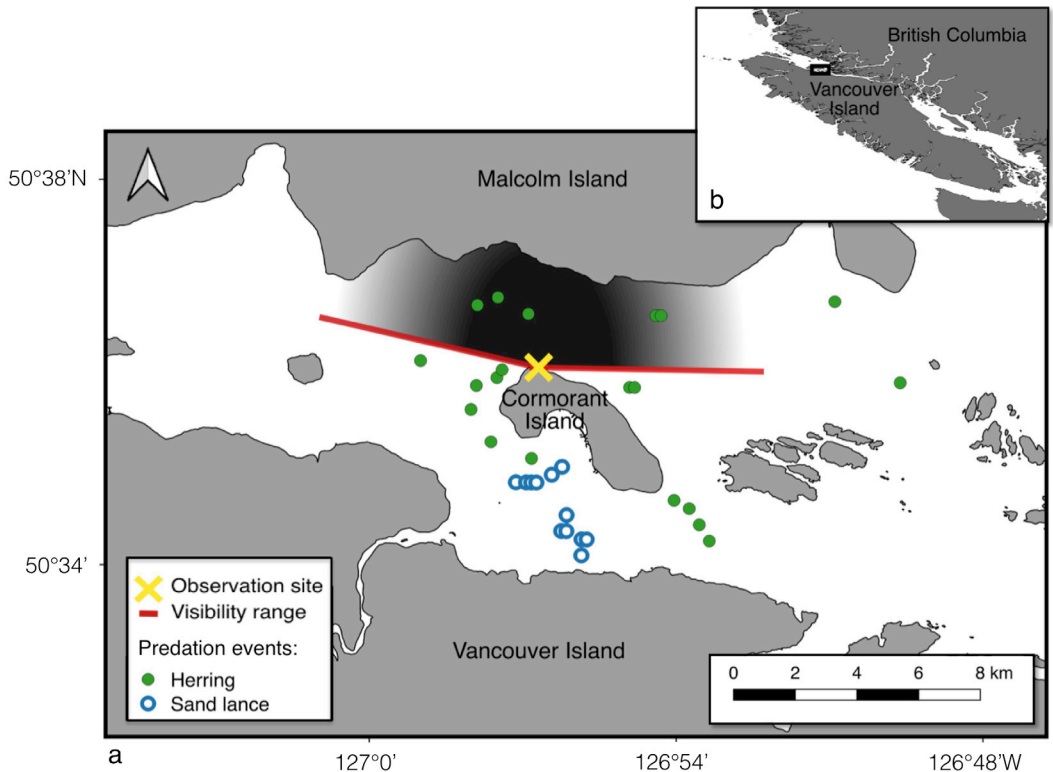


FIGURE 1. The study area off northeastern Vancouver Island, with a. showing the point on Cormorant Island from which observations were made, the arc of visibility, and the locations of Minke Whale (*Balaenoptera acutorostrata*) predation events and prey species documented from research vessels from 2010 to 2014 in relation to b. the south and central coasts of British Columbia.

states). Data, including Beaufort sea state, tide height, and notes on visibility, were recorded every 30 minutes of survey effort. The time, compass bearing, and reticle distance were recorded each time a cetacean surfaced (Nikolich and Towers 2018), but when Minke Whales and other species were present in the study area, priority was given to recording the surfacings of Minke Whales. The behaviour of cetaceans was noted when apparent, and an effort was made to identify individual whales visually when they were within range. Individual Minke Whale identifications were based on unique natural markings as described and shown in Towers (2011). To reduce any biases arising from animals being missed when sighting effort was focussed in another section of the study area, cetacean occurrence is portrayed in this paper as presence per unit effort (PPUE). A unit of effort was classified as 55–60 minutes of uninterrupted visual surveys and PPUE was defined as the number of effort units that the species was present divided by the total number of effort units.

