

FIRST RECORDED ACCOUNT OF A HUMPBACK WHALE
(*MEGAPTERA NOVAEANGLIAE*) FEEDING ON SPAWNING
PACIFIC HERRING (*CLUPEA PALLASII*) IN
THE SALISH SEA, AND LOOKING FORWARD

CHLOE V ROBINSON, BRITTANY C VISONA-KELLY, GARY J SUTTON, MICHAEL WD JUDSON, AND
JARED R TOWERS

ABSTRACT—Humpback Whales (*Megaptera novaeangliae*) in the North Pacific are typically found in breeding grounds at low latitudes during winter months. However, some individuals remain on northern feeding grounds (including the Salish Sea) year-round or return to high latitudes earlier. Here, we report on the 1st documented case of a Humpback Whale foraging on winter-spawning Pacific Herring (*Clupea pallasii*) in the Salish Sea in British Columbia, Canada. We observed a single juvenile Humpback Whale lunge feeding on herring during the March herring spawn surrounding Hornby Island. Presence of Humpback Whales in foraging grounds during winter could suggest that this population is experiencing some degree of nutritional stress. Considering the lunge-feeding strategy used, high site fidelity, and rapid cultural transmission in Humpback Whale populations, if more individuals learn to take advantage of this winter resource, there is the potential for localized declines of herring through top-down forcing and increased risk of whale interactions with fishing vessels.

Key words: British Columbia, cetacean, *Clupea pallasii*, foraging, herring spawn, Humpback Whale, marine mammal, *Megaptera novaeangliae*, Pacific Herring, Salish Sea

Globally, Humpback Whales (*Megaptera novaeangliae*) undertake long-distance (4500–6000 km), seasonal migrations between low-latitude winter breeding and calving grounds to high-latitude, nutrient-rich feeding grounds (Craig and others 2003; Rizzo and Schulte 2009). In temperate waters of the Northeast Pacific, Humpback Whales typically arrive in April through June and depart between October and December to migrate south (Calambokidis and others 2001; Darling and others 2022). Photo-identification of Humpback Whales has enabled the documentation of which whales migrate to specific feeding and breeding grounds throughout the ocean basin (Calambokidis and others 2001, 2008; Barlow and others 2011; Darling and

others 2022; Cheeseman and others 2023). Migratory destinations for individual whales were found to be largely influenced by a combination of maternal site fidelity and natal philopatry (Baker and others 2013). Biological and environmental factors, however, are also known to influence site use by individual Humpback Whales (Stevick and others 2006; Moran and others 2018; Kettemer and others 2022).

Although many whales travel seasonally to southern breeding grounds throughout late autumn, acoustic surveys combined with targeted field efforts demonstrate that Humpback Whales are present in higher latitudes year-round (Straley and others 2018; Frouin-Mouy and others 2022; McMillan and others 2022). Humpback Whales are considered capital breeders, building up energy reserves in productive northern feeding areas before fasting during migration and the time spent reproducing and nursing on the breeding grounds (Vaugh and others 2012; Eisenmann and others 2016). The timing of when Humpback Whales begin their southbound migration is not consistent for all individuals (Silva and others 2010; Straley and others 2018; Kettemer and others 2022). It is apparent that some whales choose to remain longer at high latitudes before proceeding south or skip the breeding grounds entirely. Although there is evidence of an age and sex bias to overwintering, delaying and/or feeding on migration (Barendse and others 2010; Druskat and others 2019; Kettemer and others 2022), the drivers behind this decision are not uniform and appear to be individual-specific (Swingle and others 1993; Owen and others 2015; Ramm 2020). Both nutritional deficits and prey limitations have been suggested as potential explanations for Humpback Whales staying at higher latitudes to forage longer (Straley and others 2018; Druskat and others 2019; Kettemer and

others 2022). As Humpback Whale populations continue to increase in size to pre-whaling population levels, individuals may begin to utilize historic feeding areas to reduce competition and meet their energetic demands.

