

Short Note

Intentional Stranding by Mammal-Hunting Killer Whales (*Orcinus orca*) in the Salish Sea

Josh D. McInnes,¹ Justine N. Buckmaster,² Kelsey D. Cullen,¹
Chelsea R. Mathieson,¹ and Josh P. Tawse¹

¹Transient Killer Whale Research Project, 201-1002 Pakington Street, Victoria, BC, V8V 3A1
E-mail: jmcinnes@uwic.ca

²14500 Admiralty Way, Apt. Q204, Lynnwood, WA 98087, USA

Killer whales (*Orcinus orca*) are cooperative apex predators that have been documented foraging on a wide array of prey, ranging from small schooling fish to large cetaceans (Jefferson et al., 1991; Baird, 2000; Ford, 2009). Foraging strategies of killer whales that hunt marine mammals are complex and vary globally (Hoelzel, 1991). A high-risk and specialized form of killer whale foraging behaviour is known as intentional stranding. During this foraging behaviour, members of a group of killer whales deliberately direct themselves towards pinniped prey, accelerate towards the shore, and become temporarily stranded on their ventral surface in the surf zone (López & López, 1985; Guinet, 1991; Silber & Fertl, 1995).

In Patagonia, along the shores of the Peninsula Valdéz, a small population of killer whales exhibit intentional stranding by using channels between reefs and steeply sloping beaches to partially beach themselves to capture southern sea lions (*Otaria flavescens*) and southern elephant seals (*Mirounga leonina*) (López & López, 1985; Hoelzel, 1991; Vila et al., 2008). Intentional stranding has also been documented by killer whales on Possession Island in the Crozet Archipelago in the sub-Antarctic Indian Ocean. Unlike the steep beaches of Peninsula Valdéz, the two prominent beaches on Possession Island where killer whales use intentional stranding have a low grade slope. Southern elephant seals are their primary prey in this region (Guinet, 1991; Guinet & Bouvier, 1995).

In the coastal waters off British Columbia (Canada) and Washington (USA), Bigg's (transient) killer whales are well-known predators of marine mammals, particularly harbour seals (*Phoca vitulina*) (Baird, 1994; Baird & Dill, 1995; Ford & Ellis, 1999). While foraging for harbour seals, Bigg's killer whales frequently follow the contours of the shoreline and enter shallow regions where harbour seals are congregated on

or near exposed reefs, sand bars, and beaches (Baird & Dill, 1995). The occurrence of foraging for harbour seals tends to increase during the harbour seal pupping period from late July through September as seal pups are easily captured while taking their first swims (Bigg, 1969; Baird, 1994; Baird & Dill, 1995). On Protection Island, Washington, a National Wildlife refuge for marine mammals and birds (Figure 1), there is a significant harbour seal haulout site where approximately 500 harbour seals have been documented annually using the sand and cobble beaches for resting, molting, and pupping (Hayward et al., 2005; Cowles & Hayward, 2008). Due to this abundance of seals, sightings of Bigg's killer whales in the vicinity of Protection Island occur throughout the year (J. McInnes, unpub. data, 2011-2020). Prior to 1994, there was an anecdotal report of killer whales intentionally stranding on one of this island's beaches while pursuing harbour seals (Baird & Dill, 1995). The only other documented live-stranding events by Bigg's killer whales in the Salish Sea have been reported as accidental events that most likely occurred while the whales were foraging in shallow water (Towers et al., 2020). Herein, we report the first photo-documented record of Bigg's killer whales intentionally stranding themselves in pursuit of harbour seals in the Salish Sea at a haulout site on Protection Island.

On 14 August 2016 at 1545 h, two groups of Bigg's killer whales were encountered feeding on unidentified prey in the Strait of Juan de Fuca (approximately 48° 10' N, 122° 44' W). The two killer whale groups were identified by photographs as the T037A and T065A matriline (known as the T037As and T065As, respectively) (Transient Killer Whale Research Project, unpub. catalog, 2011-2020; Towers et al., 2019). When the feeding event concluded, the T037A group