Between 11 June and 15 August 2012, weather conditions allowed for observers to make shore-based visual surveys on 54 days: 20 in June, 19 in July, and 15 in August (Figure 2). In total, 513 units of visual survey effort were conducted. Seven species of cetaceans were documented: Minke Whale, Humpback Whale, Fin Whale, Bigg's Killer Whale (*Orcinus orca*; also known as West Coast Transient population), Dall's Porpoise (*Phocoenoides dalli*), Harbour Porpoise (*Phocoena phocoena*), and Pacific White-sided Dolphin (*Lagenorhynchus obliquidens*; Figure 2). Minke Whales had the highest PPUE (0.44), as they were observed during 224 units of effort (Figure 2; Table 1). Six previously known and individually recognizable Minke Whales were visually identified (M001, M002, M003, M004, M006, and M022; Towers 2011). Harbour Porpoises were the second most commonly present species in the study area followed by Humpback Whales and Dall's Porpoises (Figure 2; Table 1). The species with the lowest PPUE was Fin Whale (Figure 2; Table 1). All species were documented transiting; although most species likely foraged at depth in the study area, only Minke Whales,

Humpback Whales, and Bigg's Killer Whales were observed feeding at the surface. Bigg's Killer Whales were documented preying on a Dall's Porpoise on one occasion, and Minke and Humpback Whales were observed feeding on small schooling fish on 15 and two occasions, respectively. No relation between tidal activity and the foraging behaviour or occurrence of any species was detected.

Between 10 September 2010 and 7 August 2014, predation at the surface by Minke Whales around Cormorant Island was also opportunistically documented from small research vessels on 32 occasions (Figure 3; Table 2). Prey species were visually identified from photographs, video, or samples of remains collected near the surface with a dip-net after the feeding event. Of the predation events, 20 were on Pacific Herring and 12 were on Pacific Sand Lance (Figures 1 and 3; Table 2). Of the six photo-identified Minke Whales involved in these events (Table 2), five were visually documented during the shore-based component of this study.

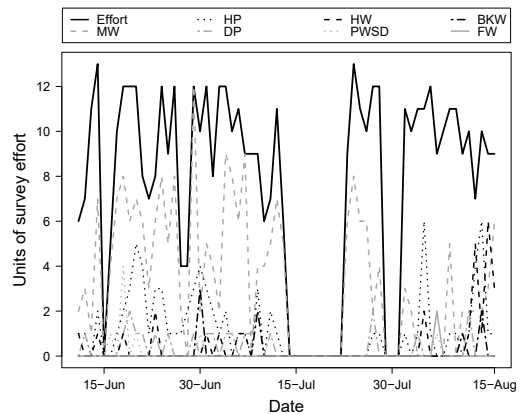


FIGURE 2. Units of survey effort and the presence per unit effort (PPUE) of each species of cetacean sighted between 11 June and 15 August 2012 off Cormorant Island, British Columbia. MW = Minke Whale (*Balaenoptera acutorostrata*), HP = Harbour Porpoise (*Phocoena phocoena*), HW = Humpback Whale (*Megaptera novaeangliae*), DP = Dall's Porpoise (*Phocoenoides dalli*), PWSD = Pacific White-sided Dolphin (*Lagenorhynchus obliquidens*), BKW = Bigg's Killer Whale (*Orcinus orca*), and FW = Fin Whale (*Balaenoptera physalus*).

TABLE 1. Occurrence of cetaceans and presence per unit effort (PPUE) based on sightings from the north shore of Cormorant Island, British Columbia, 11 June to 15 August 2012.

	MW	HP	HW	DP	PWSD	BKW	FW
Days observed	45	39	14	20	5	4	1
Sightings	1551	109	113	35	23	40	3
Units present	224	80	27	23	8	8	2
PPUE	0.44	0.16	0.05	0.04	0.02	0.02	0

Note: BKW = Bigg's Killer Whale (*Orcinus orca*), DP = Dall's Porpoise (*Phocoenoides dalli*), FW = Fin Whale (*Balaenoptera physalus*), HP = Harbour Porpoise (*Phocoena phocoena*), HW = Humpback Whale (*Megaptera novaeangliae*), MW = Minke Whale (*Balaenoptera acutorostrata*), and PWSD = Pacific White-sided Dolphin (*Lagenorhynchus obliquidens*).

