Petition for an Emergency Order for the Southern Resident Killer Whales under s. 80 of the Species at Risk Act

To the Honourable Dominic LeBlanc, Minister of Fisheries and Oceans Canada, and the Honourable Catherine McKenna, Minister Responsible for Parks Canada Agency

On behalf of David Suzuki Foundation, Georgia Strait Alliance, Natural Resources Defense Council, Raincoast Conservation Foundation and World Wildlife Fund Canada (the "Petitioners")

Prepared by Ecojustice

Photo credit: Rachael Merrett, Georgia Strait Alliance

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I Introduction to Petition for an Emergency Order for Southern Resident Killer Whales

> *"There is hope they can come back, but it's going to take some very serious actions to be implemented very quickly." – Dr. John Ford, October 2017*[1]
>
> *"There are some short-term things that can be done — they're practical, well-supported and cautionary [...] We'd better stop talking about them and start doing them."*
> *– Dr. Lance Barrett-Lennard, October 2017*[2]

The Petitioners ask the Ministers[3] to make an emergency order pursuant to s. 80 of the *Species at Risk Act*, SC 2002, c 29 ("SARA") to protect the endangered Southern Resident Killer Whales ("Southern Residents").

The Southern Residents are in crisis. This population of genetically and culturally distinct salmon-eating killer whales is declining and has recently been reduced to 76 individuals. They face imminent threats to their survival and recovery.

The Southern Residents face three main threats: a lack of prey (primarily Chinook salmon), acoustic and physical disturbance from vessels, and environmental contaminants. Each of these threats continues to intensify, and they act synergistically, exacerbating each other. At present the most urgent of the threats appears to be the lack of prey – a threat which is exacerbated by acoustic and physical disturbance from vessels. The population show many signs of nutritional stress[4] including failing to carry pregnancies to term, increased calf mortality, and the loss of adult whales due to apparent starvation. In such a small population, every mortality is significant and causes a population level effect. They face extinction under current conditions.

The Petitioners propose specific following emergency measures to protect the Southern Residents, in light of the imminent threats to their survival and recovery. To summarize, the emergency order should:

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[1] Pynn, Larry, "Action needed now to restrict vessels in critical killer whale habitat, scientists warn", *Vancouver Sun* (12 October 2017), online: http://www.canada.com/news/local+news/action+needed+restrict+vessels+critical+killer+whale+habitat/15111735/story.html [Pynn, 12 Oct 2017].

[2] Pynn, 12 Oct 2017, *ibid*.

[3] The Minister of Fisheries and Oceans is the competent minister under SARA for Southern Residents. The Minister Responsible for Parks is engaged as portions of identified critical habitat are within Gulf Islands National Park Reserve and thus under her jurisdiction. Implementation of the recommended measures will also require collaboration with the Minister of Transport.

[4] Wasser, SK et al, "Population growth is limited by nutritional impacts on pregnancy success in endangered Southern Resident killer whales (*Orcinus orca*)" (June 29, 2017) 12:6 *PLoS ONE* e0179824, online: <http://doi.org/10.1371/journal.pone.0179824> [Wasser et al 2017]; Lacy, RC et al, "Evaluating anthropogenic threats to endangered killer whales to inform effective recovery plans" (2017) 7 *Scientific Reports*, article no: 14119, online: <https://www.nature.com/articles/s41598-017-14471-0> [Lacy et al 2017]; Matkin, CO; MJ Moore & FMD Gulland, "Review of Recent Research on Southern Resident Killer Whales (SRKW) to Detect Evidence of Poor Body Condition in the Population" (2017) *Independent Science Panel Report to the SeaDoc Society* [Matkin et al 2017].

- Designate additional areas of protected critical habitat on the west coast of Vancouver Island;
- Ensure prey availability through creation of feeding refuges that are closed to commercial and recreational salmon fishing. As well, restrict Chinook fisheries in the region to enable Chinook salmon populations to recover;
- Prohibit commercial and recreational whale-watching on Southern Resident killer whales in feeding refuges at relevant times of year (May 1 through November 30);
- Outside of feeding refuges, establish and strictly enforce a 200 meter buffer between all vessels and Southern Residents, as well as speed restrictions for commercial and recreational whale-watching vessels;
- Institute a series of operational measures to reduce noise and disturbance from commercial vessels traveling in or near Southern Resident foraging areas. Key actions include speed limits, redirecting ship traffic away from feeding refuges, and making vessels quieter; and
- Take steps to limit the cumulative effects of vessel traffic.

The emergency measures requested in this Petition are necessary, actionable and based on best available science. These measures are also informed by and consistent with the Amended Southern Resident Recovery Strategy (2011) and Action Plan (2017).[5]

While longer-term measures are needed to address the full suite of threats to the Southern Residents, the whales cannot wait. The risk to Southern Residents from short term nutritional stress and vessel disturbance is acute and must be addressed now. Further, from a practical perspective the decision-making process regarding fisheries planning for 2018 Chinook fisheries is already underway within Fisheries and Oceans Canada (DFO). Thus, we require a response to this petition by March 1, 2018.

II The Petitioners

The Petitioners are five conservation organizations with a longstanding interest in, and history of working to protect, the Southern Residents and Chinook salmon.

The David Suzuki Foundation ("DSF") is a leading Canadian environmental non-profit organization whose combined digital channels engage upwards of one million people weekly. DSF collaborates with all people in Canada, including government and business, to conserve the environment and find solutions that will create a sustainable Canada through evidence-based research, public engagement and policy work. DSF has worked to improve the sustainability of Pacific salmon fisheries in Canada for more than 20 years, participating in planning processes and playing a key role in the design and implementation of Canada's Wild Salmon Policy. DSF has provided input into the recovery strategy and action plan for Southern Residents focused on

[5] Fisheries and Oceans Canada, 2011, *Recovery Strategy for the Northern and Southern Resident Killer Whales (Orcinus orca) in Canada, Species at Risk Act* Recovery Strategy Series, Ottawa [Recovery Strategy]; Fisheries and Oceans Canada, 2017, *Action Plan for the Northern and Southern Resident Killer Whales (Orcinus orca) in Canada, Species at Risk Act* Action Plan Series, Ottawa [Final Action Plan].

restoring Chinook salmon abundance and accessibility as a primary food resource necessary for the recovery of these whales, along with recommendations on reducing noise and contaminant impacts. DSF has a long standing commitment to protect Southern Residents, including as litigant before Canadian and American courts in cases concerning the legal protection of critical habitat for the Southern Residents.[6]

Georgia Strait Alliance ("GSA") is a registered charity with extensive membership in British Columbia. GSA collaborates with individuals, businesses, and government in pursuit of its mission: to protect and restore the marine environment and promote the sustainability of Georgia Strait, its adjoining waters, and communities. This includes protecting the diversity of wildlife and their habitat. For more nearly 30 years, GSA has been an advocate around protecting the habitat of Southern Residents from the negative impacts of pollution and the loss of their prey species, Chinook salmon. During the last few years, GSA has focused on securing the release of the final action plan (supported by over 800 GSA members who sent in letters), participated in consultations and dialogues around orca protection, took a lead at the recent DFO hosted orca symposium (sat on the advisory committee and let one of the workshop sessions), and has resumed advocacy to have open-net cage salmon farms removed and the industry transitioned to closed containment to protect all wild salmon species. GSA has been a litigant before Canadian and American courts in cases concerning the legal protection of critical habitat for the Southern Residents.[7]

Natural Resources Defense Council ("NRDC") is a not-for-profit membership organization, incorporated under the laws of the State of New York in the United States of America. They combine more than three million members and online supporters with the expertise of hundreds of scientists, lawyers, and policy advocates in the United States and across the globe. The NRDC works to safeguard the earth – its people, its plans and animals, and the natural systems on which all life depends. Their Oceans Program, which includes their work on the Southern Residents, fights to restore marine vitality by working to end overfishing, protect important marine areas, improve oceans governance, and combat emerging threats. For more than two decades, through litigation, national and international advocacy, and science-based policy development, they have helped lead the environmental community in preventing and mitigating the impacts of ocean

[6] In the Federal Courts of Canada: *David Suzuki Foundation v Canada (Fisheries and Oceans)*, 2010 FC 1233; *Canada (Fisheries and Oceans) v David Suzuki Foundation*, 2012 FCA 40. In the United States District Court: *Inter Tribal Sinkyone Wilderness Council et al* v *National Marine Fisheries Service et al* (Northern District of California, Eureka Division, decided 25 September 2013).

[7] In the Federal Courts of Canada: *David Suzuki Foundation v Canada (Fisheries and Oceans)*, 2010 FC 1233; *Canada (Fisheries and Oceans) v David Suzuki Foundation*, 2012 FCA 40. In the United States District Court *Center for Biological Diversity et al v Robert D Lohn et al* (Western District of Washington at Seattle, decided 17 December 2003); In the United States District Court: *Washington State Farm Bureau et al v National Marine Fisheries Service et al* (Western District of Washington at Seattle, decided 20 December 2006); *Inter Tribal Sinkyone Wilderness Council et al* v *National Marine Fisheries Service et al.* (Northern District of California, Eureka Division, decided 25 September 2013).

noise pollution on marine wildlife. With their partners in the Orca Salmon Alliance, they have worked in the United States to improve prey availability for the Southern Resident population.

Raincoast Conservation Foundation ("Raincoast") is a charitable, non-profit organization comprised of scientists and conservationists who are empowered by their research to protect the lands, waters and wildlife of British Columbia. They use rigorous, peer-reviewed science, education, and community engagement to further conservation objectives. Raincoast operates a research lab at the University of Victoria, a field station, and research vessel. They collaborate with academic and government scientists to produce high-quality publications that further scientifically sound conservation decisions. For more than decade, Raincoast has used these tools to defend the critical habitat and lives of the Southern Residents. They have been a litigant before Canadian and American courts in cases concerning the application of SARA to the Southern Residents, including the legal protection of critical habitat.[8] Raincoast has published a population viability analysis that evaluates and ranks threats to Southern Residents. They participate in federal fisheries planning processes to manage and recover Chinook populations, challenge projects that harm Southern Resident critical habitat, advocate for vessel regulations to reduce noise and disturbance, and advocate for vessel regulations to reduce noise and disturbance.

World Wildlife Fund Canada ("WWF-Canada") is a registered charity and Canada's largest international conservation organization, with the active support of hundreds of thousands of Canadians. WWF-Canada is committed to building a future where nature and people thrive. Over time, their work has evolved from protecting particular wildlife species and habitats to protecting life on Earth – including our own. Today, their work is about life, because everything they do is about securing the future of healthy, thriving ecosystems. And living, because the choices we make will decide that future – for us and for all species. WWF-Canada's work is grounded in science, using the best available data and knowledge to understand ecological connections, identify pressing issues and work with partners in pragmatic ways to develop effective conservation strategies. WWF-Canada has been working since 2011 to quiet the oceans for Southern Residents and other Pacific marine species. By working with government and industry, WWF-Canada has been advancing solutions to the increasing problem of underwater noise, while seeking strong protections and measurable reductions to the threats killer whales face.

III The Southern Residents are in a state of emergency

The facts concerning the Southern Residents, the threats to them, and their current situation are well-known to DFO. The following is a summary of these facts as they pertain to this Petition.

[8] In the Federal Courts of Canada: *David Suzuki Foundation v Canada (Fisheries and Oceans)*, 2010 FC 1233; *Canada (Fisheries and Oceans) v David Suzuki Foundation*, 2012 FCA 40; *Tsleil-Waututh Nation et al v Canada (Attorney General) et al*, decision pending. In the United States District Court: *Inter Tribal Sinkyone Wilderness Council et al* v *National Marine Fisheries Service et al* (Northern District of California, Eureka Division, decided 25 September 2013).

The Petitioners additionally rely on the January 26, 2018 statement of Dr. Lance Barrett-Lennard, which is Appendix A to this Petition, addressing the rationale for and urgency of actions to address threats to Southern Residents.

