

Humpback Whale (*Megaptera novaeangliae*) observations in Laskeek Bay, western Hecate Strait, in spring and early summer, 1990–2018

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Abstract

We describe observations of Humpback Whales (*Megaptera novaeangliae*) made along the west side of central Hecate Strait, British Columbia, during the spring and summer of 1990–2018. From none in March, the frequency of sightings increased from early April to a peak in May, then fell in June with few in July. The frequency of sightings during the peak period (1 May–20 June) increased over the course of the study at a mean rate of 6% a year, similar to increases recorded elsewhere in British Columbian waters. The frequency of sightings was highest in years when the Oceanic Niño Index for January–March was low and peaked earlier in years when the Oceanic Niño Index was high. Both of these relationships suggest a connection between Humpback Whale sightings in western Hecate Strait and the larger oceanographic context, with sightings more frequent in years of lower water temperatures.

Key words: Humpback Whale; *Megaptera novaeangliae*; Hecate Strait; seasonal occurrence; population trends; oceanography

Introduction

Humpback Whale (*Megaptera novaeangliae*) is the most common rorqual along the west coast of Canada during the spring and summer, occurring in northern British Columbia (BC) waters principally from May to September (COSEWIC 2011; Ford 2014). Most of the population that occurs in summer in northern BC waters winters around the Hawaiian Islands (Calambokidis *et al.* 2001). Whales sighted in spring in BC waters may remain for the whole summer or may pass through *en route* to summering grounds farther north (Ashe *et al.* 2013; Ford 2014). Most Humpback Whales are believed to be faithful to their summering areas, with the same individuals identified in particular parts of the summer range over several years (Rambeau 2008; Gabriele *et al.* 2017).

Humpback Whale populations were heavily impacted by commercial whaling that took place along the BC coast between 1905 and 1967 (Trites *et al.* 2007). Since then, detailed observations between 1985 and 2014 in Glacier Bay, Alaska, showed that a humpback population summering there increased over that period at a mean 5% annually. A similar estimate, but based on fewer years, has been obtained for

the population summering in inlets along the mainland coast of Hecate Strait (Ashe *et al.* 2013), while an assessment of trends in BC waters by COSEWIC (2011) suggested an annual rate of increase in adult numbers of 4%. These trends reflect a population recovery after severe reductions by commercial whaling in the period before 1970 (COSEWIC 2011).

Since 1990, the Laskeek Bay Conservation Society, a citizen science non-governmental organization based on the archipelago of Haida Gwaii, BC, has conducted observations of marine mammals in western Hecate Strait, in one of the three important Humpback Whale areas in BC waters identified by Dalla Rosa *et al.* (2012). Observations were made from a seasonal camp on East Limestone Island, a 40-ha island off the southeast corner of the much larger Louise Island, on the east coast of Haida Gwaii (Figure 1).

In this paper, we summarize observations of Humpback Whales made over the period 1990–2018 from March to July. We analyze seasonal and inter-annual variation and compare our observations with those made elsewhere in the northeast Pacific. Given the large amount of inter-annual variation in our data, we compare them with variations in oceanographic