An important feeding ground for the North Pacific population of Humpback Whales includes the Salish Sea, which is located in British Columbia (BC, Canada) and Washington state (USA; Fig. 1, Fig. 2; Fraser and others 2020). The Salish Sea ecosystem supports numerous marine and terrestrial species owing to its productive waters and is a large drainage basin for several watersheds including the Fraser River (Gaydos and Pearson 2011).

Throughout the 1860s to 1907, Humpback Whales were targeted by historic and modern whaling fleets throughout the Salish Sea, with a majority of whales taken during summer and autumn from nearshore waters of the Strait of Georgia (Merilees 1985). Whaling Station Bay, located on Hornby Island, was the site of one of the largest whaling operations in the area, taking at least 22 Humpback Whales between June 1870 to January 1871 (Merilees 1985). Following a 70-y absence of Humpback Whales in this area, the Salish Sea now provides an important feeding ground for these animals. From 2003–2023, the Humpback Whales of the Salish Sea project has documented 1219 unique individuals (Malleeson and Shaw, unpubl. data), with over 7500 encounters reported between 2001 and 2021 (Cheeseman and others 2023). The Ocean Wise Sightings Network (OWSN; formerly the British Columbia Cetacean Sightings Network, www.ocean.org), which holds a >20-y database of cetacean sightings from BC and Washington state, has a total of 15,941 sighting reports of Humpback Whales in the Salish Sea between 1990 and January 2023 (Fig. 1, Fig. 2). Although there are historic (Merilees 1985) and more recent reports (Richter and others 2024; Storlund and others 2024) of Humpback Whales year-round in the Salish Sea (Table 1), a majority (12,025) of sightings are from April–September (Fig. 2; Table 1).

Forage fish, including Pacific Herring (*Clupea pallasii*), are an important food source for Humpback Whales throughout BC (McMillan and others 2014, 2018; Reidy and others 2022). In some parts of BC, herring consumption allows non-reproductive females, pregnant females, and

adult male Humpback Whales to meet over 50% of their estimated energetic requirements, and juvenile and lactating females between 20–50% (McMillan and others 2018). Based on archeological records, the north-eastern Salish Sea has been an important herring habitat for at least the last 800 y (McKechnie and others 2014). Between February and May annually, herring populations spawn in shallow subtidal areas throughout the Salish Sea, primarily between Salt Spring Island (48.817694 N, –123.5095 W) and Denman Island (49.563167 N, –124.798361 W; Therriault and others 2009). The Strait of Georgia herring biomass in the Salish Sea has one of the largest spawning events along the coast (Fisheries and Oceans Canada 2022). Various bird and pinniped species have been recorded utilizing the short-term prey patches incurred throughout the herring spawn (Willson and Womble 2006). Although a recent study described the presence of Pacific Herring DNA in a Humpback Whale fecal sample collected from the Strait of Georgia during summer–autumn (Reidy and others 2022), there are no modern records of Pacific Herring being present in Strait of Georgia Humpback Whale diets during spawning events. Throughout the Salish Sea whaling period, Humpback Whales were observed feeding in this area until early February; however, their diet mostly consisted of krill-like species instead of herring (Merilees 1985). Throughout the Northeast Pacific, few published reports exist of cetaceans exploiting the annual herring spawn in Lynn Canal, Prince William Sound, and Sitka Sound in Alaska (Moran and others 2018; Straley and others 2018; Wild and others 2023) and Kitasoo Bay in British Columbia (Kitasoo/Xai'xais First Nations 2018).

Winter presence of Humpback Whales is not uncommon in the Salish Sea, but there have been no reports of individuals foraging on Pacific Herring spawns, until now. On 15 March 2023, we observed a Humpback Whale near Hornby Island (49.511194 N –124.645889 W). Based on the individual's small size, we estimated this whale to be between 1 and 3 y of age. The whale had bright white cookie-cutter shark scars on its body, evidence that it had been in low-latitude waters only weeks before and had only recently returned to the Salish Sea after its migration (Towers and others 2013). This whale had extensive propeller scarring along its dorsal surface (Fig. 3). We observed this individual lunge-