1. Southern Resident Killer Whales population numbers and demographics

Resident-type killer whales feed exclusively on fish and cephalopods, and the Southern Residents feed primarily on Chinook salmon and forage selectively for them.[9]

The Southern Residents are genetically isolated from other killer whale populations.[10] They have a slow growth rate, with healthy females producing a calf on average every five to six years during a 25-year reproductive period. When evaluating population status, it is important to recall that population numbers include post-reproductive females who no longer directly contribute to growth.[11] Further, cultural behaviours influence their association and mating and so also limit population growth.[12] Southern Residents mate outside the matriline and presumably outside the pod, but within the Southern Resident population. Thus, growth is further limited by the population size and by a lack of sexually mature males, which restricts options.[13]

The current Southern Resident population consists of three pods: J pod (23 whales), K pod (18 whales) and L pod (35 whales).[14]

As of January 2018, the Southern Residents currently number only 76 individuals.[15] This is their lowest level in more than three decades. They are not recovering; on the contrary, the population is in a decline.[16] Without intervention, the situation will worsen.[17]

The population has previously been as low as 70 in 1974, in the immediate aftermath of live capture fisheries during 1962-1974 when 47 Southern Residents were removed for the aquarium trade.[18] While their numbers increased after captures ended in 1975, the higher quality of their critical habitat at that time, in contrast with its current quality, may have been a factor in that

[9] Recovery Strategy, *supra* note 5 at 2, 10.
[10] Recovery Strategy, *supra* note 5 at 8.
[11] Recovery Strategy, *supra* note 5 at 12.
[12] Recovery Strategy, *supra* note 5 at 9.
[13] Recovery Strategy, *supra* note 5 at 12. Females prefer males from other dialect groups, or, pods: Recovery Strategy, *supra* note 5 at 13.
[14] Recovery Strategy, *supra* note 5 at 2, 4.
[15] "2017 SRKW Census-July1", *Centre for Whale Research* (2017), online: <https://simplebooklet.com/publish.php?wpKey=HiPDDCYGTuXh2pyNPxHwB6#page=1> [2017 Census].
[16] Fisheries and Oceans Canada, 2017, *Southern Resident Killer Whale: A science-based review of recovery actions for three at-risk whale populations*, Ottawa, online: <http://www.dfo-mpo.gc.ca/species-especes/whalereview-revuebaleine/review-revue/killerwhale-epaulard/page01-eng.html> [DFO Review of Recovery Actions] at 58.
[17] Lacy et al 2017, *supra* note 4; Vélez-Espino, LA et al, "Sensitivity of resident killer whale population dynamics to Chinook salmon abundance" (2013) prepared for Pacific Salmon Commission Southern Boundary Restoration and Enhancement Fund [Vélez-Espino et al 2013].
[18] Recovery Strategy, *supra* note 5 at 7, 16.

increase.[19] This included high survival rates of immature Chinook salmon populations prior to 2000[20]; higher abundance of Fraser River Chinook returns, especially in the spring and early summer[21]; changes in the size of Chinook salmon[22]; and lower levels of noise and disturbance associated with vessel traffic[23]. Notably, the Southern Residents' current low numbers are likely due to ongoing and intensifying threats to the whales and their habitat, described below, not to exceptional events.

Recent research, using photo-identification, mortality, and other sighting data; photogrammetry (aerial photography allowing measurement of whales); mortality data; social dynamics and relationships; and stress hormones shows evidence of poor body condition in Southern Residents. Further, these recent studies indicate that that prey availability, acoustic and physical disturbance, and contaminants appear to be acting in concert, causing the decline of the population.[24] Best available science indicates that poor body condition and malnutrition in Southern Residents is associated with the deaths of fetuses, calves, and adults.[25]

Following a recent "baby boom" beginning in December 2014 and ending in 2016 (no calves having been born in 2017), which resulted in 9 calves, the Southern Residents have suffered a series of setbacks. Three calves have since died (J54 and J55 in 2016, J52 in 2017).[26] In at least one case (J52), the calf was sighted showing signs of malnutrition before its death.[27] The population has not produced any surviving calves since 2015, and K pod has not produced any surviving calves since 2011.[28]

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[19] Lacy et al 2017, *supra* note 4.
[20] Riddell, B et al, "Assessment of Status and Factors for Decline of Southern BC Chinook Salmon: Independent Panel's Report" (2013) prepared for Fisheries and Oceans Canada and Fraser River Aboriginal Fisheries Secretariat [Riddell et al 2013].
[21] Jones, Lisa & Jeff Grout, Fisheries and Oceans Canada, "Southern Resident Killer Whales and Chinook Salmon" (2017) presentation from 2017 Post-Season Salmon Meeting – Southern Salmon at slide 23 [Jones & Grout 2017].
[22] Fisheries and Oceans Canada, "Preliminary 2018 Salmon Outlook" (2018) provided to Integrated Harvest Planning Committee at 12 [Preliminary 2018 Salmon Outlook]: S. Thompson Chinook: Fecundity for South Thompson Chinook has been declining and is about 20% below the average of a decade ago;
Lewis, BW et al, "Changes in Size and Age of Chinook Salmon *Oncorhynchus tshawytscha* Returning to Alaska" (2015) 10:7 *PLoS ONE* e0130184, online:
<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0130184> [Lewis et al 2015].
[23] Williams, R et al, "Acoustic quality of critical habitats for three threatened whale populations" (2014) 17:2 *Anim Conserv* 174 [Williams et al 2014].
[24] Matkin et al 2017, *supra* note 4.
[25] DFO Review of Recovery Actions, *supra* note 16 at 31-32; Matkin et al 2017, *supra* note 4.
[26] 2017 Census, *supra* note 15; "Southern Resident Orca Community Demographics, Composition of Pods, Births and Deaths since 1998" *Orca Network* (23 September 2017), online:
<http://www.orcanetwork.org/Main/index.php?categories_file=Births%20and%20Deaths> [Orca Network 23 Sept 2017].
[27] Balcomb, Kenneth, "Media Release: Another 'Baby Boom' Southern Resident Killer Whale Has Died", *Centre for Whale Research*, online: <https://www.whaleresearch.com/j52> [CWR Media Release].
[28] 2017 Census, *supra* note 15.

The population has also suffered losses among its reproductive aged adults. The Center for Whale Research has identified "alarming mortality" among reproductive-aged females: two lost in 2014 (J32, carrying a near-term fetus[29], and L53) and two lost in 2016 (J28, whose calf J54 subsequently died, and J14).[30] The number of reproductively contributing animals is small given the population's size.[31]

Other recent mortalities include deaths of post-reproductive females: the 45-year-old female K13 in 2017 and the matriarch of J-Pod (J2[32]) in 2016. In 2016, an adult male (J34) was killed by blunt force trauma consistent with a vessel strike[33], and another adult male (L95) by an infection from a research tag[34].

Dr. Barrett-Lennard notes that the deaths of 11 other population members "more than offset" the six surviving calves born in the same period from December 2014 through 2016, and identifies as particularly concerning the unusual loss of reproductive-aged females, and the lack of any surviving calves in K pod since 2011 (see Appendix A).

The U.S. National Oceanic and Atmospheric Administration ("NOAA") recently stated that "[t]here is great concern right now about this population. There has been a loss of too many whales in the last six months to a year".[35]

2. Southern Resident Critical Habitat

Much of the Canadian and American portions of the Salish Sea have been identified as Southern Resident critical habitat. Critical habitat is defined in SARA as "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical

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[29] Balcomb, Kenneth, "Preliminary Necropsy Report for J32", *Centre for Whale Research*, online: <https://www.whaleresearch.com/j32-report> [CWR J32]; British Columbia, Ministry of Agriculture, *Final Report AHC Case: 14-5856*, Animal Health Centre (2016) online: <https://docs.wixstatic.com/ugd/760f65_472b71509c40426f8c2bc1aaac494117.pdf> [BC MoA].

[30] 2017 Census, *supra* note 15.

[31] DFO Review of Recovery Actions, *supra* note 16 at 2-3.

[32] Laanela, Mike, "Orca 'Granny' missing and presumed dead", *CBC News* (03 January 2017), online: <http://www.cbc.ca/news/canada/british-columbia/orca-j2-granny-dead-killer-whale-1.3919060> [Laanela 2017].

[33] "Orca found on Sunshine Coast died of blunt force trauma, DFO says", *CBC News* (22 December, 2016), online: <http://www.cbc.ca/news/canada/british-columbia/orca-death-b-c-1.3909858> [CBC News 22 Dec 2016]; Lopes, Luiz, "Orca's death off BC coast not likely caused by another whale, expert says", *The Globe and Mail* (25 December 2016), online: <https://www.theglobeandmail.com/news/british-columbia/orcas-death-off-bc-coast-not-likely-caused-by-another-whale-expert-says/article33429688/> [Lopes 2016].

[34] Welch, Craig, "Orca Killed by Satellite Tag Leads to Criticism of Science Practices", *National Geographic* (6 October 2016), online: <https://news.nationalgeographic.com/2016/10/orca-killed-by-satellite-tag-l59/> [Welch 2016].

[35] Givetash, Linda, "Study finds US regulations to protect killer whales near BC coast effective", *Winnipeg Free Press* (1 January 2018), online: <https://www.winnipegfreepress.com/arts-and-life/life/greenpage/study-finds-us-regulations-to-protect-killer-whales-near-bc-coast-effective-467516233.html> [Givetash 2018].

habitat in a recovery strategy or in an action plan for the species."[36] The Southern Residents use the Salish Sea year round, and in most years are continuously present from May to November.

Southern Resident critical habitat currently identified is described in the Recovery Strategy and legally protected by a Critical Habitat Protection Order issued under s. 58(4) of SARA.[37]

As confirmed by the Federal Court, Southern Resident critical habitat includes the attributes that make it useful for them, including its acoustic and environmental quality and the availability of Chinook salmon.[38] Their presence in critical habitat is likely driven primarily by the availability of migrating salmon, especially in summer months.[39]

As noted in the Recovery Strategy, the Southern Residents' range extends beyond their currently designated critical habitat and identification of critical habitat is incomplete.[40] A recent Science Advisory Report published by the Department of Fisheries and Oceans has identified an additional area that meets the criteria for designation of resident killer whale critical habitat under SARA (Figure 4). This area is on the continental shelf off southwestern Vancouver Island at the mouth of the Juan de Fuca Strait and includes Swiftsure Bank.[41]

3. Conservation status and imminent threats to survival and recovery

The Southern Residents are listed as endangered in schedule 1 of SARA. They are endangered due to their small population size, low reproductive rate, and anthropogenic threats.[42] The three main threats are identified in the Recovery Strategy: 1) environmental contamination; 2) acoustic and physical disturbance; and 3) unavailability of their preferred prey, Chinook salmon.

DFO has acknowledged that the Southern Residents' small population size, and small number of reproductive adults (known as the effective population), exacerbates the impact of a single mortality or a loss of reproductive potential on the survival of the population as a whole.[43]

Small populations are particularly vulnerable to population-level effects from the loss of even one individual. As a consequence of their small population size, the Southern Residents experience a greater likelihood of inbreeding, a shortage of suitable mates, lower reproductive rates, reduced resilience to disease or pollution, reduced population fitness, and increased risk of

[36] *Species at Risk Act*, SC 2002, c 29 [SARA] s 2(1).
[37] *Critical Habitat of the Northeast Pacific Northern and Southern Resident Populations of the Killer Whale (Orcinus orca) Order*, SOR/2009-68 [Critical Habitat Order].
[38] *David Suzuki Foundation v Canada (Fisheries and Oceans)*, 2010 FC 1233 at para 339; upheld 2012 FCA 40.
[39] Recovery Strategy, *supra* note 5 at 10
[40] Recovery Strategy, *supra* note 5 at 4, 51; Action plan, *supra* note 5 at 7.
[41] Fisheries and Oceans Canada, 2017, *Identification of Habitats of Special Importance to Resident Killer Whales (Orcinus orca) off the West Coast of Canada*, DFO Can Sci Advis Sec Sci Advis, Rep 2017/011 [Habitats of Special Importance 2017].
[42] Recovery Strategy, *supra* note 5 at 13.
[43] DFO Review of Recovery Actions, *supra* note 16 at 3.

extinction from catastrophic events.[44] Variation in reproduction and survival, genetic drift[45], and environmental change (whether long-term, such as increasing ocean noise, or single events, such as oil spills) can interact to doom a small population to extinction. This positive feedback loop is called an "extinction vortex": the negative consequences of lower effective population size make the population smaller, causing stronger negative effects from habitat degradation and other human activity, leading to an even smaller population size. As a result, the extinction probability for a small population can be very high.

In the case of the Southern Residents, the three main anthropogenic threats work synergistically. For example, a shortage of prey is exacerbated by physical or acoustic disturbance that makes it harder for the whales to successfully forage for already limited prey. In turn, this can exacerbate the contamination problem by causing whales that are not getting enough prey to metabolize their fat releasing the contaminants stored in it – which further weakens the animals.

All three of the major threats to the Southern Residents must therefore be addressed in order for this population to survive and recover to a healthy size. While all three threats require immediate and ongoing response from regulators, the recent deaths, including those of fetuses, calves and adults, are indicators of nutritional stress, which is an urgent problem.[46] It appears that the whales cannot access enough of their preferred prey – Chinook salmon – to maintain a healthy body mass. A recent population viability analysis concluded that prey limitation is the most important factor affecting population growth.[47] Dr. John Ford has stated that "[f]ood supply is clearly a big issue, probably the overwhelming issue."[48]

The two main drivers of nutritional stress are the diminished availability of Chinook salmon[49] and the physical and acoustic disturbance from vessels that interferes with the whales' ability to forage efficiently[50]. This petition seeks an emergency order to address these immediate threats.

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[44] Recovery Strategy, *supra* note 5 at 13-14: The Southern Residents appear to avoid inbreeding, but suffer from a shortage of suitable mates.

[45] Variation in the relative frequency of different genotypes in a small population, owing to the chance disappearance of particular genes as individuals die or do not reproduce.

[46] Matkin et al 2017, *supra* note 4; DFO Review of Recovery Actions, *supra* note 16.

[47] Lacy et al 2017, *supra* note 4.

[48] Pynn, Larry, "Vessel noise is reducing ability of killer whales to hunt by about 25 per cent, new research suggests" *Vancouver Sun* (11 October 2017), online: <http://www.canada.com/news/local+news/fisheries+minister+pledges+22to+whatever+takes+save+endangered/15107114/story.html> [Pynn 11 Oct 2017].