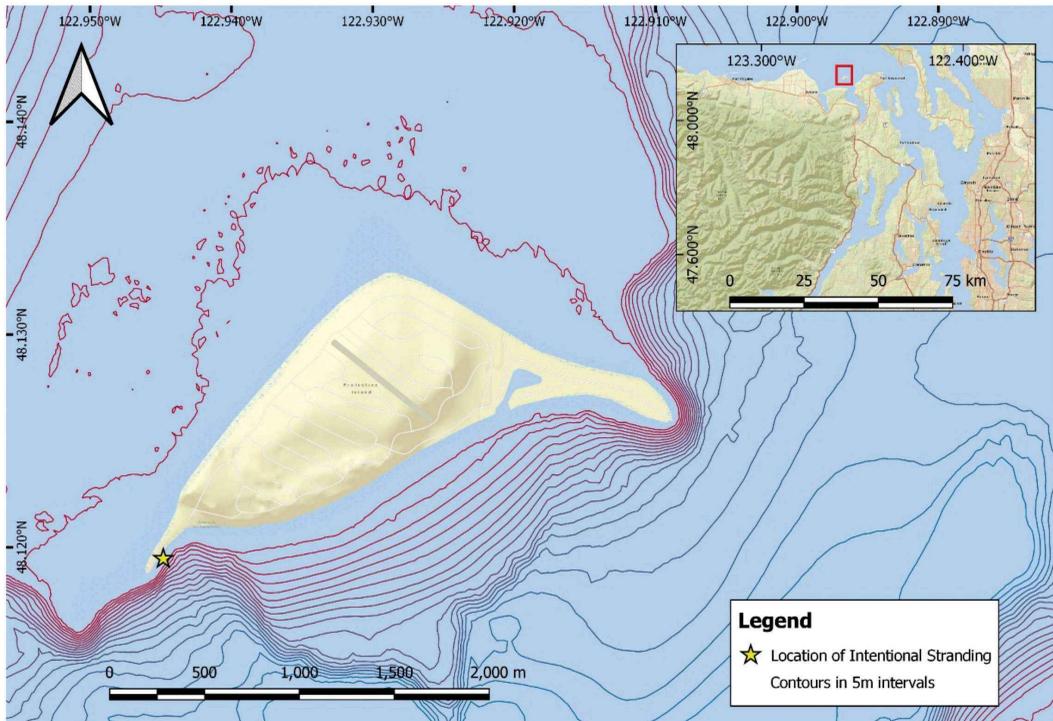


Figure 1. Bathymetry surrounding Protection Island, located in the southeastern portion of the Strait of Juan de Fuca, near the entrance to Admiralty Inlet. The star identifies the location where the intentional stranding event took place. Contours are in 5 m intervals. Bathymetric data were acquired from the National Oceanic and Atmospheric Administration (NOAA) (NOAA Office of Ocean Exploration and Research, 2014). Map was created using *QGIS*, Version 3.12.0 ('Burcuresti').

departed, while the T065As remained in the area until 1630 h. The T065As are frequently observed in the waters off Southern Vancouver Island, British Columbia, and Puget Sound, Washington (J. McInnes, unpub. data, 2011-2020). At the time of the event, the T065A matriline was comprised of five members (Figure 2; Towers et al., 2019).

The T065A group then travelled southeast towards the western tip of Protection Island, reaching approximately $48^{\circ}07' N$, $122^{\circ}53' W$ at 1652 h. The whales foraged nearshore at the south side of the island, and a successful harbour seal predation event was documented at 1742 h (Figure 3A).

The first documented intentional stranding event occurred at 1756 h along Kanem Point, the westernmost tip of the island, where the majority of the harbour seals were hauled out (Figure 1). T065A and T065A2 rushed the shoreline parallel to each other and halted just prior to the edge of the beach. Their dorsal fins oscillated as the full weight of their bodies was not supported in the water column, demonstrating that they had run aground in the shallows leading up to the beach. There was no immediate reaction from the harbour seals to this first attempt at intentional stranding.

T065A then regrouped with T065A3, T065A4, and T065A5 approximately 30 m offshore (Figure 3B). T065A2 remained close to shore and rushed the beach for a second time at 1757 h. During this approach, the harbour seals reacted with some fleeing up the beach and others entering the water. T065A2 arched his body and swung his flukes to maneuver himself off the beach into deeper water where he regrouped with the other whales. At 1758 h, T065A and T065A4 moved in to patrol the beach by closely following the contour of the shoreline, passing within 3 to 5 m of the harbour seals. Once T065A and T065A4 completed their pass of the beach and moved out into the deeper water of the bay, T065A2 and T065A3 performed the same patrol of the beach.

The third intentional stranding event took place at 1805 h. T065A2 directed himself towards the beach and accelerated towards the harbour seals. Due to the shallow slope of the approaching beach, his movement was impeded just metres from shore. He became stranded on his ventral surface at a point where it was not possible for him to submerge more than three quarters of his body, exposing his dorsal fin and the midline of