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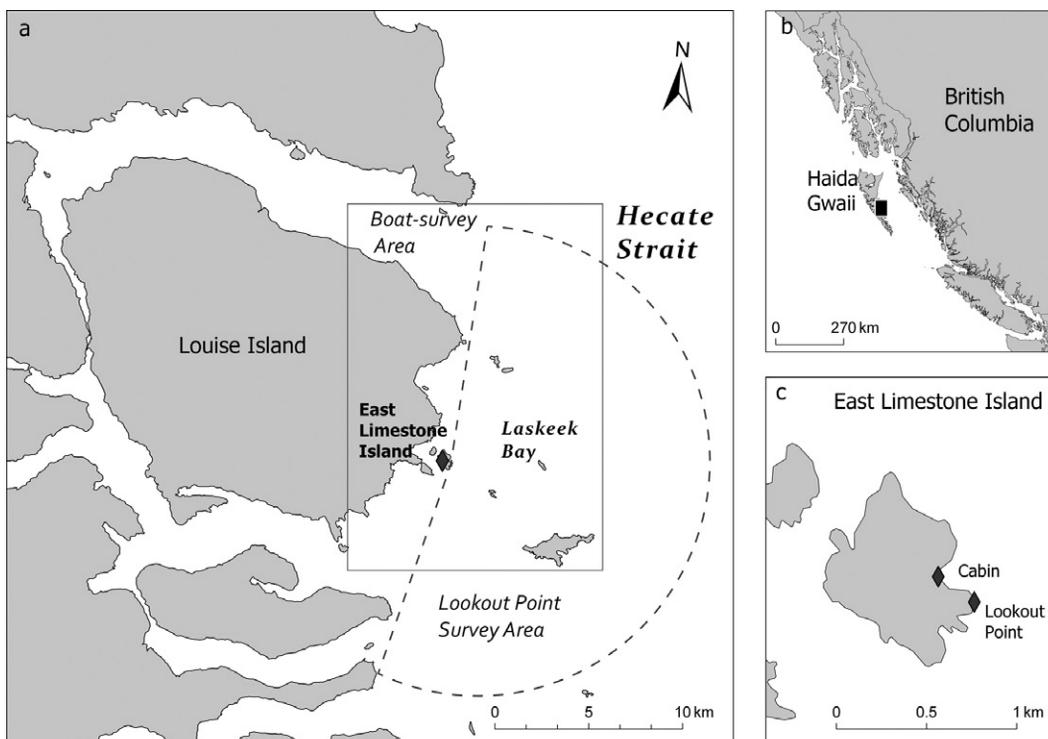


FIGURE 1. Map of the study area showing: a. the arc of view from Lookout Point (dashed line) and the area within which boat surveys were conducted regularly (rectangle); b. the location of Haida Gwaii; c. detail of East Limestone Island.

conditions, both in the northeast Pacific and more locally in BC waters, to improve our understanding of the factors influencing Humpback Whale occurrence in western Hecate Strait.

Methods

Fieldwork

The Laskeek Bay Conservation Society camp on East Limestone Island (Figure 1a–c) has been active in spring and early summer since 1990. Marine mammals were noted both systematically and incidentally throughout the period when camp was occupied, for periods between 56 and 126 days (mean 88 days/year). Starting dates varied from 15 March to 5 May. In 1990, the first year of operations, camp was open 25 April–5 June, but thereafter, in all years up to 2004, camp opened before 10 April and closed between 3 and 25 July. From 2005 to 2018, camp opened later, with starting dates between 21 April and 5 May and closure between 8 and 22 July (Table 1).

Systematic timed observations of marine mammals were made for several hours each week from a point ~20 m above sea level (asl; maximum tidal range 4 m; Fisheries and Oceans Canada 2019) at the southeastern tip of the island. If two or three observers were present, they watched together for 30 or 60 min,

continuously, scanning waters within sight (an area of ~120 km² shown approximately in Figure 1a). When marine mammals were sighted, they were observed through a 25×60 spotting scope. Single observers scanned the area by dividing it into three sectors and spent 10 min on each sector in rotation. Watches were conducted during good visibility (usually >15 km), with sea conditions reflecting a Beaufort sea state of 3 or less (defined by World Meteorological Office as waves <1.25 m; National Oceans and Atmosphere Administration 2002).

Incidental observations were made from several locations. The camp is located on the east shore of the island (Figure 1c), from which an arc of ~120° is visible in an east-northeast direction. Most observations from camp were made from the cabin, ~5 m asl. People were present in camp for several hours each day. Incidental observations were made from other parts of the island shores and additional observations were also made from a small boat, used to survey for marine birds for 6–8 h every 10–15 days (area of rectangle in Figure 1a), as well as while travelling between islands for other fieldwork.

Analysis

To investigate seasonal variation in whale num-

TABLE 1. Period during which the East Limestone Island camp was active in each year of the study.

Year	Start date	End date	Days of observation
1990	25 April	19 June	56
1991	26 March	14 June	81
1992	9 April	3 July	86
1993	9 April	10 July	98
1994	5 April	15 July	102
1995	25 March	15 July	113
1996	20 March	11 July	114
1997	15 March	11 July	119
1998	3 April	9 July	98
1999	2 April	25 July	115
2000	1 April	20 July	111
2001	22 March	25 July	126
2002	20 March	7 July	102
2003	20 March	4 July	99
2004	30 April	22 July	84
2005	22 April	22 July	92
2006	28 April	20 July	84
2007	28 April	13 July	77
2008	5 May	16 July	73
2009	1 May	14 July	75
2010	1 May	9 July	70
2011	29 April	9 July	71
2012	4 May	12 July	70
2013	3 May	12 July	71
2014	1 May	11 July	72
2015	1 May	10 July	71
2016	30 April	22 July	84
2017	4 May	22 July	80
2018	4 May	20 July	78