[49] Fisheries and Oceans Canada, 2009, Ford, JKB et al, *Chinook salmon predation by resident killer whales: seasonal and regional selectivity, stock identity of prey, and consumption rates*, DFO Can Sci Advis Sec, Res Doc 2009/101, online: <http://www.dfo-mpo.gc.ca/csas-sccs/publications/resdocs-docrech/2009/2009_101-eng.htm> [Ford et al 2009]; Ford, JKB et al, "Linking killer whale survival and prey abundance: food limitation in the oceans' apex predator?" (2010) 6 *Biology Letters* 139 [Ford et al 2010].

[50] Lusseau, D et al, "Vessel traffic disrupts the foraging behavior of southern resident killer whales *Orcinus orca*" (2009) 6 *Endangered Species Research* 211 [Lusseau et al 2009]; Noren, DP et al, "Close approaches by vessels elicit surface active behaviors by southern resident killer whales" (2009) 8 *Endangered Species Research* 179

DFO has recently identified a possible additional threat: injury or death due to vessel strikes.[51] The measures put forward in this Petition to address physical and acoustic disturbance would have the additional benefit of reducing the likelihood of ship strikes.

a. Reduced availability of the Southern Residents' preferred prey, Chinook salmon is an urgent threat their survival and recovery

The Recovery Strategy identifies reduced prey availability as one of the three main threats to the survival and recovery of the Southern Residents. The Recovery Strategy further identifies large, fatty Chinook salmon as the whales' preferred prey. Overall adult Chinook salmon abundance in critical habitat has reached historic low levels in spring and early summer. Certain other Chinook stock groups that were more abundant in recent decades (such as Harrison and South Thompson) have recently been below long term averages and below their spawner targets.[52] Evidence indicates that the Southern Resident population as a whole suffers from nutritional stress and that in the past three years individual whales starved to death. This is a situation requiring urgent action.

i. Declining availability of Chinook for Southern Residents

Chinook abundance has been greatly reduced from historic levels, and many populations are in decline.[53] DFO has stated that most conservation units of Southern B.C. Chinook have declined in the last 12-15 years.[54]

A recent DFO assessment of the status of the 35 Chinook salmon conservation units in southern BC (see Figure 1) reached two highly concerning conclusions. First, there was only sufficient evidence available to generate an assessment on 15 of the 35 conservation units. Second, 11 of these 15 conservation units which could be assessed were found to be in the DFO's Wild Salmon Policy (WSP) "Red zone".[55]

[Noren et al 2009]; Williams et al 2014, *supra* note 23; Lacy et al 2017, *supra* note 4; Holt, MM et al, "Noise levels received by endangered killer whales *Orcinus orca* before and after implementation of vessel regulations" (2017) 34 *Endangered Species Research* 15 [Holt et al 2017].

[51] DFO Review of Recovery Actions, *supra* note 16.

[52] Fisheries and Oceans Canada, "2017 Fraser River Stock Assessment and Fishery Summary: Chinook, Coho and Chum" (2017) provided to South Coast IHPC members on 2017-12-04 and provided electronically 2017-12-13 [2017 Fraser River Stock]; Preliminary 2018 Salmon Outlook, *supra* note 22.

[53] DFO Review of Recovery Actions at 31, citing Fisheries and Oceans Canada, 2016, *Integrated Biological Status of Southern British Columbia Chinook Salmon (Oncorhynchus tshawytscha) Under the Wild Salmon Policy*, DFO Can Sci Advis Sec Sci Advis, Rep 2016/042 [Integrated Biological Status 2016].

[54] *Ibid*.

[55] Integrated Biological Status 2016, *supra* note 54.

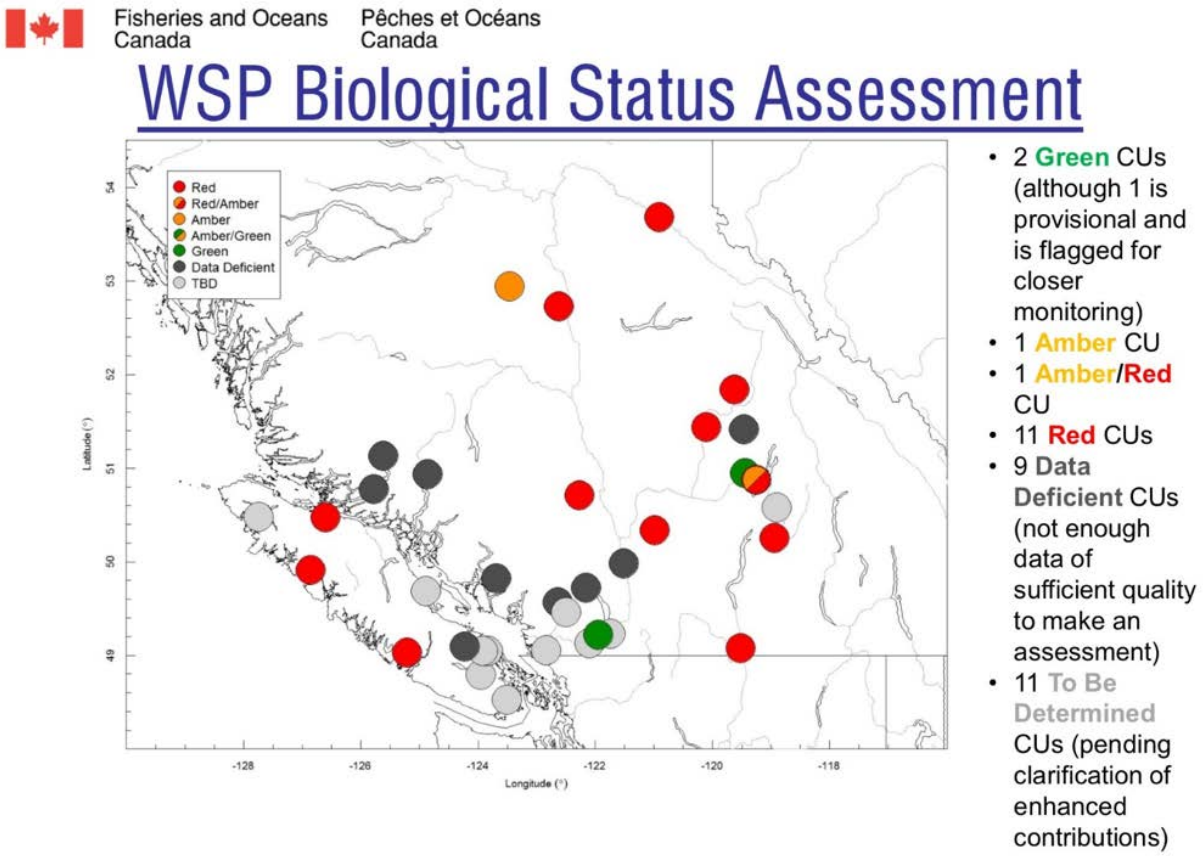

Figure 1. Assessment and status of 35 Chinook Conservation Units in Southern British Columbia as determined under Canada's Wild Salmon Policy. Of the 15 populations with an assessed status, two are in the 'green' zone, two are in the 'amber' zone, and 11 are in the 'red' zone. Map: DFO 2016.

In recent years, record-low returns of early-timed (spring and early summer) Fraser Chinook salmon have returned to the Fraser River (Figure 2). Early timed Fraser Chinook are important in the diets of Southern Residents[56] and provide a food source in critical habitat at a time of year when mature Chinook populations are generally in lower abundance.

[56] Hanson, MB et al, "Species and stock identification of prey consumed by endangered Southern Resident killer whales in their summer range" (2010) 11 *Endangered Species Research* 69 [Hanson et al 2010].

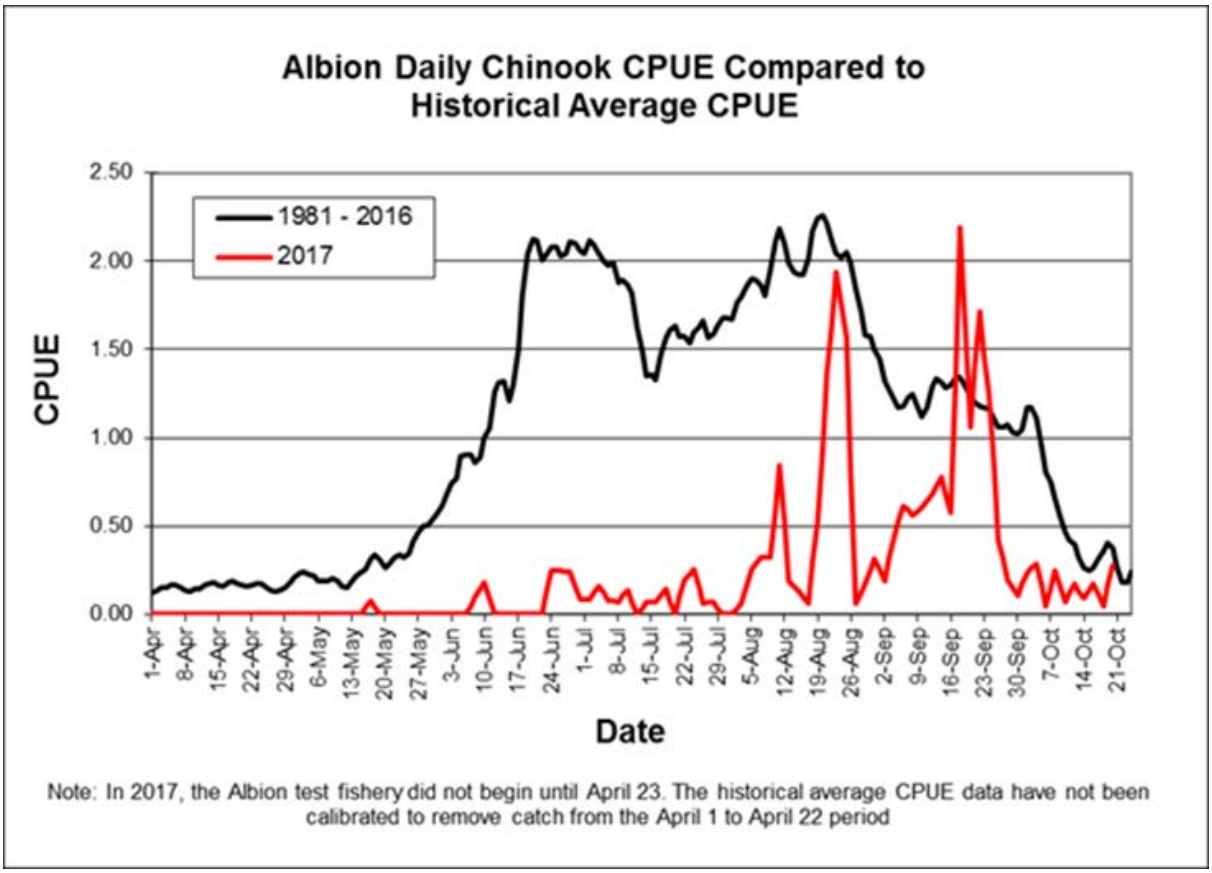

Figure 2. DFO's Albion test fishery shows the catch per unit effort (CPUE) on the three major run-timings of Chinook salmon migrating through the Lower Fraser River. The spring and early summer run-timing group that enters the river prior to mid-July is a fraction of its former abundance. 2017 was one of, if not the, worst returns on record for these spring and early summer Chinook. Abundance peaks in the later run-timing groups through the lower Fraser in August (South Thompson) and fall (Harrison) can also be observed.

Early-timed Fraser River Chinook are substantially below past levels of abundance. This means that a primary prey for Southern Residents in the spring and summer is substantially below past levels that previously sustained the Southern Residents. Fraser River spring and early summer stream-type[57] Chinook are returning at less than 40% of the number of salmon that should reach their spawning grounds.[58] Despite the run collapse of early-timed Fraser Chinook, DFO has not closed fisheries that catch these salmon.

[57] Distinct from the "ocean-type" life history of Chinook salmon which generally enter the Fraser later in the year.
[58] Based on maximum sustainable yield estimates of habitat carrying capacity as presented in Fisheries and Oceans Canada, "Pacific Region Integrated Fisheries Management Plan Salmon Southern BC June 1, 2015 to May 31,

Other Fraser Chinook populations important in the diets of the Southern Residents are also performing poorly. DFO's 2016 estimates of Fraser Chinook salmon reaching their spawning grounds (escapement estimates) in the spring, early summer, summer and fall show these runs are below or well below sustainable numbers of spawning fish.[59]

DFO's outlook for Fraser River Chinook returns in 2018 indicates that conservation concerns persist for most Fraser Chinook populations, with the potential for low returns due to low spawner abundance and low productivity associated with unfavourable marine conditions.[60]

Furthermore, the size and nutritional value of individual Chinook has declined significantly in recent decades, with consequences for the Southern Residents.[61]

A significant correlation exists between changes in Chinook salmon abundance and resident killer whale survival and mortality (described in detail below).[62] Despite the fact that many southern BC Chinook populations are depressed, directed fishing on these populations continues. Further, despite the fact that methods exist to predict and assess fisheries abundance pre-season and in-season, DFO has not used these tools to adapt or adjust fishing plans to accommodate food requirements of resident killer whales.

Finally, the fisheries management approach taken for Chinook is not aimed at stock rebuilding.

Other fisheries management approaches are available. For example, consistently meeting spawner escapement goals (the number of breeding salmon on spawning grounds) would ensure sustainability objectives are met and increase both immediate and long term Chinook abundance for Southern Residents. It would serve the Southern Residents in the short term by increasing terminal run abundance while run building of stocks can occur over the longer time frames it takes for Chinook to mature and reproduce.