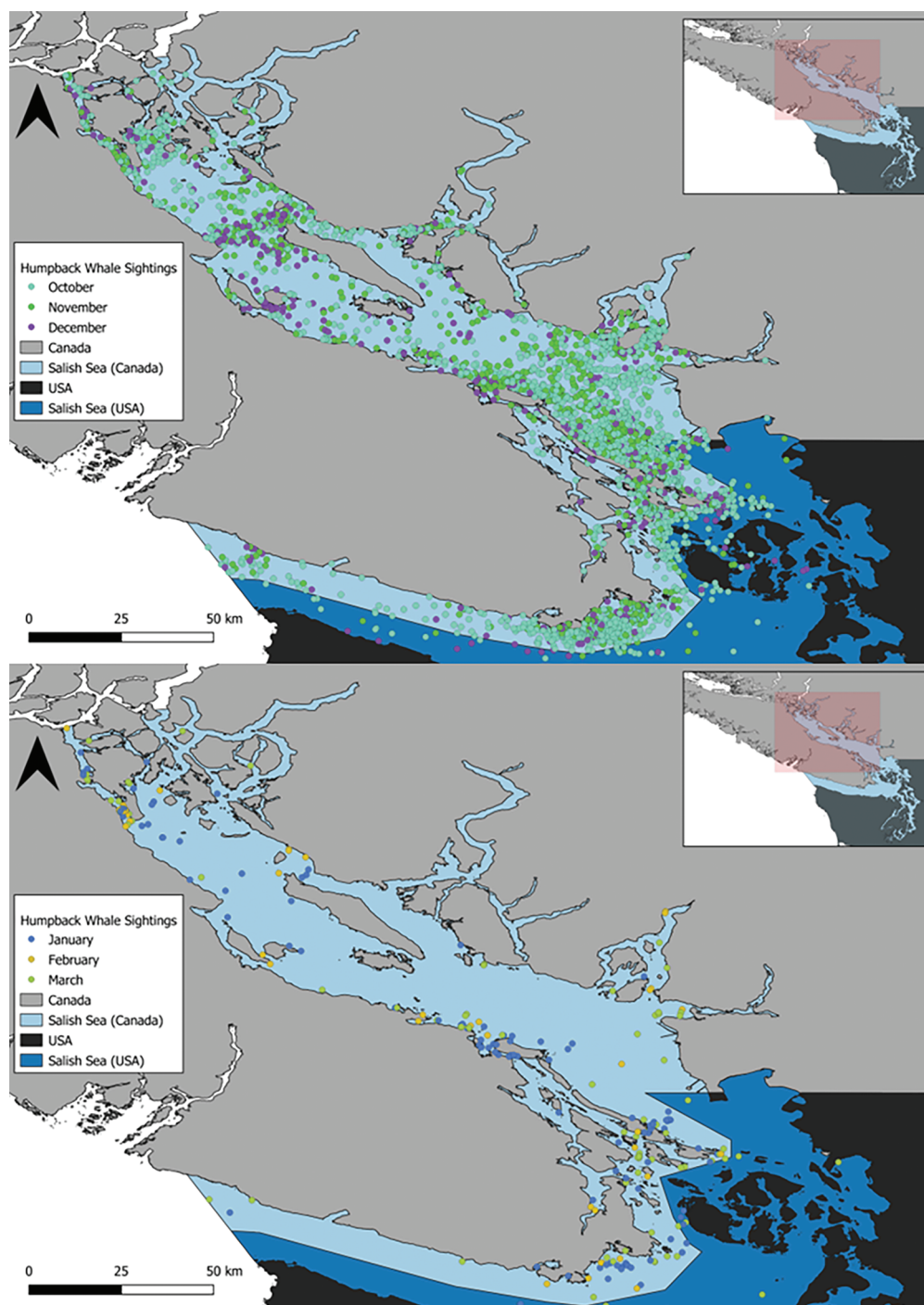


FIGURE 1. Autumn and winter Humpback Whale (*Megaptera novaeangliae*) sightings in the Salish Sea reported to the Ocean Wise Sightings Network (OWSN) in October–December (top) and January–March (bottom), 1990–2023. Sightings were filtered to contain only Humpback Whale sightings with ‘Certain’ and ‘Probable’ confidence levels ($n = 3916$). Sightings are opportunistic and not corrected for effort.