bers, we used three statistics: (a) the proportion of observation days on which whales were seen, (b) the monthly sums of the number of whales seen each day (whales \times days), and (c) the average number of whales seen on days when at least one was recorded. We included all years in this analysis, although no observations were made in July 1990 and 1991 and, after 2003, no observations were made before 21 April. Because of variation in observing dates each year, only records from the 50-day period 1 May–20 June were used for inter-year trend analysis. Observations were made daily in every year during this period. We used the proportion of days on which one or more whales were seen during this 50-day period as our index of whale frequency (whale index, WI) for time-trend analysis.

To examine the possible influence of large-scale oceanographic variation on the occurrence of Humpback Whales in Laskeek Bay, we corrected the number of whales observed assuming an increasing population trend of 4% annually, as suggested by COSEWIC (2011). The resulting adjusted index of whale abundance is referred to as the “corrected whale index” (CWI):

$$CWI = (D_w / D_t) \times 1.04^{(2018 - y)}$$

where D_w = days on which whales were sighted in a given year; D_t = total days camp was occupied during 1 May–20 June; and y = year of observations.

This index was compared with the following ocean climate indices:

As a measure of the El Niño/Southern Oscillation (ENSO), the Oceanic Niño Index (ONI) for January–March, the three-month running mean of ERSST.v5 (extended reconstructed sea surface temperature anomalies in the Niño 3.4 region; 5°N–5°S, 120–170°W), based on centred 30-year base periods updated every five years (National Weather Service n.d.). Sea surface temperatures in the northeast Pacific tend to be closely correlated with indices of the ENSO cycle (e.g., Niño 3.4 index; Tseng *et al.* 2017).

As a measure of the Pacific Decadal Oscillation (PDO), the H300-based PDO index (HPDO), defined as the projections of monthly mean H300 anomalies from the National Centers for Environmental Prediction’s Global Ocean Data Assimilation System onto their first empirical orthogonal function vector in the North Pacific (20°–60°N), based on the 30-year period from 1981 to 2010 (GODAS n.d.).

Years in which the ONI was -0.5 or lower for the first three months of the year were classified as “cold” (as defined at National Weather Service n.d.) and the CWI for these years was compared with the CWI for warmer years. Comparisons among days with and without whale sightings were made using the Fisher exact probability test. Tests for time trends were made using linear regression and the Pearson correlation coefficient. Statistics were performed using Statistica v. 7.1 (Statsoft, Inc., Tulsa, Oklahoma, USA). Mean values are given \pm 1 SE.

Results

Humpback Whales were seen in all but three years of the study, with sightings from early April to late July. They were recorded on 14% of the 2572 days that camp was occupied and on 20% of the 1673 days during the period 1 May–20 June. No humpbacks were seen in March and the frequency of sightings built up during April, with the buildup continuing longer in cold than in warmer years (Figure 2). The highest sighting frequency occurred in May, peaking 21–31 May in cold years (when whales were seen on 36% of days) and 1–10 May in other years (recorded on 21% of days). WIs were significantly higher in cold years than in others during 21–31 May and 1–10 June (Fisher exact test, $P < 0.001$ for both periods).

No humpbacks were seen in 1990, 1991, or 1996. The highest frequencies for 1 May–20 June occurred in 2007 (WI = 56% of days), 2008 (63%),