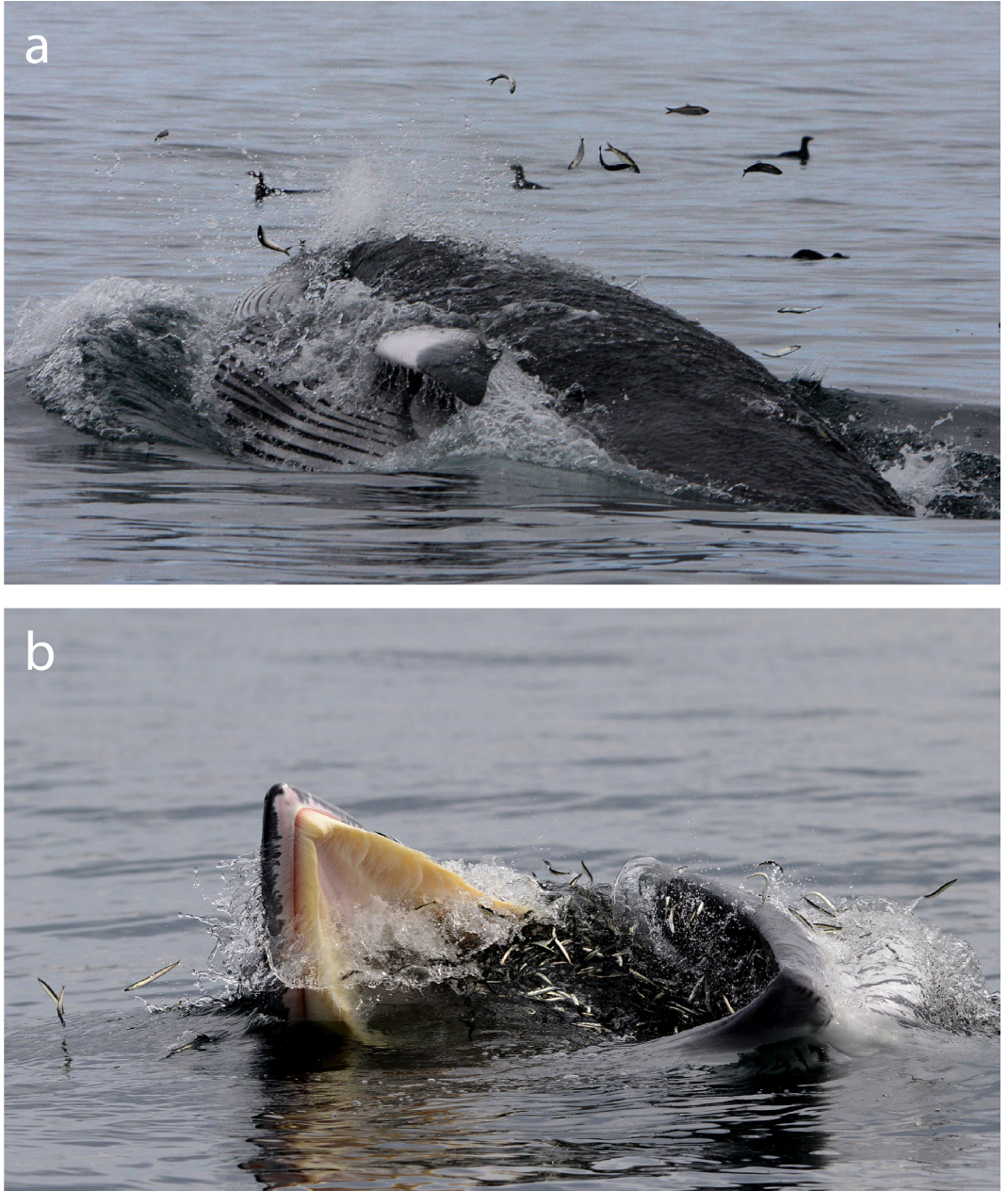


FIGURE 3. Minke Whale (*Balaenoptera acutorostrata*) M001 lunging on a. juvenile Pacific Herring (*Clupea pallasii*) on 18 July 2011 and b. juvenile Pacific Sand Lance (*Ammodytes personatus*) on 11 June 2014. Photos: Jared Towers.

Of the other species documented in this study, all but Bigg's Killer Whales are also known to feed on Pacific Herring (Walker *et al.* 1998; Morton 2000; Nichol *et al.* 2013; McMillan *et al.* 2018; Towers *et al.* 2018). Among them, at least the second, third, and fourth most commonly observed species in this study, Harbour Porpoise, Humpback Whale, and Dall's Por-

poise also feed on Pacific Sand Lance (Walker *et al.* 1998; Nichol *et al.* 2013; Marine Education and Research Society unpubl. data). All species documented are relatively common in many coastal regions of the eastern North Pacific with the exception of Fin Whale. This species is rarely observed in the inshore waters around Vancouver Island and the individual

TABLE 2. Dates of foraging events by identified Minke Whales (*Balaenoptera acutorostrata*) around Cormorant Island, British Columbia, from 2010 to 2014, and prey species consumed: Pacific Herring (*Clupea pallasii*) and Pacific Sand Lance (*Ammodytes personatus*).

