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Recovery of a Mid-Gestational Gray Whale (*Eschrichtius robustus*) Fetus Near Tofino, British Columbia

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Gray whales (*Eschrichtius robustus*) are the only extant species of Eschrichtiidae. In the North Pacific, they comprise a western population of ~250 animals and an eastern group with up to 16,650 individuals as of 2021/2022 (this reflects a 38% decline in population; Eguchi et al., 2022; Torres et al., 2022). These animals have the longest migration route of any marine mammals, which extends from summer feeding grounds in the Bering, Chukchi, and Beaufort Seas to calving, breeding, and assemblage areas off Baja California and Mexico. Gray whales transit neritic or coastal zones with cow–calf pairs avoiding open waters, presumably due to threats associated with transient killer whale predation (Swartz, 2018). These whales occasionally have incursions into shallow mud flats to forage for infaunal and benthic crustaceans and other prey species. In Canada, gray whales were subdivided in 2014 into two distinct populations, consisting of the Northern Migratory and Pacific Coast Feeding Groups; and in 2017, both groups were designated Schedule 1, Special Concern (Committee on the Status of Endangered Wildlife in Canada [COSEWIC], 2017).

Over the last three decades, the population status of gray whales has had considerable fluctuation with declines reported in 1998-1999; and more recently, the population has diminished from an estimate of 28,000 in 2016 to 21,000 in 2021 (Torres et al., 2022) with most losses incurred in calf and adult age cohorts and a prominent reduction in annual calf crops (Stewart & Weller, 2021). In recognition of the precipitous decline in gray whale numbers, an Unusual Mortality Event (UME) was declared by the National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA) in 2019 (Torres et al., 2022). Animals have stranded throughout the migratory corridor with evidence of suboptimal body condition or emaciation (Christiansen et al., 2021; Torres et al., 2022), but vessel strike and killer whale (*Orcinus orca*) predation have been associated regionally with significant mortality (Raverty et al., 2019). Prey availability and changes in ocean biophysics have been linked to dynamics in gray whale distribution and nutritional condition (Moore et al., 2022), possibly contributing to reduced fecundity, early embryonic loss, and fetal resorption, culminating in diminished calf recruitment. Rapid and ongoing transformations in the Pacific Arctic ecosystem (Huntington et al., 2020) have been implicated in not only suboptimal nutritional condition but also reproductive failures (Moore et al., 2022).

In a review of NOAA and Department of Fisheries and Oceans (DFO) level A data collected with stranding incidents, all age classes of gray whales have been observed stranded between 2016 and 2021, with most fetal and neonatal strandings recorded in Mexico calving lagoons (Raverty et al., 2019). To the best of our knowledge, no fetuses have previously been identified in gray whale strandings recorded in British Columbia (DFO, unpub. incident data, 2007-2022). This paper reports the recovery of a gray whale carcass in 2021, with morphometrics consistent with a mid-gestational fetus off the east coast of Vancouver Island, British Columbia.

On 30 October 2021, a small male gray whale carcass was reported dead and floating nearshore in Tofino Harbor, British Columbia (latitude: 49.15003040; longitude: -125.9229541; Figure 1). DFO officers were dispatched to the site, and the carcass was secured, towed ashore, and a necropsy performed on 31 October 2021.

Figure 1. Gray whale (*Eschrichtius robustus*) fetus observed dead and floating near Tofino Harbor, British Columbia (Photo courtesy of Dr. J. Darling)

The animal presented in moderate body condition and fair (code: 3.5 to 4.0) postmortem condition (Geraci & Lounsbury, 2005). There were reduced subcutaneous and visceral (e.g., perirenal, epicardial, mesenteric) adipose stores. Little fat oozed on incision of the blubber, and the animal was moderately muscled. Throughout the torso and on the leading edges of the flippers and flukes, there was multifocally extensive sloughing and loss of skin with partial maceration (with imbibed water) of the exposed dermis and blubber. Three transverse fetal folds were noted along the left flank, and the right torso could not be readily assessed due to epidermal loss. Throughout the rostrum, there were three widely distributed vibrissae. The umbilical stock was moist, pale tan yellow, and measured 80 cm (vein), 105 cm (vein), and 111 cm (artery); the vasculature was patent, the distal limits were abruptly truncated, and the entire length was splayed. There was partial retraction of the skin around the margin of the umbilicus with eversion of the underlying blubber. The vasculature within the internal aspect of the umbilicus was partially patent. Along the right lateral aspect of the thoracic and abdominal walls, there was moderate multifocal subcutaneous congestion (possible hypostasis), and the chest cavity contained ~10 ml of clear serosanguinous fluid that did not clot on exposure to air. The lungs were partially inflated; representative portions of lung tissue floated or were neutrally buoyed on immersion in formalin. There was mild multifocal subpleural congestion and atelectasis. The thymus was well developed and within the cranial mediastinum, and the foramen ovale and ductus arteriosus were patent. The stomach contained a few strands of seaweed and 5 ml of ingested placental fluid. Extending from the distal third level of the small intestine and entire length of colon, the lumen was distended by abundant meconium; and within the midlevel of the jejunum, there were prominent transverse constriction bands with segmental serosal congestion and injected vasculature. The urinary bladder was empty and collapsed. The morphometrics for this carcass were compiled (see Table 1). Premature live birth and subsequent death of this animal were attributed to the stage of fetal development, possibly exacerbated by the lack of colostral consumption and associated metabolic derangements of hypoglycemia and presumptive hypogammaglobulinemia.