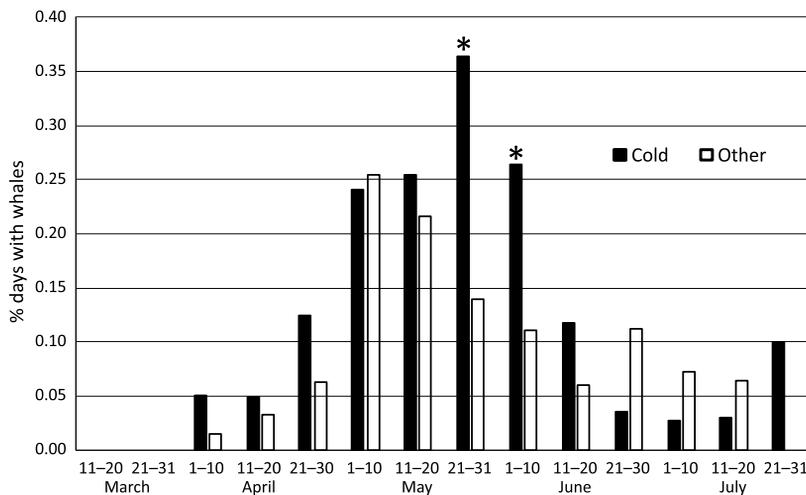


FIGURE 2. Proportion of days when Humpback Whales (*Megaptera novaeangliae*) were seen in Laskeek Bay in relation to date, for years when the Oceanic Niño Index was less than -0.5 during January–March (cold) and other years (1990–2018). *Proportion of days with whales was significantly greater in cold years than in other years (Fisher exact $P < 0.001$).

2016 (39%), and 2018 (41%). Six of the 10 lowest years occurred before 1999 (Figure 3). There was a significant positive correlation between year and the proportion of days with whales during 1 May–20 June ($r_{27} = 0.48, P = 0.009$). A similar positive correlation was found for non-cold years ($r_{17} = 0.48, P = 0.04$) when analyzed separately. The correlation coefficient was similar, but non-significant for cold years ($r_8 = 0.41, P = 0.24$). The linear regression slope for the proportion of days with whales over time was consistent with an annual rate of increase of 6%. Slopes were similar for cold and non-cold years when analyzed separately, but were closer

to a 4% rate of annual increase (Figure 4).

Number of whales per day

Summing daily counts, 1750 humpback sightings were recorded, 1602 during the period 1 May–20 June. Probably many of these involved the same animals on different days, but we think it unlikely that many involved the same animal seen more than once on a given day. The highest number was recorded during May (1304, 75% of all sightings). Highest numbers of whales \times days were recorded in 2003 (142), 2007 (213), and 2014 (233). The number sighted on days when at least one whale was seen aver-

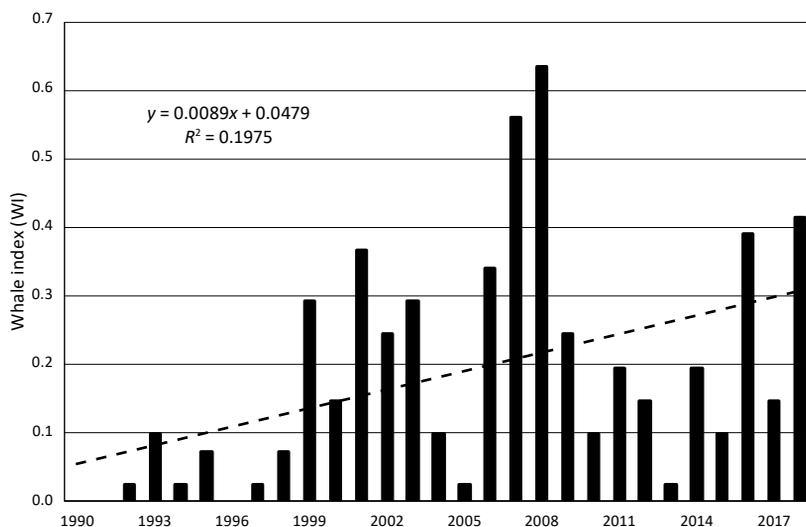


FIGURE 3. Whale index (WI), i.e., days when Humpback Whales (*Megaptera novaeangliae*) were seen in Laskeek Bay (11 May–20 June) as a proportion of all days, during 1990–2018, showing linear regression.