Date	Individual whale	Prey species	Date	Individual whale	Prey species
10 Sep. 2010	M004	Pacific Herring	18 Jul. 2012	M004	Pacific Sand Lance
10 Sep. 2010	M006	Pacific Herring	20 Jul. 2012	M022	Pacific Herring
18 Jul. 2011	M001	Pacific Herring	25 Jul. 2012	M001	Pacific Herring
27 Jul. 2011	M006	Pacific Herring	26 Aug. 2012	M006 or M004	Pacific Herring
1 Aug. 2011	M022	Pacific Herring	17 Jun. 2013	M001	Pacific Herring
18 Sep. 2011	M007	Pacific Herring	17 Jun. 2013	M001	Pacific Herring
18 Sep. 2011	M007	Pacific Herring	17 Jun. 2013	M001	Pacific Herring
15 Jul. 2012	M001	Pacific Sand Lance	17 Jun. 2013	M001	Pacific Herring
15 Jul. 2012	M004	Pacific Sand Lance	11 Sep. 2013	M001	Pacific Herring
15 Jul. 2012	M001	Pacific Sand Lance	11 Jun. 2014	M001	Pacific Sand Lance
15 Jul. 2012	M002	Pacific Sand Lance	11 Jun. 2014	M001	Pacific Sand Lance
16 Jul. 2012	M001	Pacific Sand Lance	14 Jun. 2014	M006	Pacific Herring
16 Jul. 2012	M004	Pacific Sand Lance	1 Jul. 2014	M022	Pacific Herring
18 Jul. 2012	M004	Pacific Sand Lance	1 Jul. 2014	M022	Pacific Herring
18 Jul. 2012	M004	Pacific Sand Lance	31 Jul. 2014	M006	Pacific Herring
18 Jul. 2012	M004	Pacific Sand Lance	7 Aug. 2014	M001	Pacific Herring

observed is likely the same one photographed nearby the previous day as reported in Towers *et al.* (2018).

Although the species observed in this study are widely distributed throughout the eastern North Pacific (Ford 2014), the high rates of Minke Whale sightings compared with other cetacean species and numerous predation events recorded confirm this area as an important summer feeding ground for some individual Minke Whales that show intra- and inter-annual fidelity to these waters. To our knowledge, no other shore-based cetacean study in the eastern North Pacific has documented such high rates of Minke Whale occurrence, and the feeding observations reported here are among the first of this species in western Canada.

The environmental variables in the waters around Cormorant Island that create favourable habitat for Minke Whales and their prey are not unlike those documented in Minke Whale habitat in other regions. Minke Whale occurrence is positively correlated with shallow water that is near deeper water in Washington (Hoelzel *et al.* 1989) and Scotland (Robinson *et al.* 2009). The dynamic bottom topography of such areas often result in strong currents that drive upwelling and increase ocean productivity (Croll *et al.* 2005; Tynan *et al.* 2005). In addition, the sand and gravel substrate around Cormorant Island and in other areas where Minke Whales are often found in the western and eastern North Atlantic (Naud *et al.* 2003; MacLeod *et al.* 2004; Robinson *et al.* 2009; de Boer 2010) can provide suitable burrowing or rearing habitat for Minke Whale prey, such as Pacific Sand Lance (Bizzarro *et al.* 2016) and Pacific Herring (Hay and McCarter 2006), respectively. Further studies on Minke Whales off Cormorant Island could focus on relations between their occurrence and temporal fluctuations

in the abundance and distribution of their prey and other environmental variables.

Author Contributions

Writing – Original Draft: J.T.; Writing – Review & Editing: J.T., C.M., and R.P.; Conceptualization: J.T.; Investigation: J.T., C.M., and R.P.; Methodology: J.T. and C.M.; Formal Analysis: J.T., C.M., and R.P.; Funding Acquisition: J.T.

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