Stranding records between 2008 and 2021 were reviewed, and 44 gray whale strandings were recorded. Based on morphometrics, these consisted of nine adults, seven subadults, five juveniles, two calves, and one fetus (DFO, unpub. incident data, 2007-2022). There were 20 incidents with no age identified. The stranding incident number, date,

Table 1. Carcass morphometrics; lengths and blubber thickness are provided in cm.

Straight lengths	Measurement (cm)		
Total length	307		
Snout to eye	47		
Snout of anterior flipper	79		
Snout to umbilicus	156		
Snout to anus	207		
Axillary girth	155		
Anus girth	88		
Flipper anterior length	51* and 37**		
Flipper maximum width	21		
Tail fluke width	83		
Blubber thickness	Axillary	Mid-thoracic	Anus
Mid-dorsal	1.5	2.0	2.4
Mid-lateral	2.4	2.4	2.3
Mid-ventral	2.6	1.9	1.9

*Cranial insertion
**Caudal insertion

Table 2. Summary of gray whale stranding identification number, date, location, and, when identified, age class. Twenty-four animals were identified by age. A = adult, SA = subadult, J = juvenile, C = calf, and F = fetus.

DFO ID (AHC ID)	Date (d/mo/y)	Stranding location	Age class
4904	4 June 2009	Hesquiat	
5596	24 March 2010	Hesquiat	
5631	4 April 2010	Sooke	
5672	6 May 2010	Quatsino	
5963	2 November 2010	Ucluelet	
6614	11 May 2011	Graham Island	
6624	28 May 2011	Sooke	
6665	10 June 2011	Port Hardy	
6922	1 August 2011	Graham Island	
12-0060	22 April 2012	Nitnat	
12-0124	4 June 2012	Masset	C
12-0134	15 June 2012	Nitnat	
13-0070	24 April 2013	Port Hardy	
13-0194	18 July 2013	Graham Island	
14-0346	20 September 2014	Prince Rupert	
15-112 (15-2923)	20 April 2015	Tofino	J
15-470	6 October 2015	Port Hardy	J
16-091	29 March 2016	Tofino	SA
17-104	2 April 2017	Tofino	
17-171	30 April 2017	Port Hardy	J
18-038	6 February 2018	Victoria	C
18-105	22 March 2018	Hesquiat	J
18-246	6 June 2018	Masset	SA
19-0107 (19-0280)	4 April 2019	Duncan	A
19-0681	9 May 2019	Graham Island	J
19-0180	15 May 2019	Graham Island	
19-0206 (19-3119)	26 May 2019	Queen Charlotte	A
19-0237 (19-3671)	5 June 2019	White Rock	A
19-0248	10 June 2019	Port Hardy	
19-0249	9 June 2019	Port Hardy	
19-0255	18 April 2019	Tofino	SA
19-0271	16 June 2019	Graham Island	
19-0340 (19-4585)	6 July 2019	Graham Island	SA
19-0677 (20-2109)	6 November 2019	Tofino	SA
20-0119 (20-3994)	14 April 2020	Tofino	A
20-0177 (20-3010)	14 May 2020	Barkley Sound	SA
20-0240	11 June 2020	Graham Island	SA
20-0278 (20-6381)	4 July 2020	Port Hardy	A
20-0307 (20-6383)	9 July 2020	Tofino	A
21-0140 (21-2739)	16 April 2021	White Rock	A
21-0195	3 May 2021	Quatsino	A
21-0566	14 August 2021	Nootka	
21-0787	30 October 2021	Tofino	F
21-0792	5 November 2021	Kyuquot	A

geographic location, and age class are presented in Table 2. Most strandings occurred along the outer coast of Vancouver Island with a preponderance of reports along the inner coast of Haida Gwaii (Figure 2); these likely reflect the regional migratory routes. Annual gray whale sightings off the British Columbia coast tend to occur between November and January, with a peak in the latter half of December. Southward migrations tend to be segregated demographically with pregnant and near-term females in the initial phase, followed by estrous females, adult males, and then immature whales of both sexes, with a similar migration pattern apparent on the northward journey (Ford, 2014).