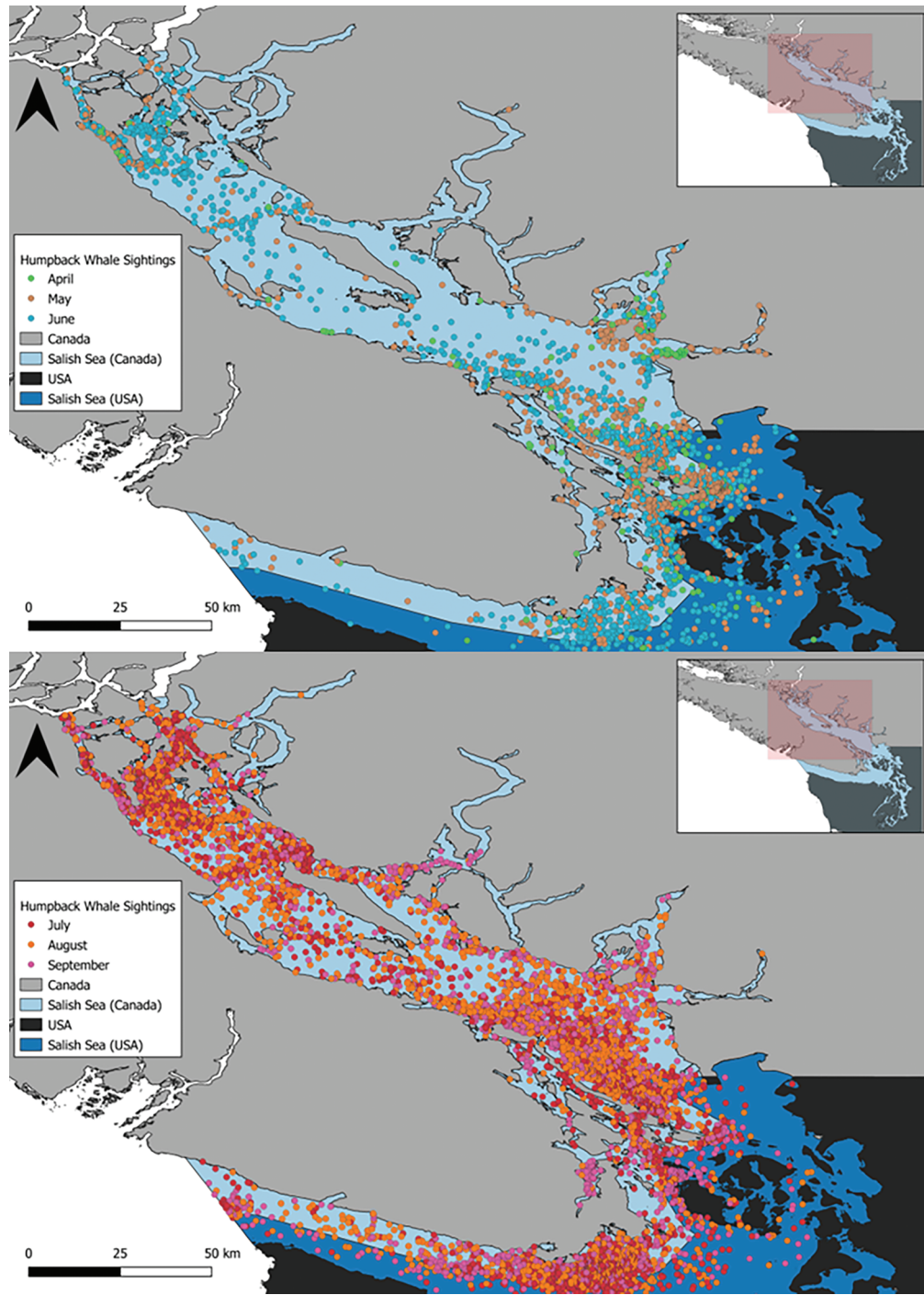


FIGURE 2. Spring and summer Humpback Whale (*Megaptera novaeangliae*) sightings in the Salish Sea reported to the Ocean Wise Sightings Network (OWSN) in April–June (top) and July–September (bottom), 1990–2023. Sightings were filtered to contain only Humpback Whale sightings with ‘Certain’ and ‘Probable’ confidence levels ($n = 12,025$). Sightings are opportunistic and not corrected for effort.