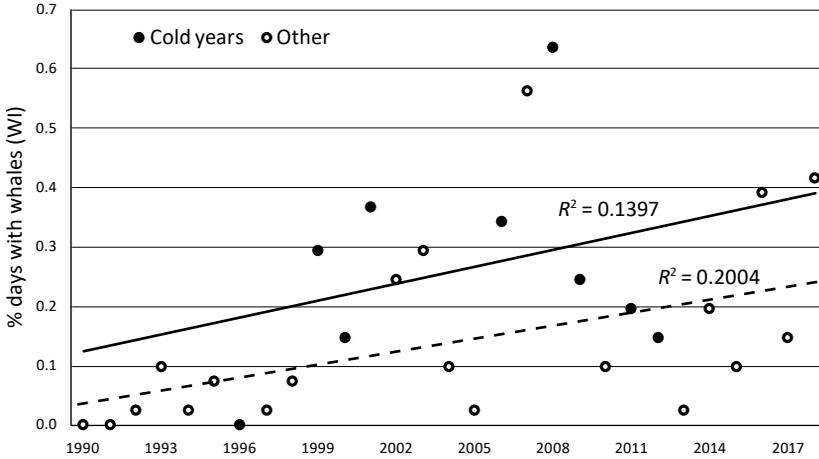


FIGURE 4. Proportion of days with whales (WI) in Laskeek Bay (11 May–20 June) separated into years with Oceanic Niño Index below -0.5 during January–March (cold years) and warmer years (other).

aged 5.6 whales/day during 1 May–20 June and 2.3 whales/day outside that period (Figure 5). The number of whales seen per day on days when at least one whale was seen did not differ significantly between cold years (4.5 ± 1.8 whales/day) and other years (4.3 ± 0.9 whales/day, $t_{24} = 0.11$, $P = 0.9$).

Effects of oceanography

The proportion of days with whales was generally higher in years with negative ONI (cold years, $28\% \pm 5\%$) than others ($15\% \pm 4\%$, $t_{28} = 2.02$, $P = 0.05$). CWI was negatively correlated with ONI for January–March ($r_{27} = 0.37$, $P = 0.037$; Figure 6), but did not show any relation to the HPDO index ($P > 0.10$). The ONI accounted for 17% of variation in CWI ($F_{1,27} = 4.82$, adjusted $R^2 = 0.17$, $\beta = -0.41$).

Discussion

Despite substantial variation in the amount of effort devoted to whale observations and the inevitable fluctuations in viewing conditions created by weather, our results show a clear increasing trend in the frequency of Humpback Whale sightings in Laskeek Bay since 1990. The complete set of annual indices has a regression coefficient consistent with a 6% annual rate of increase, while dividing the years into those displaying colder relative oceanic conditions and others (average or warmer conditions), based on the ONI, suggests a rate of increase closer to 4% for both samples. Observations of marine mammals from nearby Reef Island (5 km ESE of East Limestone Island) during April–June of 1984–1989

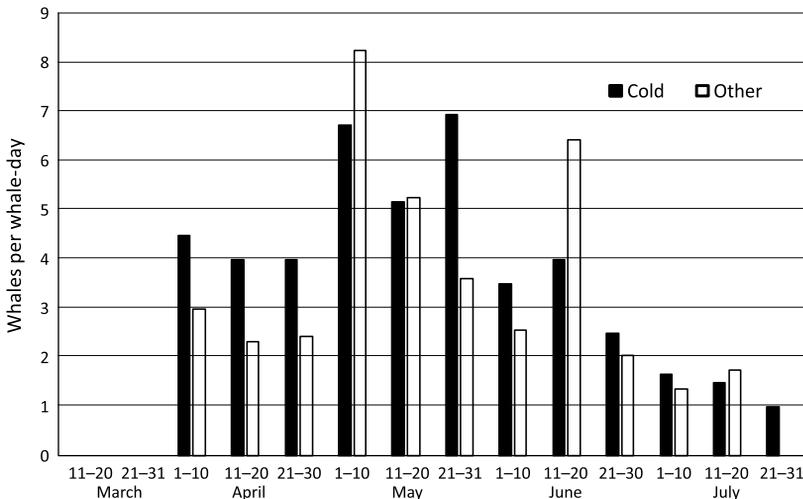


FIGURE 5. Number of whales seen per day in Laskeek Bay (11 May–20 June) on days when at least one was recorded (1990–2018).