Female gray whales attain sexual maturity at a mean of 8 y (range = 6 to 12 y; Swartz, 2018). There is a strong phenology of seasonal and synchronized mating that typically occurs within 3 wks between late November and early December *en route* or near the southern extent of the migration, in or near the calving grounds and nearshore assemblages. Late conceptions may occur in January in the southern extent of the migration route. Breeding appears promiscuous with a single estrous every 2 y (Rice & Wolman, 1971; Swartz, 2018). In some cases, however, delayed pregnancies have been inferred with possible early embryonic loss and subsequent return to estrous resulting in a secondary ovulation.

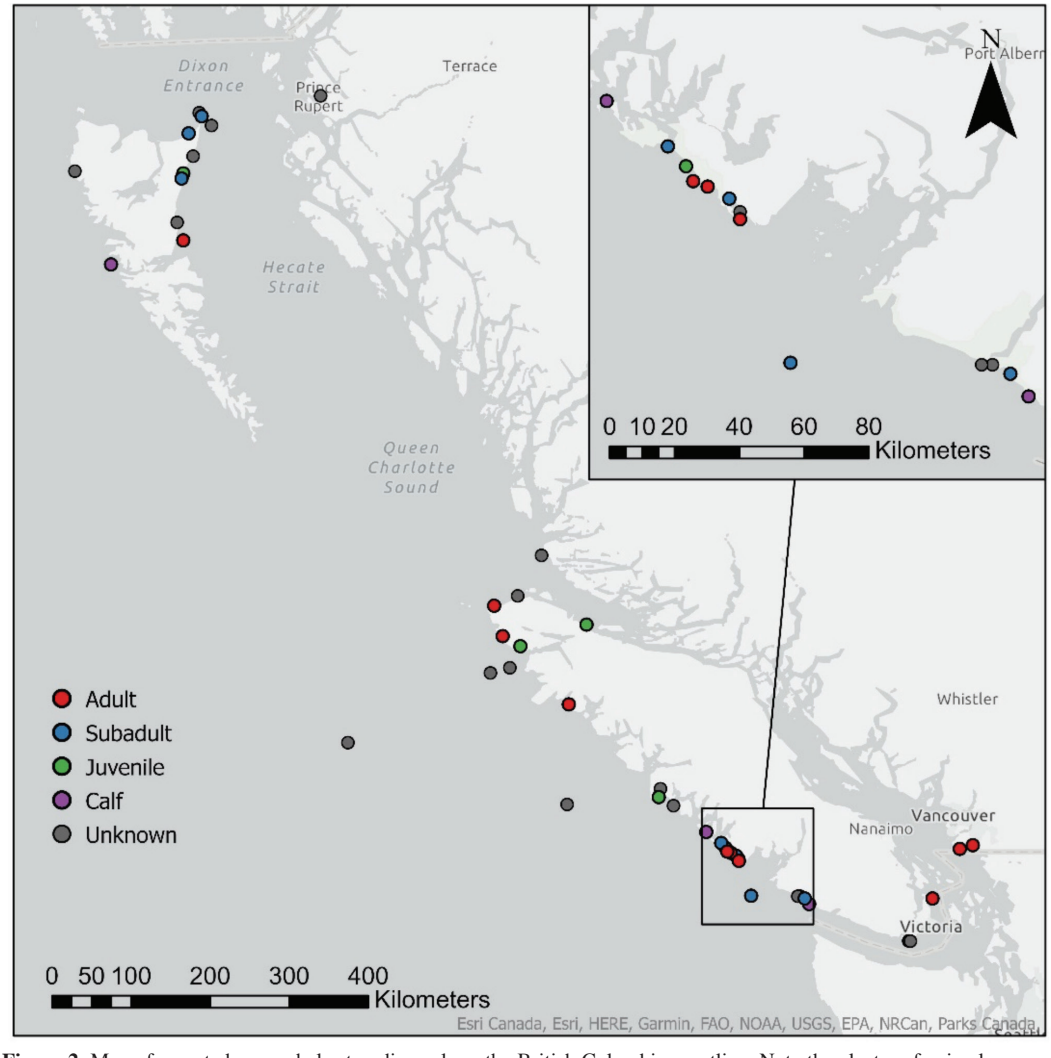

Figure 2. Map of reported gray whale strandings along the British Columbia coastline. Note the cluster of animals around Nootka Sound. The fetus stranded along the northwestern portion of Vancouver Island.