The Minister of Fisheries and Oceans has acknowledged the need to address Chinook availability for Southern Residents through fisheries management, stating that:

> Restoring the habitat, ensuring better survival and recovery of chinook salmon is part of answering the prey challenge, but it also comes down to making allocation decisions. You have a lot of people competing with the whales for those chinook salmon.[63]

2016", Canada, online: <http://www.dfo-mpo.gc.ca/Library/358101.pdf> at 57 [Integrated Management Plan 2015-2016].

[59] 2017 Fraser River Stock, *supra* note 53.

[60] *Ibid*.

[61] DFO Review of Recovery Actions, *supra* note 16 at 31, citing Bigler, BS; DW Welch & JH Helle, "A review of size trends among North Pacific salmon (*Oncorhynchus* spp)" (1996) 53 *Canadian Journal of Fisheries and Aquatic Science* 455 [Bigler et al 1996].

[62] Ford et al 2010, *supra* note 50; Ford et al 2009, *supra* note 50; Wasser et al 2017, *supra* note 4.

[63] Pynn 11 Oct 2017, *supra* note 49.

Fisheries management actions are urgently needed to avoid the imminent threat of the Southern Resident population reaching a point at which survival and recovery is no longer possible.

ii. Relationship between Chinook availability and Southern Residents' health

The survival and recovery of the Southern Residents is linked to Chinook availability: both abundance and accessibility. Chinook abundance is strongly correlated with birth, growth, and mortality rates of the Southern Residents, as well as being linked to their level of nutritional and physiological stress[64].

The strong positive correlation between mortality of Southern Residents and low abundance of Chinook salmon has been identified to the extent that Chinook availability is considered the primary factor limiting the Southern Resident population. Lacy et al. identified reduced consumption of Chinook salmon as having the largest effect on depressing the Southern Resident population size, possibly leading to extinction.[65]

High pregnancy failure is linked to nutritional stress and low salmon abundance. A 2017 study by the University of Washington Center for Conservation biology, NOAA's Northwest fisheries Science Center, and the Center for Whale Research shows that up to 69% of pregnancies failed from 2008 to 2014 and links this low reproductive success to stress brought on by low or variable abundance of Chinook salmon.[66] The lead author says: "These findings indicate that pregnancy failure – likely brought on by poor nutrition – is the major constraining force on population growth in southern resident killer whales".[67] The authors concluded that "[l]ow availability of Chinook salmon appears to be an important stressor among these fish-eating whales as well as a significant cause of late pregnancy failure, including unobserved perinatal loss." [68] The authors further conclude that the release of contaminants stored in Southern Residents' fat when they lack food and metabolize their fat may also be a contributing factor. These findings indicate that when food is adequate during pregnancy, females are more likely to carry their unborn calves to term, thus building the population. When food is scarce, resident killer whales fail to have successful calves. Unusually high mortality has followed periods of

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[64] Ford et al 2010, *supra* note 50; Recovery Strategy, *supra* note 5 at 23; Wasser et al, *supra* note 4. See also: Ward, EJ; E Holmes & KC Balcomb, "Quantifying the effects of prey abundance on killer whale reproduction" (2009) 46 *Journal of Applied Ecology* 632 [Ward et al 2009]; Vélez-Espino et al 2013, *supra* note 17; Vélez-Espino, LA et al, "Relative importance of Chinook salmon abundance on resident killer whale population growth and viability" (2014) 25 *Aquatic Conservation: Marine and Freshwater Ecosystems* 756 [Vélez-Espino et al 2014]; Ayres, KL et al, "Distinguishing the impacts of inadequate prey and vessel traffic on an endangered killer whale (*Orcinus orca*) population" (June 6, 2012) 7:6 *PLoS ONE* e3684, online: < https://doi.org/10.1371/journal.pone.0036842> [Ayres et al 2012]; Lacy et al 2017, *supra* note 4.

[65] Lacy et al 2017, *supra* note 4; Ford et al 2010, *supra* note 50.

[66] Wasser et al 2017, *supra* note 4.

[67] Urton, James, "Study shows high pregnancy failure in south resident killer whales; links to nutritional stress and low salmon abundance", *University of Washington News* (29 June 2017), online: <http://www.washington.edu/news/2017/06/29/study-shows-high-pregnancy-failure-in-southern-resident-killer-whales-links-to-nutritional-stress-and-low-salmon-abundance/> [Urton 2017].

[68] Wasser et al 2017, *supra* note 4.

reduced or low Chinook abundance. Conversely, the probability of calving is 50% higher following years of higher Chinook abundance.[69]

Recent studies have observed poor and declining body condition in some Southern Residents and have associated it with loss of fetuses, calves and adults.[70] Aerial photogrammetry provides information on body condition, and researchers have observed disproportionate declines in body condition of reproductive-aged females (who have higher energetic demands) compared with other age classes. Documented declines in body condition of six reproductive females preceded their deaths in 2008, 2013, and 2016.[71] Because the loss of individual fetuses, calves, and mature whales to malnutrition has population-level consequences, the entire Southern Resident population can be characterized as nutritionally stressed.

Velez-Espino et al. demonstrated that fisheries reductions and closures would improve vital rates and recovery trajectories of Southern Residents.[72] Lacy et al. further demonstrated that a 30% increase in Chinook consumption would increase the Southern Residents' growth rate as high as 1.9%.[73] This growth rate is in range of the US recovery target[74] and would provide a high probability that the currently impaired population could survive at larger and more viable numbers into the future.

The most important seasonal feeding grounds in the Canadian portion of Southern Resident critical habitat include Boundary Passage, Swanson Channel off North Pender Island, the southwestern tip of Vancouver Island, and the mouth of the Fraser River delta.[75] These sites are major corridors for migrating salmon and can contain high concentrations of recreational and sometimes, commercial fishing vessels. These sites are not in any way protected to allow Southern Residents to feed in an undisturbed environment. Protection of these key feeding areas should be a priority, and urgent action should be taken to see that this is done.

b. Acoustic and physical disturbance is an urgent threat to Southern Resident survival and recovery

[69] Ward et al 2009, *supra* note 65.
[70] DFO Review of Recovery Actions, *supra* note 16 at 31-32, citing Fearnbach, H et al, "Individual-based photogrammetric measures of length, growth and shape to infer body condition and reproductive status of southern resident killer whales" (2015) Unpublished Report from the Center for Whale Research and NOAA, USA, online: <https://swfsc.noaa.gov/uploadedFiles/Events/Meetings/MMT_2015/Documents/4.2%20Ppr%202015_Fearnbach%20et%20al_Report_SRKW%20Photogrammetry.pdf> [Fearnbach et al 2015]; Matkin et al 2017, *supra* note 4.
[71] Matkin et al 2017, *supra* note 4.
[72] Vélez-Espino et al 2013, *supra* note 17.
[73] Lacy et al 2017, *supra* note 4.
[74] The US recovery objective for the Southern Residents is a growth rate of 2.3% year. The Canadian Recovery Strategy does not identify a growth rate target.
[75] Ashe, E; DP Noren & R Williams, "Animal behaviour and marine protected areas: incorporating behavioural data into the selection of marine protected areas for an endangered killer whale population" (2010) 13 *Animal Conservation* 196 [Ashe et al 2010]; Fisheries and Oceans Canada, 2006, Ford, JKB, *An Assessment of Critical Habitats of Resident Killer Whales in Waters off the Pacific Coast of Canada*, DFO Can Sci Advis Sec, Res Doc 2006/072 [Ford 2006]; DFO Review of Recovery Actions, *supra* note 16.

The Recovery Strategy identifies physical and acoustic disturbance as one of the three main threats facing the Southern Residents. Physical and acoustic disturbance can impact the whales directly, and also exacerbate the problem of prey unavailability. The Salish Sea is one of the noisiest places along the coast – with commercial and recreational vessel traffic on the rise. The whales are also the focus of an active whale watching industry. These stressors combine to result in a level of physical and acoustic disturbance which must urgently be addressed.

i. How physical and acoustic disturbance impact Southern Residents

In the dark ocean environment the Southern Residents use sound for essential activities: to detect prey using echolocation, to communicate with each other, and to get information about their environment.[76] Southern Residents are hindered in their critical life processes by both the physical presence of vessels and underwater noise from their engines.[77]

The Recovery Strategy identifies chronic disturbance from vessels as a threat to the Southern Residents and their critical habitat.[78] The Recovery Strategy states that underwater noise from vessels interferes with the Southern Residents' ability to carry out basic life processes. It also identifies a link between vessel activity and short-term behavioural changes that have energetic and other costs for Southern Residents.[79]

Resident killer whale behaviour during vessel interactions has been widely documented and includes avoidance tactics,[80] disruption of foraging behaviour,[81] and differences in surface active behaviours and time spent travelling.[82] Dr. John Ford has stated that sport fishing and whale watching vessels can physically interfere with the whales' ability to hunt.[83] The presence of and noise from these vessels, along with merchant, passenger and other ships, can incur significant reductions in foraging activity and limit food acquisition.[84] The presence of vessels can cause

[76] Recovery Strategy, *supra* note 5 at 27.
[77] Veirs, S; V Veirs & JD Wood, "Ship noise in an urban estuary extends to frequencies used for echolocation by endangered killer whales" (2015) 4 *PeerJ* e1657, online: <https://doi.org/10.7717/peerj.1657> [Veirs et al 2015].
[78] Recovery Strategy, *supra* note 5 at 26-33.
[79] Recovery Strategy, *supra* note 5 at 27.
[80] Williams, R; AW Trites & DE Bain "Behavioural responses of killer whales (*Orcinus orca*) to whale-watching boats: opportunistic observations and experimental approaches" (2002) 256:02 *J of Zoology* 255 [Williams et al 2002]; Williams, R & E Ashe, "Killer whale evasive tactics vary with boat number" (2007) 272 *J of Zoology* 390 [Williams et al 2007].
[81] Lusseau et al 2009, *supra* note 51; Williams, R; D Lusseau & PS Hammond, "Estimating relative energetic costs of human disturbance to killer whales (*Orcinus orca*)" (2006) 133 *Biological Conservation* 301 [Williams et al 2006].
[82] Williams, R et al, "Effects of vessels on behaviour patterns of individual southern resident killer whales Orcinus orca" (2009) 6 *Endangered Species Research* 199 [Williams et al 2009]; Noren et al 2009, *supra* note 51.
[83] Pynn, 12 Oct 2017, *supra* note 1.
[84] Lusseau et al 2009, *supra* note 51; Noren et al 2009, *supra* note 51; Williams et al 2014, *supra* note 23; Lacy et al 2017, *supra* note 4; Holt et al 2017, *supra* note 51.

whales to spend 25% less time catching and eating salmon,[85] translating to a 16% reduction in food intake.[86]

Vessel noise can make more difficult for Southern Residents to detect scarce prey as it is capable of masking critical sounds such as echolocation reflecting off of Chinook salmon or the calls of other whales.[87] This masking or altering of vital communication calls is likely to induce chronic stress.[88]

Research shows that underwater noise from vessels is reducing the Southern Residents' ability to hunt by 20 to 23 per cent, due to the whales' behavioural responses to noise and due to the noise masking echolocation. In the Salish Sea, the effects of noise from large commercial vessels (including tug boats and ferries) are responsible for two thirds of this lost foraging time, and commercial and recreational whale watching vessels for the other third.[89]

Further, Southern Residents are known to increase the duration and amplitude of calls in the presence of vessel traffic and other noise.[90] When whales attempt to compensate for background noise by vocalizing more loudly they expend more energy.[91] This exacerbates problems caused by the lack of prey availability.

The ability to effectively find and catch prey items already at low abundance is further reduced when foraging is occurring with acoustic and physical disturbance from vessel traffic. This reduction in foraging efficiency translates to lower intake of food energy and lowers survival, lowers birthrates and increases mortality. These impacts are particularly troubling given that the Southern Residents already face a shortage of prey; in this context they raise population-level, conservation concerns.[92] Furthermore, DFO acknowledges that "[f]urther reductions to foraging opportunities are anticipated with future increases in shipping."[93]

Finally, while collisions with vessels are rare, they can occur and can result in serious injury or death.[94] Two recent Southern Resident mortalities have been attributed to blunt force trauma

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[85] Lusseau et al 2009, *supra* note 51.
[86] Lacy et al 2017, *supra* note 4.
[87] Clark, Christopher, "Potential Acoustic Impacts of Vessel Traffic from the Trans Mountain Expansion Project on Southern Resident Killer Whales" (2015) prepared for Raincoast Conservation Foundation for submission to National Energy Board Hearing OH-001-2014 at 9 [Clark Report 2015].
[88] Foote, AD; RW Osborne & AR Hoelzel, "Whale-call response to masking boat noise" (2004) 428 *Nature* 910 [Foote et al 2004]; Holt, MM et al, "Speaking up: Killer whales (*Orcinus orca*) increase their call amplitude in response to vessel noise" (2009) 125:1 *Journal of the Acoustical Society of America* EL27 [Holt et al 2009]; Holt, MM; DP Noren & CK Emmons, "Effects of noise levels and call types on the source levels of killer whale calls" (2011) 130:5 *Journal of the Acoustical Society of America* 3100 [Holt et al 2011].
[89] Pynn 11 Oct 2017, *supra* note 49; Tollit, D; R Joy & J Wood, "Estimating the effects of noise from commercial vessels and whale watch boats on Southern Resident Killer Whales" (2017) prepared for Vancouver Fraser Port Authority ECHO Program [Tollit et al 2017].
[90] Foote et al 2004, *supra* note 89; Holt et al 2009, *supra* note 89; Holt et al 2011, *supra* note 89.
[91] Clark Report 2015, *supra* note 88.
[92] Clark Report 2015, *supra* note 88 at 8.
[93] DFO Review of Recovery Actions, *supra* note 16 at 51.
[94] Recovery Strategy, *supra* note 5 at 33.

consistent with a vessel strike.[95] DFO has identified ship strikes in critical habitat as a "new threat".[96]

ii. Increasing noise and disturbance in critical habitat

Southern Resident critical habitat is subject to significant vessel noise. It carries a high ecological cost, and Southern Resident cannot tolerate additional noise.[97] Present acoustic conditions are not sustainable.