TABLE 1. Monthly breakdown of Humpback Whale (*Megaptera novaeangliae*) sightings in the Salish Sea reported to the Ocean Wise Sightings Network (OWSN) between 1990 and January 2023. Sightings were filtered to contain only Humpback Whale sightings with ‘Certain’ and ‘Probable’ confidence levels. Sightings are opportunistic and not corrected for effort.

Month	Number of sightings
January	127
February	46
March	89
April	360
May	1442
June	1945
July	2655
August	3217
September	2406
October	2177
November	995
December	482
Total	15,941

feeding on Pacific Herring on 4 occasions within 35 min (Fig. 4), with herring observed milling near the surface ~200 m around the whale. From 2 of these feeding events, we collected scales and photographs (Fig. 4). This individual whale could not be matched in the Humpback Whales of the Salish Sea photo-identification

catalogue (Malleeson and Shaw 2022), nor from catalogues covering the remainder of the BC coast via the Canadian Pacific Humpback Collaboration (www.bchumpbacks.com).

To the best of our knowledge, this event marks the 1st time that a Humpback Whale has been recorded feeding on spawning herring in the vicinity of the associated fishery in the Strait of Georgia in the Salish Sea. However, Humpback Whales have been reported feeding on herring spawn events along other areas of the coast, including Sitka Sound (56.953333 N, -135.526972 W), Prince William Sound (60.704444 N, -146.988556 W), and Lynn Canal (58.692306 N, -135.114111 W) in southeast Alaska (Moran and others 2018; Straley and others 2018), and Kitasoo Bay (52.542556 N, -128.787667 W) and Spiller Channel (52.409222 N, -128.137694 W) in BC (Kitasoo/Xai'xais First Nations 2018). Off Haida Gwaii in northern BC, Frouin-Mouy and others (2022) recorded the highest levels of Humpback Whale acoustic presence during the spring herring spawn, but confirmation of foraging was not recorded.

Accounts of juveniles and pregnant or post-lactating, resting females undertaking foraging stops along migratory routes or foregoing migration entirely to overwinter at higher



FIGURE 3. Humpback Whale (*Megaptera novaeangliae*) observed on 15 March 2023, with propeller scarring. DFO Marine Mammal License MML-18; Credit: Ocean Wise.



FIGURE 4. Lunge sequence (A–D) of the observed Humpback Whale (*Megaptera novaeangliae*) feeding on Pacific Herring (*Clupea pallasii*) during the winter spawn near to Hornby Island, British Columbia (Canada). DFO Marine Mammal License MML-18; Credit: Ocean Wise.

latitudes have been reported in Alaska (Straley and others 2009), northeastern USA (Clapham and others 1993; Swingle and others 1993), Norway (Ramm 2020; Kettemer and others 2022), and the Antarctic (Brown and others 1995). The additional energetic demands associated with pregnancy and lactation can cause females to spend more time on feeding grounds or remain on feeding grounds year-round (Craig and others 2003; Kennedy and others 2014; Kettemer and others 2022). For juveniles, it is suggested that the nutritional requirements necessary for growth may restrict their ability to build adequate fat reserves for migration, making the trip unfeasible (Pinto de sá Alves and others 2009; Silva and others 2010). Based on the size of the individual we observed, this may be 1 factor for its presence in the Salish Sea in early March. Alternatively, the presence of Humpback Whales on high-latitude feeding grounds during winter months could also suggest that some animals in the North Pacific population are experiencing nutritional stress, and therefore limit time in low-latitude breeding grounds or avoid migrating altogether (Straley and others 2018; Cartwright and others 2019).