The mean gestation is 418 d but may range from 11 to 13 mo. Calving typically occurs between 26 December and 1 March (Swartz & Jones, 1983), with a peak reported in mid-January. Some variation in the calving intervals may be attributed to genetics, nutritional condition, environmental factors, intercurrent disease, and other factors.

Gestation length and fetal growth curves for gray whales have largely been derived from historic whale fisheries along the coast (Rice, 1983), live captures, and evaluation of presumed abortions, perinates, or neonates in calving lagoons (Sanchez Pacheco, 1998). When ovaries were available, the morphometric data were compared to presence and size of a *corpus luteum* (Rice, 1983), particularly when an embryo was not readily apparent on examination of the uterine contents. Copulation has been reported throughout the year; however, based on analysis of body lengths grouped by months, a mean conception date of 5 December has been cited (Rice & Wolman, 1971), which coincides with near completion of the southward migration. Early embryonic growth is completed by early March with a mean length of 10.1 cm, followed by a more accelerated, near exponential mid-gestational growth phase from June to October. In October, the mean body length of three examined fetuses was 340 cm (range: 301 to 374 cm; Zimushko & Ivashin, 1980). Some variation in growth at this stage of development was attributed to more prolonged breeding and conception intervals, possible primiparous females, intercurrent disease, suboptimal nutritional condition, females of small stature, and variation in individual development rates (Sumich et al., 2013). More gradual fetal growth has been reported between December and January with a proposed 4-wk prenatal diapause, characterized by a late gestational cessation in linear growth but increase in body mass (Rice, 1983). However, evaluation of additional mid-gestational and near-term fetuses and neonates did not substantiate this phenomenon (Sumich et al., 2013), and growth appears sustained throughout gestation. Average gray whale neonate length varies between publications and extends from 457 cm (range: 376 to 516 cm) in January, 437 cm (range: 360 to 510 cm) in February, and 444 cm (range: 354 to 540 cm) in data combined for January and February (Swartz & Jones, 1980a, 1980b; Rice, 1983; Sanchez Pacheco, 1998; Sumich et al., 2013). Past average birth lengths ranged between 4.6 and 4.7 m (Sumich et al., 2013); and in a more recent study modelling postpartum growth and development of North Pacific gray whales, mean birth length of females was 4.66 m with a SD of 0.379, and in males, it was 4.60 m with a SD of 0.305 (Agbayani et al., 2020).

Based on the stranding location, date, and morphometrics, the examined fetus was most consistent with a mid-gestational stage of development. Unfortunately, there are too few examined fetuses with a known conception time, so some variability in *in utero* growth is acknowledged. However, the total length of the examined animal was 307 cm, well below near-term or postpartum fetal lengths. The observation of vibrissae, fetal folds, patent ductus arteriosus and foreman ovale, and enterocolonic meconium were consistent with fetal development. The eyes were scavenged, and the apposition of the palpebral margins could not be assessed. However, partial aeration of the lungs and closure of the umbilical vasculature suggest that the animal had been born alive, inhaled, and succumbed shortly thereafter. The immature stage of fetal development presumably resulted in the loss of this animal.

Several threats to gray whales have been recognized and include coastal development, entanglements, entrapment, vessel or propeller strike, increased ambient noise, ocean acidification, disruption of feeding habitats, climate change, prey shifts, killer whale predation, exposure to harmful algal blooms (biotoxins), ingestion of plastic and marine litter, potential toxic or oil spills, and possible resumption of First Nations harvest (Gavrilchuk & Doniol-Valcroze, 2021). Few infectious agents have been detected in examined gray whales and include calicivirus, enterovirus, equine encephalitis (arbovirus), parapoxvirus, paramyxovirus, *Toxoplasma gondii*, *Sarcocystis* spp., multiple opportunistic and recognized pathogenic bacteria, secondary fungal involvement, numerous helminths, and ectoparasitic lice and barnacles (Stimmelmayr & Gulland, 2020). Ongoing efforts to report, recover, and conduct postmortem examinations not only provide insights into the natural history of these animals, but invaluable information on potential infectious and non-infectious disease processes that may impact individual and population health.

The migratory and reproductive strategies of gray whales are closely linked with active foraging in highly productive regions in Alaska during the summer and prolonged migration to southern breeding and calving grounds (Rice, 1983). The recovery of this fetus along the west coast of Vancouver Island coincided with the early stages of the southward migration from summering feeding grounds in Alaska to the calving lagoons along the coasts of California and Mexico. With the recent decline in annual calf recruitment through the gray whale UME, recovery and thorough examination of fetuses and perinates may provide valuable insights into potential infectious and non-infectious processes that may contribute to the overall decline of the eastern gray whale population.

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