One large ship transits the area on average every hour of every day; at the busiest times there are three transits per hour.[98] Commercial shipping is the largest source of noise, but smaller vessels make a substantial contribution in certain sub-areas.[99] Due to underwater noise from vessels, Southern Residents can lose 62% of their opportunities to communicate out to a distance of 8km in portions of their critical habitat under typical conditions, and 97% during periods of high traffic.[100]

The situation is poised to worsen with increasing traffic due to regional port expansion and approval of projects with shipping components. For example, the National Energy Board found in its review of the Trans Mountain Expansion Project oil export pipeline proposal that the "the increase in vessels associated with the Project would further contribute to cumulative effects that are already jeopardizing the recovery of the Southern resident killer whale."[101] The Port of Vancouver anticipates that container traffic on the west coast (the vast majority of which is through Vancouver) will nearly double from 2015 levels by 2035, and the Port of Vancouver's Container Capacity Improvement Program aims to increase capacity at the two container terminals within its jurisdiction and build a third.[102]

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[95] CBC News 22 Dec 2016, *supra* note 33; DFO Review of Recovery Actions, *supra* note 16 at 58; Bolton, Jennie, "Persistent organic pollutant and lipid analyses of blubber from a Southern Resident killer whale (*Orcinus orca*)" (2013) Northwest Fisheries Science Center to Brent Norberg, online: <http://www.westcoast.fisheries.noaa.gov/publications/protected_species/marine_mammals/killer_whales/recovery/dl112_nwfsc_pops_rpt_final_11-21-2013.pdf> [Bolton 2013].

[96] DFO Review of Recovery Actions, *supra* note 16 at 47.

[97] Clark Report 2015, *supra* note 88 at 9.

[98] DFO Review of Recovery Actions, *supra* note 16 at 35 citing Erbe, C; A MacGillivray & R Williams, "Mapping cumulative noise from shipping to inform marine spatial planning" (2012) 132:5 *Journal of the Acoustical Society of America* EL423, online: < https://doi.org/10.1121/1.4758779> [Erbe et al 2012]; Williams et al 2014, *supra* note 23.

[99] DFO Review of Recovery Actions, *supra* note 16 at 35; MacGillivray, A et al, "Regional ocean noise contributors analysis" (2016) tech rep by JASCO Applied Sciences for Vancouver Fraser Port Authority ECHO Program [MacGillivray et al].

[100] Williams et al 2014, *supra* note 23; Erbe et al 2012, *supra* note 99.

[101] National Energy Board, "Trans Mountain Expansion Project: May 2016", *National Energy Board Report OH-001-2014* (Calgary: National Energy Board, 2014) at 350 [National Energy Board Report].

[102] Port of Vancouver, "Container Capacity Improvement Program", online :<https://www.portvancouver.com/development-and-permits/development/container-capacity-improvement-program/?doing_wp_cron=1515630488.6720960140228271484375> [Container Capacity].

Southern Resident killer whales have a high likelihood of being in the presence of vessels. They are within 400m of a vessel most of the time during daylight hours from May to September.[103] Vessels are present approximately 78% of the time that the Southern Residents forage and feed.[104] Commercial whale watching vessels in the Salish Sea outnumber the Southern Residents[105], and are joined by privately owned kayaks, sailboats and powerboats. During the summer months, the Southern Residents are almost continuously watched and followed by commercial whale watching vessels or other small vessels during daylight hours while in the Canadian portion of critical habitat.[106] They are followed by an average of 14-28 vessels, with peak numbers exceeding 70.[107] In addition, more than 55,000 boat trips are now made annually by recreational fishers pursuing Chinook and other salmon in core Southern Resident feeding areas within existing and proposed critical habitat.[108]

As acknowledged by DFO, no mitigation actions have been implemented to address the threat of physical and acoustic disturbance from vessel traffic in identified or proposed critical habitat.[109] Action is urgently needed to address this significant and growing threat.

c. Contamination

As stated in the Recovery Strategy and Action Plan, toxic contamination of the marine environment and therefore the marine food chain is having detrimental effects on the Southern Residents and has been identified as one of the key threats to their recovery. Indeed, the fact that the whales carry heavy contaminant loads in the bodies is a factor that increases their risk from nutritional stress – when the whales are unable to obtain enough food, they metabolize the chemical pollutants stored in their blubber, further weakening their resilience.

While it is critically important that measures are implemented to eliminate contaminants and sources of contamination in critical habitat the actions necessary to achieve those goals must be part of a longer term pollution reduction strategy. It is imperative that the work on mitigating contaminants in the Southern Residents' critical habitat begins immediately so that actions can be initiated within the next year and continue into the long term. The exclusion of short term actions to address contaminants in this Petition should not diminish the importance of DFO moving forward with plans to address this threat, nor be interpreted to suggest that this threat is less important to the survival of the Southern Residents than acoustic and physical disturbance or prey availability.

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[103]Lusseau et al 2009, *supra* note 51.
[104] Lacy et al 2017, *supra* note 4.
[105] DFO Review of Recovery Actions, *supra* note 16 at 36: As of 2016 there are 100 commercial whale watching vessels.
[106] Recovery Strategy, *supra* note 5 at 26.
[107] Ashe et al 2010, *supra* note 76; Seely, E, "Final 2016 Soundwatch Program Annual Contract Report" (2016) prepared for NOAA [Soundwatch 2016].
[108] Based on sport fishery data provided by DFO, 2017.
[109] DFO Review of Recovery Actions, *supra* note 16 at 39.

Because research indicates that there are situations where Southern Residents may experience adverse health effects from exposure to exhaust gases from whale watching vessels, the measures suggested in this Petition to address physical and acoustic disturbance from vessels may have the additional benefit of reducing these adverse health effects.[110]

IV Southern Resident Survival and recovery require urgent action to address these threats

At the recent Southern Resident Killer Whale Symposium, Dr. John Ford spoke to the need for urgent action if the whales are to recover, stating that "There is hope they can come back, but it's going to take some very serious actions to be implemented very quickly."[111]

Dr. Lance Barrett-Lennard spoke to the availability of actions that can be taken and the need to do so without further delay: "There are some short-term things that can be done — they're practical, well-supported and cautionary [...] We'd better stop talking about them and start doing them."[112]

Independent and government scientists have concluded that Southern Residents face extinction risks as high as 25%-49% within 100 years under scenarios where threats remain unabated.[113]

The most recently published population viability analysis for Southern Residents shows that, under status quo or worsening conditions, the Southern Residents will at best fail to recover, and at worst decline and become extinct.[114] They have "no scope to withstand additional pressures" – which pressures are, as explained above, expected to materialize. By contrast, if acoustic and physical disturbance were reduced in concert with improved Chinook abundance, a 50% reduction in vessel noise and disturbance coupled with a 15% increase in coast-wide Chinook abundance could reverse the population's negative growth rate and enable the population to achieve a 2.3% annual growth rate. Thus, the population viability analysis concludes that increasing the Southern Residents' numbers will likely require both increasing in the number of Chinook and addressing other threats, including noise and disturbance.

[110] Lachmuth, CL et al, "Estimation of southern resident killer whale exposure to exhaust emissions from whale-watching vessels and potential adverse health effects and toxicity thresholds" (2011) 62 *Marine Pollution Bulletin* 792 [Lachmuth et al 2011].
[111] Pynn, 12 Oct 2017, *supra* note 1.
[112] *Ibid*.
[113] Vélez-Espino et al 2014, *supra* note 65; Lacy et al 2017, *supra* note 4.
[114] Lacy et al 2017, *supra* note 4.

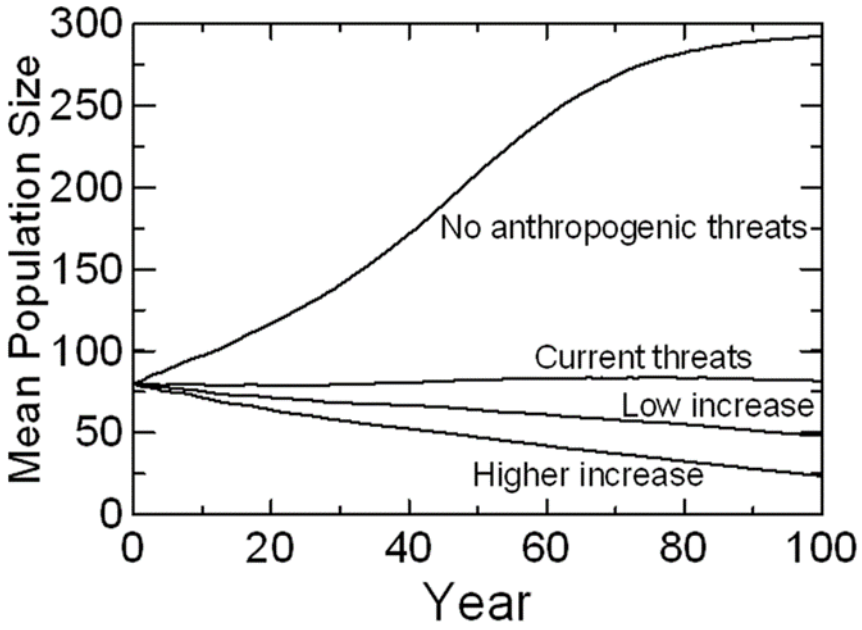

Figure 3. Mean projected Southern Resident population sizes for scenarios examined in population viability assessment from top to bottom: (1) reduced anthropogenic noise and contaminants, and an assumption that Chinook are not declining; (2) current Chinook abundance, noise, and PCBS; (3) reduced Chinook, increased noise, and additional threats of oil spills and ship strikes as estimated for low level impacts of industrial development; and (4) increased threats with higher level impacts of development. (Lacy et al. 2017.)

DFO has acknowledged that the Southern Resident population is in a decline[115] and the Minister of Fisheries and Oceans has committed to act to recover the population, including by recently pledging "to do whatever it takes with whoever it takes" to prevent extinction.[116] Further, DFO has identified the need to prioritize recovery measures in the immediate future to provide access to Chinook both by reducing competition from fisheries and reducing physical and acoustic disturbance.[117]

The Southern Residents are among the world's best-studied marine mammals; they have been closely monitored, including through an annual census, since 1976. The threats they face are well-documented, including in DFO documents, and widely agreed upon. Remaining gaps in knowledge are inevitable; that is the nature of science. It cannot be prudent or precautionary to

[115] Fisheries and Oceans Canada, 2017, *Evaluation of the Scientific Evidence to Inform the Probability of Effectiveness of Mitigation Measures in Reducing Shipping-Related Noise Levels Received by Southern Resident Killer Whales*, DFO Can Sci Advis Sec Sci Advis, Rep 2017/041 [DFO Evaluation 2017].
[116] Pynn 11 Oct 2017, *supra* note 49.
[117] DFO Review of Recovery Actions, *supra* note 16 at 59.

wait to act in such a time-sensitive situation, with imminent threats to survival and recovery clearly identified. The problems are adequately understood. Action is needed now in the form of immediate, tangible measures. Uncertainty as to the efficacy of any given measure can be resolved through monitoring of measures once implemented, and outcomes can be improved iteratively through an adaptive management approach.[118]

1. An emergency order is appropriate and required in these circumstances

The competent Ministers must recommend that the Governor in Council make an emergency order to provide for the protection of the Southern Residents if they are of the opinion that the Southern Residents face imminent threats to their survival and recovery.

The Petitioners submit that the only reasonable conclusion to be drawn from the above facts is that the Southern Residents face imminent threats to their survival or recovery, such that the requirements of s. 80(2) are met and you must recommend an emergency order.

SARA expressly recognizes the Southern Residents' intrinsic value along with their aesthetic, cultural, spiritual, recreational, educational, historical, economic, ecological and scientific value.[119]

SARA is intended to prevent extinction of wildlife species and provide for their recovery. The purposes of SARA as set out in s. 6 is as follows:

> The purposes of this Act are to prevent wildlife species from being extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity and to manage species of special concern to prevent them from becoming endangered or threatened.

SARA is also intended to implement Canada's commitment to the world to conserve biological diversity and do its part to halt the trend towards species extinction.[120]

SARA includes many tools to protect and recover species including the power to issue an emergency order for the protection of a listed wildlife species, including emergency orders.

Section 80(1) provides that "The Governor in Council may, on the recommendation of the competent minister, make an emergency order to provide for the protection of a listed wildlife species." Section 80(2) provides that "The competent minister must make the recommendation if he or she is of the opinion that the species faces imminent threats to its survival or recovery."