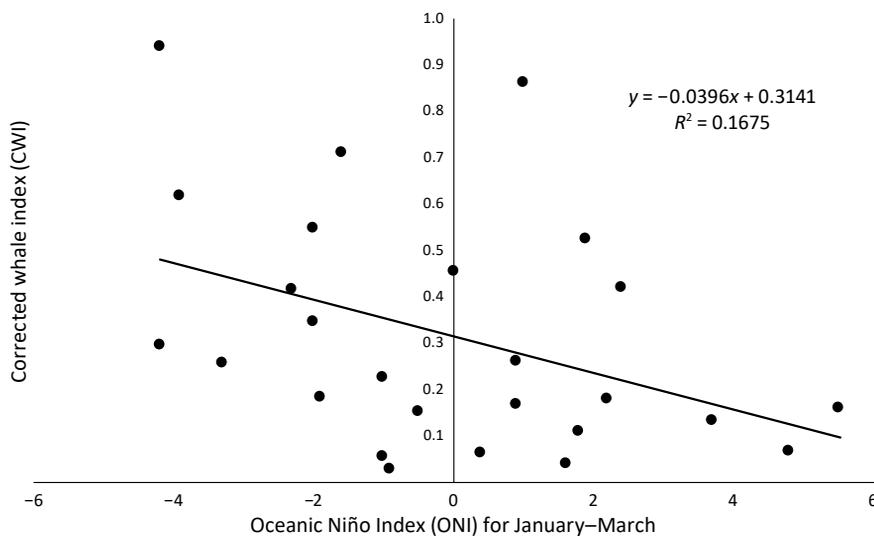


FIGURE 6. The corrected whale index (assumes a 4% annual rate of population increase) compared with El Niño/Southern Oscillation conditions, represented by the Oceanic Niño Index (ONI). Negative ONI is associated with colder than average ocean conditions, while positive ONI is associated with warmer than average conditions (Laskeek Bay, 1990–2018).

included sightings of Humpback Whales only in 1985 (up to three on 17 days), 1987 (one on a single day), and 1989 (up to five on six days; Gaston and Jones 1991). In all years, these observations extended from early April to mid-June, but all sightings fell between 2 May and 6 June (Gaston and Jones 1991). The paucity of sightings during the 1980s supports the idea that numbers have increased substantially since then. Our results are consistent with those obtained elsewhere in BC waters (COSEWIC 2011; Ashe *et al.* 2013). An estimate by Fisheries and Oceans Canada (2009) suggested a mean rate of increase for the BC population of 4.1% a year, identical with ours once warm and cold years are separated. The appearance of large numbers of Humpback Whales in Queen Charlotte Strait and the inside passage off Vancouver Island since the early 2000s (Nichol *et al.* 2017) is also consistent with our findings.

The absence of humpbacks in March and low numbers in the first 20 days of April may be partly accounted for by lower population size in the early years of the study, when most observations in March and April occurred. However, the number of days of observations after 10 July was biased toward recent years; thus, the decrease in number of sightings after mid-June is unlikely to have been influenced by the population trend.

Some of the humpbacks recorded in Laskeek Bay may be migrating to summering areas farther north. The timing of peak numbers reported in Laskeek Bay fits well with data from Glacier Bay, Alaska, ~750 km by sea to the north of Laskeek Bay, where the peak arrival of humpbacks occurs in June (Gabriele

et al. 2017), about three weeks after the peak in Laskeek Bay. This rate of travel (about 36 km/day) is comfortably within the migration speed of 48 km/day observed for humpbacks by satellite telemetry (Lagerquist *et al.* 2008). However, it is possible that some or all of the whales seen in Laskeek Bay shift to other BC waters in July. Animals were frequently observed feeding in Laskeek Bay, both lunging at the surface and “flick feeding” (A.J.G. unpubl. data), which Ford (2014) mentions as common in waters off Moresby Island. It seems likely that most whales observed were feeding in the vicinity, causing them to pause in the area for a period.

Inter-year variability in sighting frequency was high, with the proportion of days with humpback sightings during the period 1 May–20 June, varying from 0 to 60%. Part of this variation can be explained by oceanographic processes, with the Oceanic Niño Index accounting for 17% of variation in the trend-corrected proportion of whale sightings. Seasonal trends in sightings, with sightings in cold years peaking later than those in other years, suggests that ocean conditions, influenced by large-scale processes, such as ENSO, may affect the suitability of inshore waters along the western side of Hecate Strait for humpback foraging. A similar effect of large-scale oceanographic forcing on Humpback Whales (in that case on diet) was reported by Fleming *et al.* (2016). The fact that numbers seen on a given day were not affected by ONI suggests that much of the variation in observation frequency probably relates to the rate at which the whales pass through the area, rather than being accounted for by fluctuations in the number of indi-

viduals using the area. Given the much greater frequency of whale sightings in Laskeek Bay in recent years, we may be able to make more detailed observations in future, perhaps with greater emphasis on photo-identification, giving us better understanding of the importance of Laskeek Bay waters to individual Humpback Whales.

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