Historically, the North Pacific Humpback Whale population was estimated at 1200–1400 individuals in the late 1960s (Gambell 1976; Calambokidis and others 2008), with recent estimates at over 27,000 individuals in 2022 (Cheeseman and others 2023). This ‘humpback comeback’ after the cessation of commercial whaling expressed population growth rates of 8.2% from 1989 to 2004 (Calambokidis and Barlow 2004) and 4.8% from 2004 to 2022 (Curtis and others 2022). Other whale populations that have begun to recover after whaling have been sighted in historically used feeding grounds (Herr and others 2022; O’Brien and others 2022). This case includes Humpback Whales in the Salish Sea. However, given that this population is expected to continue to grow in future years, there is concern that Humpback Whales in the Northeast Pacific will reach a carrying capacity of the habitat they currently occupy (Calambokidis and others 2017). With limited time to build reserves before migration, Humpback Whales in the Pacific must find ample foraging spots to avoid competition, which may mean expanding individual foraging ranges to historic or new locations. As the population begins to approach environmental limitations,

sightings of Humpback Whales in winter and in non-typical areas are expected to increase (Straley and others 2018). Whether our sighting was part of recolonization to a historic foraging area or demand based on enhanced nutritional requirements remains to be seen.

With the recent increase in Humpback Whales feeding on spawning herring in Alaska and now BC, and evidence of social learning and cultural transmission for foraging behaviour (Allen and others 2013; Parks and others 2014; Garland and Carroll 2022), it is likely that these observations will become more common throughout the Pacific Northwest. Considering the high site fidelity exhibited by Humpback Whales (Witteveen and Wynne 2017; Brown and others 2022), evidence of rapid cultural transmission of feeding strategies (Richard and others 2018; Wray and others 2021; Garland and Carroll 2022), and growing population rates (Curtis and others 2022), if more Humpback Whales experience nutritional stress and/or learn to take advantage of this winter resource, top-down forcing of this Pacific Herring fishery may occur, which could contribute to a further decline of the Pacific Herring population (Baum and Worm 2009; Straley and others 2009). Conversely, increased winter feeding of Humpback Whales in the Strait of Georgia is likely to result in increased primary productivity in the area through increased nutrient cycling via the 'whale pump' (Roman and McCarthy 2010), highlighting the enhanced ecosystem service provided by the return of these whales to historically abundant areas (Herr and others 2022).

Given the strong site fidelity observed in Humpback Whale populations, it is unlikely, however, that these areas have been used consistently for feeding in previous years. If this study's observation is predictive of future Humpback Whale feeding habits, and the use of the Salish Sea as winter habitat continues, inclusion of this behaviour in the species recovery strategy should be considered. Furthermore, additional management may be required to reduce interactions between fisheries and Humpback Whales consistently frequenting the same areas. Vessel disturbance (i.e., underwater noise and ship strikes) and entanglement in fishing gear are ongoing threats to Humpback Whales throughout the Salish Sea (Fisheries and Oceans Canada 2013; Gaydos and others 2015; Fraser and others 2020; Quayle 2021). If more Humpback Whales

learn to take advantage of the winter herring spawn, there is potential for conflicts with the herring fishery similar to what has been observed in herring fisheries in Norway (Bjørge and others 2023; Langstein 2023).

In the coming years, we plan to continue working in this area during the winter months to see how this predator-prey relationship unfolds, and we will communicate our observations accordingly. Being that winter field efforts have, to-date, been minimal in this area, future work should focus on documenting predator-prey interactions during the Salish Sea winter herring spawn.

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- Whales Initiative, Ocean Wise, Vancouver, BC Canada (CVR, BCV-K, GJS, MWDJ); chloe.robinson@ocean.org; Bay Cetology, Alert Bay, BC Canada (JRT). Submitted 12 October 2023, accepted 24 May 2024. Corresponding Editor: Kyle Tidwell.*