Section 80(4) sets out what an emergency order may include:

> The emergency order may
> (a) in the case of an aquatic species,
> (i) identify habitat that is necessary for the survival or recovery of the species in the area to which the emergency order relates, and

[118] DFO Evaluation 2017, *supra* note 116].
[119] SARA, *supra* note 36, preamble.
[120] *Ibid*; *Environmental Defence Canada v Canada (Fisheries and Oceans)*, 2009 FC 878 [*Environmental Defence*] at para 38.

(ii) include provisions requiring the doing of things that protect the species and that habitat and provisions prohibition activities that may adversely affect the species and that habitat.

As stated in s. 80(2), you "must" recommend an emergency order if you are of the opinion that the Southern Residents face imminent threats to their survival or recovery. The phrase "of the opinion" does not confer discretion on the competent Ministers to decline to make such a recommendation in a case where the Ministers are, or reasonably should be, of the opinion that the species faces imminent threats to its survival or recovery.

Your decision must be made in light of the purposes of SARA: to prevent species from becoming extinct and to provide for their recovery.

The Federal Court has confirmed, based on the plain meaning of SARA, its preamble, and its legislative history, that "subsection 80(2) is triggered by threats to recovery or survival, or both", and that "imminent threats need not be guaranteed to materialize".[121]

The terms "survival" and "recovery" are not defined it SARA itself. However, the proposed government policy on survival and recovery is relevant to the Ministers' task in advising on emergency orders.[122]

The proposed policy states that "[t]he competent minister(s) will consider that a species at risk has an acceptable chance for **survival** in Canada" when it surpasses each of a set of criteria referred to as the "survival threshold", including the following criteria relevant to the Southern Residents:

- Stable or increasing over a biologically relevant timeframe; and
- Resilient: sufficiently large to recover from periodic disturbance and avoid demographic and genetic collapse; and [...]
- Protected from anthropogenic threats: non-natural significant threats are mitigated.[123]

The proposed policy also provides a succinct definition of "survival": "The achievement of a stable (or increasing) state where a species exists in the wild in Canada and is not at significant risk of extirpation or extinction as a direct or indirect result of human activity."[124]

The proposed policy identifies a "minimum recovery threshold" as follows:

- The criteria for survival are met and/or exceeded; and

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[121] *Adam v Canada (Environment)*, 2011 FC 962 at paras 38-39.
[122] Fisheries and Oceans Canada, 2016, *Policy on Survival and Recovery [Proposed]*, *Species at Risk Act* Policies and Guidelines Series, Ottawa, online: <http://www.sararegistry.gc.ca/virtual_sara/files/policies/Survival%5Fand%5FRecovery%5FEN1%2Epdf at 4 [DFO Policy on Survival and Recovery 2016].
[123] *Ibid* at 2.
[124] *Ibid* at 8.

- There is representation addressing the historical Canadian distribution of the species, endeavouring to capture the full range of its ecological and generic diversity; and
- The condition of the species is improved over when it was first assessed as at risk [...]; and
- Once achieved, perpetuation of the recovered state is not reliant on significant, direct and ongoing intervention to maintain populations.[125]

Further, with respect to the meanings of "survival" and "recovery", the Federal Court has held that:

> [...] it is important not to confuse the "survival" of a species with its "recovery", as they are two separate concepts. The concept of "recovery" goes well beyond that of the "survival" of a species. Although there is no statutory definition of the term "recovery", Environment Canada adopted a definition in the amended *Recovery Strategy for the Roseate Tern (Sterna dougallii)*, which indicates that "recovery is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed and threats are removed or reduced to improve that likelihood of the species' persistence in the wild". Under that definition, the recovery of a species therefore includes a halt to or reversal of the decline of its population.[126]

The Federal Court has relied on this definition, which it also summarizes as "halting or reversing the decline of a species."[127]

Finally, SARA and Federal Court jurisprudence require a precautionary approach.

The Preamble to SARA states that:

> [...] the Government of Canada is committed to conserving biological diversity and to the principle that, if there are threats of serious or irreversible damage to a wildlife species, cost-effective measures to prevent the reduction or loss of the species should not be postponed for lack of full scientific certainty.

This is in keeping with the Supreme Court's articulation of the precautionary principle: "Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation."[128]

The purpose of the precautionary principle is to ensure that a lack of full scientific certainty will not bar necessary action if there is a risk of serious or irreversible damage to a species. The provisions of SARA, including s. 80, must be interpreted accordingly. The Federal Court has held that the precautionary principle applies to determinations made under SARA, including

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[125] *Ibid* at 3.
[126] *Centre Québécois du droit et de l'environnement v Canada (Environment)*, 2015 FC 773 [*Centre Québécois*] at para 23.
[127] *Ibid* at para 80.
[128] *114957 Canada Ltée (Spray-Tech, Société d'arrosage) v Hudson (Ville)*, 2001 SCC 40 at para 31.

under s. 80(2).[129] It has further held, in the context of s. 80(2), that "inaction is not permitted due to a lack of full scientific certainty".[130]

To the extent that there is a lack of full scientific uncertainty with respect to any of the specific measures sought in this petition, a lack of full certainty as to the best or most effective specific measures, or as to the details of those measures, is not a reason to postpone action – and there is no uncertainty as to the need for action. You must act according to the best available science at this time. Any uncertainty should be addressed not by refusing to make an emergency order but rather by making an emergency order containing provisions that are informed by the best available science, and amending those provisions as necessary, guided by monitoring of their effectiveness as well as any relevant developments in the science.

a. Existing protection is in adequate to ensure survival and recovery

As stated above, the Southern Residents are listed as endangered under Schedule I of SARA. Additionally, their identified critical habitat is protected from destruction by s. 58(1) of SARA, through the operation of the *Critical Habitats of the Northeast Pacific Northern and Southern Resident Populations of the Killer Whale (Orcinus orca) Order*, SOR/2009-68. DFO has prepared a Recovery Strategy (2011) and Action Plan (2017) for the species. Notwithstanding these protective provisions under SARA and the existence of the Recovery Strategy and Action Plan, the Southern Residents still face imminent threats to their survival and recovery.

An emergency order must be recommended where there is an imminent threat to survival and recovery; it is not based on the presence or absence of other protective measures. The Federal Court has held that "tangible measures to assist the recovery of the species" are required, not merely an intention to implement recovery plans in future years.[131]

No measures have yet been taken that will actually reduce threats to the Southern Residents. DFO's 2017 review of the effectiveness of recovery actions for Southern Residents reveals that, of the measures identified in the Action Plan, only research-based, information-gathering, and monitoring measures are underway.[132] Amendments to the Marine Mammal Regulations to minimize or eliminate acoustic and physical disturbance have been promised since at least March 2012[133], and DFO's 2017 review of recovery actions states that they have been drafted; however, they have yet to materialize.[134] DFO itself is unable to report on the status of Action Plan measures related to commercial or recreational whale watching and related enforcement, including: incorporating content from whale experts into SARA enforcement training, considering a license program for commercial whale watching, and promoting responsible advertising demonstrating appropriate practices.[135]

[129] *Centre Québécois*, *supra* note 127 at para 76.
[130] *Adam v Canada (Environment)*, 2011 FC 962 [*Adam*] at para 38.
[131] *Centre Québécois*, *supra* note 127 at para 81.
[132] DFO Review of Recovery Actions, *supra* note 16.
[133] Regulatory Impact Analysis Statement, (2012) C Gaz I:146, No 12 (March 24, 2012).
[134] DFO Review of Recovery Actions, *supra* note 16 at 12.
[135] DFO Review of Recovery Actions, *supra* note 16 at 17-18.

Despite the existing legal protection and recovery documents, no measures have been taken to reduce threats to the Southern Residents. The population continues to decline and is in a state of emergency. Urgent action is needed to reverse the decline of this already small population.

b. The recommended actions below are consistent with the Recovery Strategy and Action Plan

The goal of the Recovery Strategy is to "[e]nsure the long-term viability of resident killer whale populations by achieving and maintaining demographic conditions that preserve their reproductive potential, genetic variation, and cultural continuity."[136]

The Recovery Strategy identifies four objectives to achieve its goal:

1) to ensure an adequate and accessible food supply to allow recovery;
2) to ensure that pollutants do not prevent recovery;
3) to ensure that disturbance from human activity does not prevent recovery; and
4) to protect critical habitat and identify additional areas for critical habitat designation and protection.[137]

The Federal Court has held that recovery objectives identified in a Recovery Strategy "are relevant factors that should be considered by the Ministers in reaching an opinion under subsection 80(2)."[138]

DFO has identified measures to achieve the Recovery Strategy's goal and recovery objectives, and action on these measures is needed now.

Strategies identified in the Recovery Strategy to achieve the first objective (food supply) include "Protect the access of resident killer whales to important feeding areas" and "Ensure that resident killer whale populations and their (the prey's) habitat are adequately protected from anthropogenic factors such as exploitation and degradation [...]."[139] Examples given of performance measures include "Guidelines for human activities in important whale feeding areas" and "Incorporation of killer whale predation into fisheries management plans".[140]

Strategies to achieve the third objective (disturbance) include "Develop and implement regulations, guidelines, sanctuaries and other measures to reduce or eliminate physical and acoustic disturbance or resident killer whales."[141] Examples of performance measures include "Revised whale watching guidelines, and/or regulations that reflect most recent understanding of

[136] Recovery Strategy, *supra* note 5 at vi, 47.
[137] Recovery Strategy, *supra* note 5 at vi, 48-51.
[138] *Adam, supra* note 131 at para. 42.
[139] Recovery Strategy, *supra* note 5 at 49.
[140] Recovery Strategy, *supra* note 5 at 53.
[141] Recovery Strategy, *supra* note 5 at 50.

effects of chronic physical disturbance" and "Establishment of acoustic sanctuaries in critical habitat areas".[142]

Strategies to achieve the fourth objective (critical habitat) include "Protect the access of resident killer whales to their critical habitat", "Protect critical habitat areas through assessment and mitigation of human activities that result in contamination, and physical disturbance" and "Ensure the sufficient prey is available to killer whales in their critical habitat."[143] Examples of performance measures include "Sanctuaries within critical habitat established".[144]

The Recovery Strategy does not identify a numerical target for the population, and states that this will be revisited in five years from the date of publication (2011) when the recovery Strategy is re-evaluated.[145] This has not been done. The Recovery Strategy identifies demographic conditions to be used as "Interim Measures of Recovery Success", including an increasing population size.[146]

Similarly to the Recovery Strategy, with respect to prey availability, the Action Plan states that DFO will:

- "Take into account both the seasonal (acute) as well as the cumulative (chronic) effects of poor returns for Chinook and other important prey species on Resident Killer Whales when managing fisheries."
- "Investigate the benefits of strategic salmon fishery planning approaches and management actions to reduce Resident Killer Whale prey competition in specific feeding areas (e.g. modeling, retention limits, fishery area boundary adjustments or closures), and implement where appropriate."[147]

With respect to physical and acoustic disturbance, the Action Plan states that DFO will:

- "Investigate the benefits of management actions (e.g. protected areas, fishery area boundary adjustments or closures) to protect important foraging and beach rubbing locations such as Robson Bight and other identified areas, and implement where appropriate."
- "Prioritize on-water enforcement efforts for compliance with legal protections for Resident Killer Whales and their habitat."

With respect to identification of additional critical habitat, the Action Plan states that DFO will:

[142] Recovery Strategy, *supra* note 5 at 53.
[143] Recovery Strategy, *supra* note 5 at 51.
[144] Recovery Strategy, *supra* note 5 at 54.
[145] Recovery Strategy, *supra* note 5 at 47.
[146] Recovery Strategy, *supra* note 5 at 47.
[147] Final Action Plan, *supra* note 5 at 5.

- "Analyse new acoustic and sightings data to identify additional areas of habitat necessary for the survival and recovery of Resident Killer Whales."[148]

The measures the Petitioners recommend below are consistent with these objectives and strategies. Furthermore, they echo the priority actions identified in DFO's 2017 review of the effectiveness of recovery actions for Southern Residents.[149]

Given the lack of progress on these measures to date, an emergency order is needed, and can be understood as a tool to implement these, and other, urgently needed measures.

c. The competent Ministers are legally obligated to recommend an emergency order

The Petitioners submit that you must recommend to the Governor in Council that it make an emergency order for the protection of the Southern Residents, consistent with your statutory duty under s. 80 of SARA.

The Petitioners submit that the only reasonable opinion you can form in this case is that the Southern Residents face imminent threats to their survival and recovery. In this case, there is clear and indisputable evidence of imminent threats to the survival of the Southern Residents, which has been assessed and evaluated through peer-reviewed scientific studies. This evidence shows that the Southern Residents face imminent threats to their survival and recovery. Furthermore, the state of Fraser Chinook and plans for major expansion of commercial shipping, as described above, indicate that, without intervention, the threats to survival and recovery will continue to increase, further reducing their chances of survival and recovery. Therefore, you have a mandatory duty under s. 80(2) to recommend that the Governor in Council make an emergency order to protect the Southern Residents as soon as possible.

Given the imminent threat to the Southern Residents' survival and recovery, refusal to recommend that the Governor in Council make an emergency order would be unlawful, unreasonable, and inconsistent with SARA, its stated purpose, s. 80 and the intent of Parliament in enacting s. 80, and the precautionary principle.