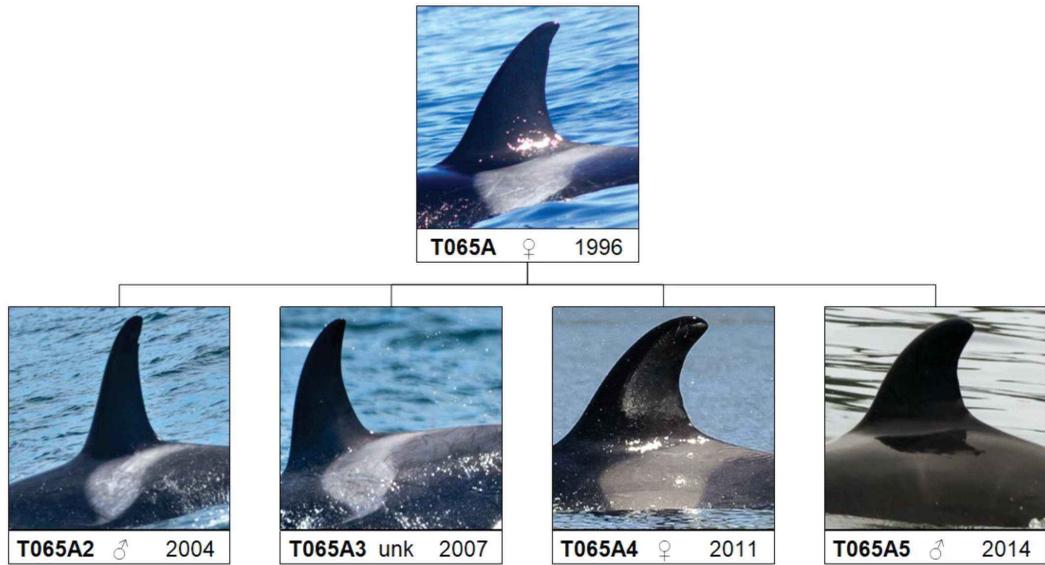


Figure 2. Genealogical schematic of the Bigg's killer whale (*Orcinus orca*) T065A matrilineal group. Photographs show identities and sex (if known) for each individual as of 2016. Representation of matrilineal descent is based on studies and methods described in Ford & Ellis (1999), and identification images are by the Transient Killer Whale Research Project.

his saddle patch (Figure 3C). A few harbour seals stampeded into the water, while others moved higher up the beach. T065A2 suddenly began swinging his body back and forth while undulating his fluke repeatedly as he worked to get off the beach and back into deeper water. Low tide occurred at 1448 h; the tide was rising throughout the observation period.

At 1812 h, T065A3 followed the remainder of the group, then quickly moved from the opposite direction into the same shallow water where T065A2 had previously stranded. The group appeared to be chasing a harbour seal pup that had stampeded into the shallow water moments after T065A2 intentionally stranded. The group pursued the seal pup along the shoreline, pushing it out past the end of Kanem Point into deeper water. When the harbour seal ran out of shallow water at 1816 h, T065A, T065A4, and T065A5 disappeared under the surface. While no direct kill was observed, it was concluded that successful predation occurred because of the presence of a surface "oil" slick and the increased activity of marine birds descending upon the area. As all members of the T065As began to feed on the seal pup, individuals from the group were seen rising vertically out of the water ("spy-hopping") and slapping their flukes on the surface. This was the only successful predation event documented during the 20 min of foraging displayed by the T065As in which they utilized intentional stranding as a

foraging technique. It should be noted that we did not observe the T065As directly capture a harbour seal while utilizing intentional stranding, but, rather, they seemed to use this technique to frighten their prey into the water.

Bigg's killer whales have developed a unique set of culturally transmitted foraging behaviours that appear to be shaped by their marine mammal prey (Ford & Ellis, 1999; Dahlheim & White, 2010; Barrett-Lennard et al., 2011). To our knowledge, this is the first recorded event of Bigg's killer whales using intentional stranding as a foraging behaviour in the Salish Sea. The infrequency of such observed events is likely due to a number of factors, including water depth, bathymetry, haulout substrate, and the associated risk of mortality (Baird & Dill, 1995). This behaviour may be further limited to killer whales that have acquired the requisite knowledge and skills through generations of extensive practice and training (Guinet, 1991). Pinniped haulout sites are often in shallow water and difficult to navigate. While the majority of pinniped haulout sites in the Salish Sea are rocky exposed reefs, the Protection Island haulout site where our observation took place was in shallow water on a moderately sloped cobble beach, similar to other regions where killer whales have been extensively documented using this behaviour (López & López, 1985; Hoelzel, 1991; Vila et al., 2008). The soft substrate may be especially beneficial for minimizing physical injury during temporary stranding events.



Figure 3. Photographs depicting behaviours of Bigg's killer whales during intentional stranding event at Kanem Point, Protection Island, on 14 August 2016: (A) Bigg's killer whales T065A and T065A4 making an exploratory pass near hauled-out harbour seals (*Phoca vitulina*); (B) T065A, T065A2, and T065A4 approaching harbour seals hauled out on shore moments before T065A2 rushed the beach intentionally stranding; and (C) male Bigg's killer whale T065A2 intentionally stranding in an attempt to capture harbour seals. He was documented here undulating his flukes in an attempt to free himself from being grounded in the surf zone.

Intentional stranding at Protection Island may have developed as an extension of nearshore and haulout foraging. However, with events only photo-documented on one day, more research is needed and more observations required of this foraging behaviour to assess whether intentional stranding is a foraging technique used with frequency in the Salish Sea.

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