V Actions requested

The Petitioners require that you recommend an emergency order under s. 80(2) of SARA (discussed in detail below) to protect the Southern Residents and the habitat necessary for their survival and recovery. If the Southern Residents are to survive and recover, the emergency order must include some or all of following measures, under s. 80(4)(a).

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[148] Final Action Plan, *supra* note 5 at 6-7.

[149] Fisheries and Oceans Canada, 2017, *Southern Resident Killer Whale: A science-based review of recovery actions for three at-risk whale populations – Summary Report*, Ottawa, online: <http://www.dfo-mpo.gc.ca/species-especes/documents/whalereview-revuebaleine/summary-resume/killerwhale-epaulard/Southern-Resident-Killer-Whale-summary.pdf>.

These measures are broadly supported by the Recovery Strategy and Action Plan, as described above, and by the January 26, 2018 opinion of Dr. Lance Barrett-Lennard (Appendix A).

1. Designation of additional areas of Critical Habitat

The emergency order should identify habitat that is necessary for survival and recovery but is not yet designated as critical habitat. Areas designated as critical habitat under SARA receive important legal protections, particularly through the prohibition on destruction of any part of the habitat.[150]

DFO has identified an area of special importance to Southern Residents and recommended it for designation and protection as additional critical habitat in a recent CSAS report.[151] For ease of reference this area is identified in the map at Figure 4. The emergency order should identify this area off southwestern Vancouver Island, which includes Swiftsure Bank, as critical habitat.[152]

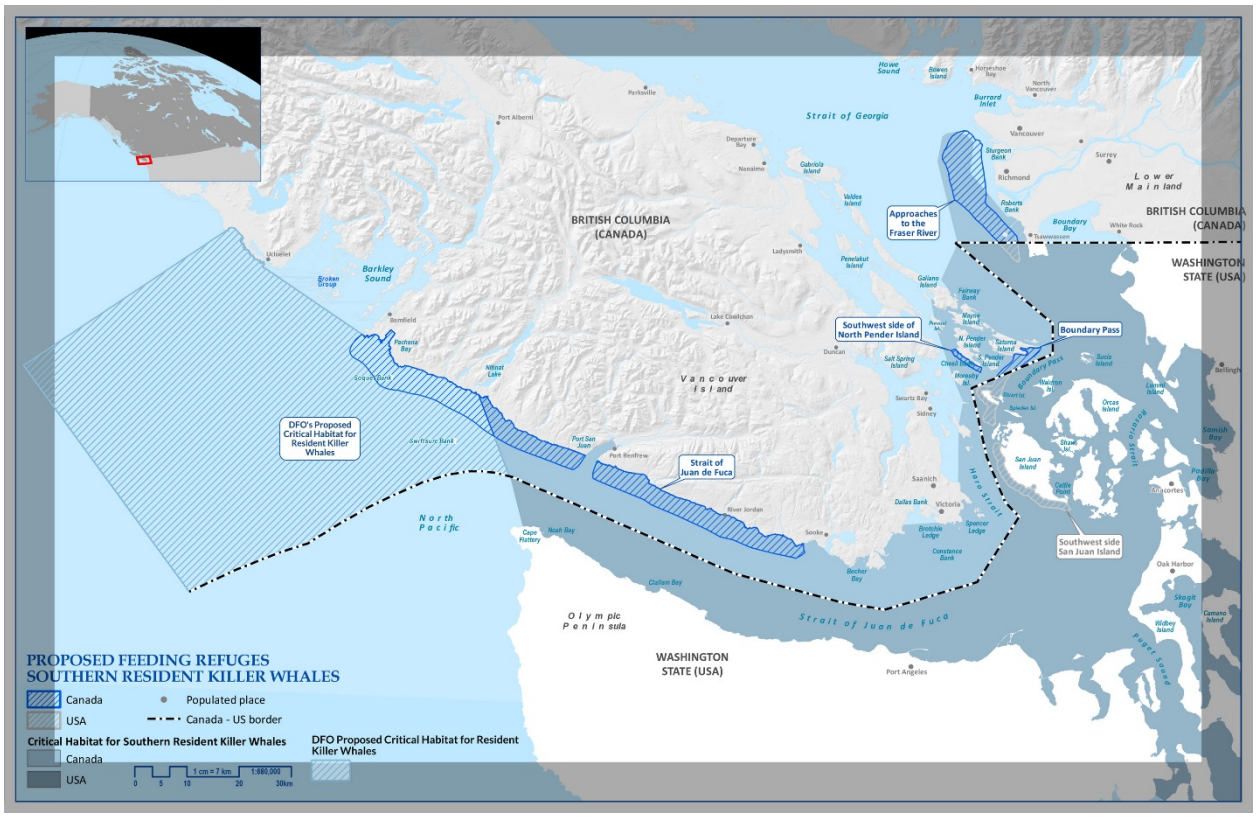

Figure 4. Proposed resident killer whale critical habitat, as identified by DFO.[153] (See Appendix B for enlarged map.)

[150] SARA, *supra* note 36, s. 58(1).
[151] Habitats of Special Importance 2017, *supra* note 41; DFO Review of Recovery Actions, *supra* note 16 at 12.
[152] Habitats of Special Importance 2017, *supra* note 41.
[153] Habitats of Special Importance 2017, *supra* note 41.

Swiftsure Bank, based on DFO and NOAA data, is an area of year-round importance for the Southern Residents, with notably high occurrence and habitat usage indicative of foraging during the winter months, probably due to the presence of feeder Chinook salmon.[154] The CSAS report concludes that Swiftsure Bank constitutes "important habitat for both [Southern Resident killer whales] and [Northern Resident killer whales] throughout most of the year."[155]

DFO has not only identified this area but stated that "[d]esignation and enforcement of this additional area should be implemented as soon as possible."[156] The emergency order should therefore identify it as critical habitat.

Consistent with DFO's statement, the Petitioners further suggest that DFO consider, in advance of the 2019 fishing season, whether any parts of this new area of critical habitat – beyond those portions already included in the core feeding area along the Southwest tip of Vancouver Island described below – should be seasonally or permanently closed to recreational and commercial fisheries and whale watching. The Petitioners note that there is an existing fin fish closure for part of this area, which may in part address concerns about competition and disturbance from salmon fishing.

2. Measures to ensure prey availability

As stated above, to date few or no direct fisheries management decisions have been taken to ensure prey availability for Southern Residents. Immediate fisheries management actions are needed to reduce the marine catch of Chinook, thereby increasing Chinook salmon abundance for Southern Residents. Changes in DFO's approach to Chinook management are needed to rebuild salmon runs, but rebuilding runs can take many years, as Chinook require four to five years to mature, and it may take several generations to rebuild salmon runs. The Southern Residents cannot wait years for habitat restoration and rebuilding plans to be successfully implemented. The Petitioners' recommended approach will provide a short-term improvement in Chinook abundance.

The measures proposed are intended to push the whales towards recovery and avoid further decline. Partial implementation – of only some of these refuges, or for a period of less than five years – would fail to adequately provide the immediate protection Southern Residents require and lack the rigour necessary to monitor whether they result in key performance metrics of recovery (e.g., body condition).

a. Measures to address direct disturbance and competition from commercial and recreational fishers

[154] Habitats of Special Importance 2017, *supra* note 41.
[155] Habitats of Special Importance 2017, *supra* note 41.
[156] DFO Review of Recovery Actions, *supra* note 16 at 59.

i. Establish protected Southern Resident feeding refuges in priority feeding areas (Figure 5) to enable Southern Residents to forage without competition, interference, noise or disturbance from recreational and commercial salmon fishing, between May 1 – November 30.

This measure is intended to prevent adverse impacts from salmon fishing within core Southern Resident feeding areas. These proposed Southern Resident feeding refuges lie within habitat identified as Southern Resident critical habitat under SARA or proposed as resident killer whale critical habitat by DFO. These areas include the Southwestern shoreline of Vancouver Island through Juan de Fuca, extending westward to Pachena Bay; Boundary Pass to southwest North Pender Island and to East Point on Saturna Island; and approaches to the Fraser River (Figure 5). (In the U.S., key foraging areas established for Southern Residents reflect the work of Ashe et al. (2010), who identified priority feeding areas near southwest San Juan Island, Salmon Bank and Stewart Island, and suggested consideration of a whale protection zone within these feeding areas near southwest San Juan Island.)

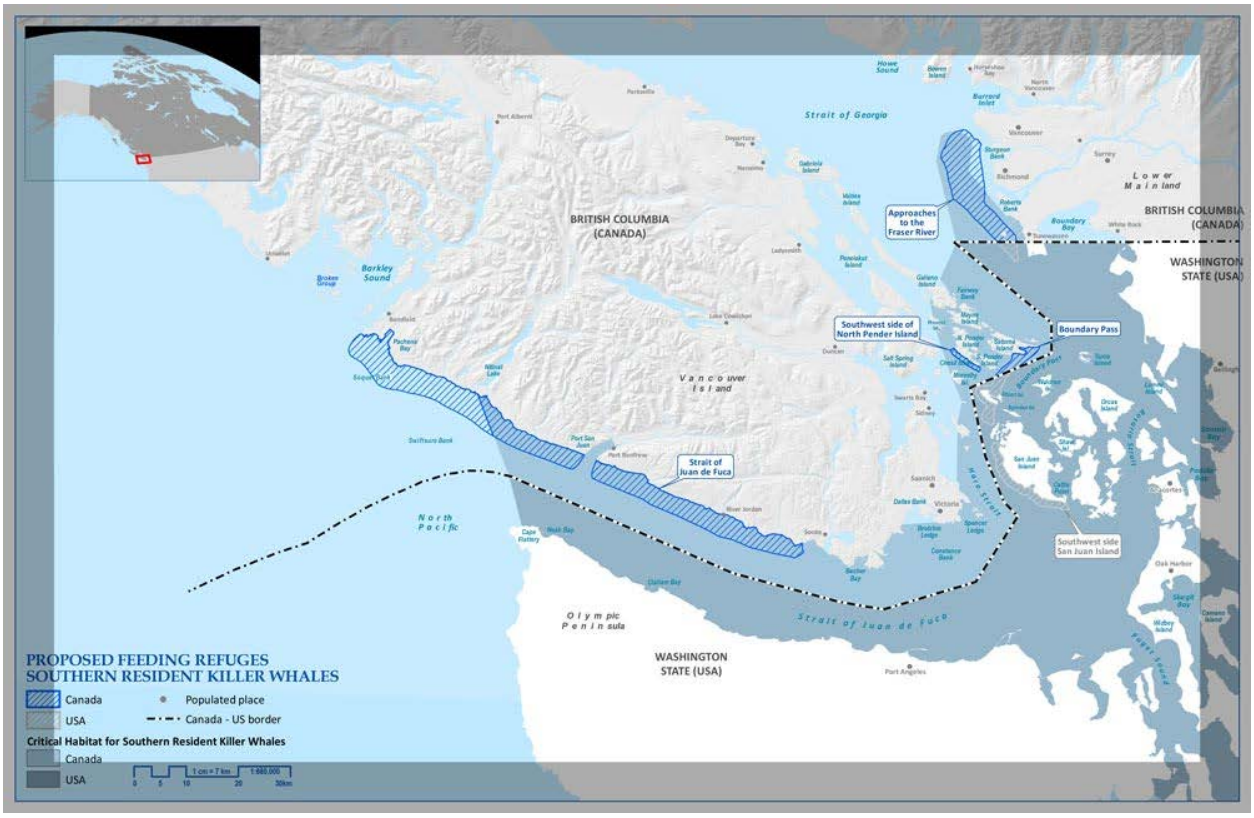

Figure 5. Proposed Southern Resident feeding refuges. Feeding refuges are recommended to enable Southern Residents to forage without competition, noise and disturbance from recreational fishing and whale watching activities between May 1-November 30. Feeding refuges in Canada should include the Southwestern shore of Vancouver Island, Boundary Pass to East Point on Saturna Island, southwest side of North Pender Island, and approaches to the Fraser River. (See Appendix C for enlarged map.)

DFO's science-based review identified the high priority need to establish greater access for Southern Residents to Chinook salmon within key foraging habitats.[157] It identified measures for greater access to prey through reduced competition from fishers, and reductions in physical and acoustic disturbance from vessels. The review states that areas should be identified and protected for periods of time to provide improved access to Chinook salmon by Southern Residents.

DFO may deem it preferable to extend the restrictions in the refuges to prohibit not only salmon fishing but all hook and line fisheries, in order to support enforcement and to increase confidence that disturbance is adequately reduced.

Southern Residents occur within the Salish Sea year-round, but more frequently between the late spring to fall when they target Chinook salmon migrating as spring, summer and fall aggregates to the Fraser River, Georgia Strait, Puget Sound, and other Salish Sea rivers.[158]

This measure should apply until there is evidence that it is not needed, i.e. until the health of Southern Residents (as determined by photogrammetry, pregnancies, hormones, vital rates or other proxies) indicates a high likelihood that Southern Residents are recovering. To determine whether this criterion is met, a reviews of this management initiative should be conducted every five years.

At a Southern Resident prey workshop organized by DFO in 2017, scientists suggested there were likely "thresholds" of Chinook abundance that would promote Southern Resident recovery. It was suggested that tools such as photogrammetry, pregnancies, vital rates or other measures of Southern Resident health could be employed as proxies to determine whether Southern Residents are recovering. Additional research and science based management advice are required to identify and calibrate such proxies and indices, and assess the effectiveness of foraging area closures, and incorporate these findings into recovery measures. Because Southern Resident recovery is expected to take longer than one generation (25 years), reviews of the recommended management measures are unlikely to confirm the likelihood of recovery if conducted more frequently than once every five years. These periodic reviews can also be used to assess the efficacy of the specific feeding refuge locations and adapt them if necessary.

[157] DFO Review of Recovery Actions, *supra* note 16.
[158] Ford, JKB et al, "Dietary specialization in two sympatric populations of killer whales (*Orcinus orca*) in coastal British Columbia and adjacent waters" (1998) 76 *Canadian Journal of Zoology* 1456; Fisheries and Oceans Canada, 2005, Ford, JKB & GM Ellis, *Prey selection and food sharing by fish-eating 'resident' killer whales (Orcinus orca) in British Columbia*, DFO Can Sci Advis Sec, Res Doc 2005/041, online: <http://www.dfo-mpo.gc.ca/csas-sccs/publications/resdocs-docrech/2005/2005_041-eng.htm>; Ford et al 2010, *supra* note 50; Ford et al 2009, *supra* note 50; Hanson et al 2010, *supra* note 57; Habitats of Special Importance 2017, supra note 41.

b. Measures to increase Chinook in critical habitat

i. Implement commercial and recreational fishing restrictions to increase the terminal abundance of Chinook in habitats identified as critical to Southern Residents and in other important Southern Resident feeding areas, and of other Chinook populations known to be important in the diets of Southern Residents.

This measure will reduce or eliminate recreational and commercial fisheries that are inconsistent with recovering the Southern Residents and rebuilding depleted Chinook populations. These initiatives should be implemented within the Integrated Fisheries Management Plan (IFMP), and allowances for Southern Resident recovery should be made within the Chinook Chapter of the new Pacific Salmon Treaty. However, if Canada is unable to achieve improvements in the Pacific Salmon Treaty that benefit Southern Resident recovery; Canada must be accountable for all the required restrictions.

DFO's review of recovery actions identified measures that increase prey availability as being of paramount importance.[159] Both government and independent scientists have modeled scenarios showing that fisheries closures that increase salmon abundance could benefit Southern Residents. Management of marine fisheries to maximize terminal Chinook Recruitment (to Rmax) is expected to reduce nutritional stress, improve birth rates, improve survival and reduce mortality for Southern Residents.

Velez-Espino et al. modelled several scenarios in a document commissioned for the Pacific Salmon Commission and subsequent published paper, where various fishery closures could improve vital rates of Southern Residents.[160] Fishery restrictions that achieved improvements to survival and fecundity included no marine harvest on various combinations of Puget Sound, Fraser Early, and Fraser Late; and 51% harvest reduction on the five large stocks (West Coast of Vancouver Island, Columbia Upriver Brights, Fraser Late, Oregon Coastal, and Puget Sound). The most powerful scenario - a 51% reduction in marine harvest on the five large stocks- significantly improved female survival and fecundity, reversing the population's modelled decline of 0.09 % annually to achieve positive growth rates and significantly lower the likelihood of extinction.

Lacy et al. further showed that a modeled 30% increase in the coast-wide Chinook abundance above the 1979-2008 average could increase Southern Resident growth rate by as much as 1.9%.[161] This growth rate provides a high probability that the currently impaired population could survive at larger and more viable numbers into the future. Achieving this level of increased abundance in the short term, and initiating recovery by harvest restrictions alone, may be difficult. When noise and disturbance are addressed in concert with Chinook abundance,

[159] DFO Review of Recovery Actions, *supra* note 16.
[160] Vélez-Espino et al 2013, *supra* note 17; Vélez-Espino et al 2014, *supra* note 65.
[161] Lacy et al 2017, *supra* note 4.

population viability modelling shows that a 15% increase in the coast wide abundance coupled with a 50% reduction in vessel noise and disturbance, can meet the US recovery target of 2.3% annual growth (based on Southern Resident demographics to 2014).

Therefore, Canada should inform the US in the Pacific Salmon Treaty re-negotiations that all fisheries from SE Alaska through Southern BC must accommodate the rebuilding of Fraser River and Southern BC Chinook populations to meet their escapement objectives in two generations.

In addition, we urge the federal government to direct DFO to work NOAA to establish a Salish Sea terminal abundance target that maximizes recruitment of Fraser River, Georgia Strait and Puget Sound Chinook populations to the Salish Sea. This will also increase Chinook abundance in the approaches to the Juan de Fuca, improving availability to Southern Residents in habitats beyond those identified as critical.

Ultimately, the 2018 domestic fishing plan must recognize and incorporate Canada's international commitments. If Canada does not achieve its rebuilding requirements under the new Pacific Salmon Treaty, it must "backfill" domestically, bearing all of the necessary fishery reductions itself. This may require closing all commercial and recreational Chinook directed fisheries until there is evidence that Chinook rebuilding, Southern Resident recovery, and Aboriginal rights under s. 35(1) of the Constitution Act are likely to be achieved.

Chinook must be managed in this way until the health of Southern Residents (as determined by photogrammetry, pregnancies, hormones, vital rates or other proxies) indicates a high likelihood that Southern Residents are recovering. To determine whether this criterion is met, a review of this management initiative should be conducted every five years.

As described above, there are likely "thresholds" of Chinook abundance that will promote Southern Resident recovery, and proxies are available to measure Southern Residents' health. Reviews of measures taken that are more frequent than every five years are unlikely to confirm the likelihood of recovery.

c. Measures to rebuild Chinook populations

i. DFO must implement rebuilding plans for weak Chinook conservation units (CUs) – i.e. ones below their spawner maximum sustainable yield[162] – with the objective of maximizing Chinook recruitment to terminal areas and spawning grounds within two generations.

The current approach of managing Chinook based on zones is not working; it has failed to recover any early-timed Fraser Chinook, and it assumes fishing of Chinook at any abundance

[162] Spawner MSY refers to the number of salmon that must reach their spawning grounds to correspond with the Maximum Sustained Yield.

level. Management zones for Fraser spring and summer stream-type Chinook should be replaced with rebuilding objectives that maximize terminal recruitment.[163]

Ongoing fishing on less productive Chinook populations is contributing to their failure to rebuild. DFO must move to an approach of maximizing recruitment and rebuilding objectives. Management of marine Chinook fisheries with the objective of maximizing terminal recruitment (Rmax) would increase spawner abundance in accordance with rebuilding objectives, addressing constitutionally protected Aboriginal access to Chinook, and increasing terminal abundance of Chinook for Southern Residents.

Rebuilding plans must be implemented that accommodate conservation, Southern Residents, and s. 35(1) constitutional Aboriginal rights before potential commercial and recreational harvest opportunities are allocated. Rebuilding plans would establish recovery-based escapement objectives from which harvest control rules can be developed.

Such a move would demonstrate that the management priority for these populations is minimizing direct or indirect impacts, rebuilding Chinook at the CU level, and addressing recovery objectives for Southern Residents.

Incorporating Fishery Related Incidental Mortality (FRIM) is critical in determining total fishery impacts on weak populations. Expansion of Chinook non-retention fisheries obligates DFO to incorporate its own science and policy advice when producing defensible estimates of total mortalities in Chinook retention and non-retention fisheries.

With respect to the duration of these measures, DFO should manage Chinook in accordance with the recommended fishing restrictions until relationships between Chinook indices (forecasts, preseason, in-season) and indicators of Southern Resident health (photogrammetry, pregnancies, hormones, vital rates or other proxies) are determined, and can be incorporated into management decisions.

3. Measures to avoid physical and acoustic disturbance

Emergency action is needed to reduce disturbance of Southern Residents and their critical habitat from vessel traffic and other human activity. As stated above at section III.3.b of this petition, physical and acoustic disturbance in the Southern Residents' identified and proposed critical habitat are significantly impeding the whales' ability to forage and are degrading the acoustic quality of critical habitat. Urgent action must be taken to address this recognized threat to the whales' survival and recovery. This will require collaboration between DFO and Transport Canada.

The following recommendations propose actions for specific categories of vessels to address the diverse ways in which disturbance is occurring. These measures are actionable, necessary, consistent with best available science, and in furtherance of the objectives set forth in DFO's

[163] Also known as Rmax.

Recovery Strategy and Action Plan. They are also consistent with options identified in DFO's 2017 evaluation of mitigation measures to reduce shipping-related noise for Southern Residents.[164]

a. Measures to reduce noise and disturbance from recreational and commercial whale watching vessels

The measures in section 1(a)-(d) are intended to apply to commercial and recreational whale watching vessels. Measure 1(e) applies only to commercial whale watching vessels.

i. Prohibit commercial and recreational whale watching on Southern Resident killer whales in feeding refuges at relevant times of year.

Time-area management, when properly designed, is one of the most effective available means of reducing the effects of human disturbance on marine animals.[165] As described separately above in the measures addressing prey availability, the emergency order should, on a seasonal basis, exclude recreational and commercial salmon fishing in Southern Resident feeding refuges, as identified on the map at Figure 5. Similarly, the emergency order should prohibit all commercial and recreational whale watching on Southern Residents within the same areas and during these same periods.

As with the area restrictions on fishing vessels set forth above, the area restrictions on whale watching should apply from May 1 through November 30. This time corresponds to the historic inshore presence of Southern Resident killer whales.[166] Alternatively, the emergency order, for greater precision, can define the start of the season each year based on whale presence, using reported sightings to the British Columbia Cetacean Sighting Network, Orca Network and the Centre for Whale Research as well as the real-time passive acoustic networks established in the region or its own systems, since the Southern Residents sometimes arrive well after May 1.[167]

For enforcement purposes, the emergency order should either prohibit whale watching on all populations of killer whales within these important feeding refuges or bar the misidentification of Southern Residents as an affirmative defence to an alleged violation of the feeding refuge exclusion.

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[164] DFO Evaluation 2017, *supra* note 116.

[165] *See, e.g.*, L.T. Hatch, C.M. Wahle, J. Gedamke, J. Harrison, B. Laws, S.E. Moore, J.H. Stadler, and S.M. van Parijs, Can you hear me here? Managing acoustic habitat in U.S. waters, *Endangered Species Research* 30: 171-186 (2016); Memorandum from Dr. Jane Lubchenco, NOAA Administrator, to Ms. Nancy Sutley, CEQ Chair (Jan. 19, 2010).

[166] Recovery Strategy, *supra* note 5 at 4-5, 37.

[167] For example, the Salish Sea Hydrophone Network produces publicly accessible data in real time from installations in Neah Bay, and in waters off Port Townsend and San Juan Island. *See* OrcaSound, "The Salish Sea Hydrophone Network," available at listen.orcasound.net/ListenLiveHere.aspx (accessed Jan. 23, 2018). Ocean Networks Canada and other institutions produce publicly available acoustic data from hydrophones located on the Canadian side of the Salish Sea. *See, e.g.*, Ocean Networks Canada, "Oceans 2.0," available at dmas.uvic.ca (accessed Jan. 23, 2018).

Prohibiting whale watching of killer whales in feeding refuges is necessary to supplement DFO's intended adoption of a 200-metre stand-off distance for whale watching and other vessels (described further below). While a 200-metre stand-off can reduce physical disturbance, it is well established in the literature that vessels at least as far as 400m can mask the echolocation signals essential to killer whale foraging, and can cause behavioural changes that result in diminished foraging activity for resident killer whales.[168] As has frequently been noted, repeated disturbance or curtailment of foraging activity, particularly to the extent experienced by the Southern Residents during the summer months, may have significant impacts on vital rates over time.[169]

Finally, as stated above, it may prove necessary to extend the whale watching exclusion to all, or portions, of the proposed critical habitat area at Figure 4, beyond the limited portions of that area currently included in the feeding refuge along the southwest coast of Vancouver Island. The emergency order should direct DFO to consider, within the next 18 months, whether feeding refuge exclusions should be extended to additional portions of the proposed critical habitat area.

i. Establish a 200m stand-off distance and speed restrictions for commercial and recreational whale-watching vessels in proximity to Southern Residents, outside the key foraging areas.

In October, following DFO's symposium on the Southern Residents, Minister LeBlanc announced that DFO would adopt regulations by spring 2018 that prohibit vessels from approaching within 200 metres of the whales.[170] Regulation of marine mammal approach distance has been proposed by DFO since at least 2012, and this measure is urgently needed to protect whales from physical disturbance. Thus, an emergency order must require DFO to:

a) Ensure that the 200-metre stand-off regulation applies, inter alia, to commercial and recreational whale watching vessels, with the exception of those taking actions necessary to avoid an imminent and serious threat to a person, vessel, or the environment.

Additionally, DFO must implement rules to mitigate vessel behaviours, and particularly vessel speed, that appear to have limited the effectiveness of the analogous U.S. approach-distance regulations.[171] Houghton et al demonstrated that, for vessels within 1 km of the Southern Residents, speed is the main factor driving sound pressure levels received by the whales,

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[168] *E.g.*, USA, NMFS, Holt MM, "Sound exposure and southern resident killer whales (*Orcinus orca*): A review of current knowledge and data gaps" (2008) NOAA Tech Memo, NMFS-NWFSC-89; Lusseau et al 2009, *supra* note 51; Noren et al 2009, *supra* note 51. *See also* Williams et al 2006, *supra* note 82.

[169] USA, NMFS, Ferrara, GA, TM Mongillo, & LM Barre, "Reducing disturbance to southern resident killer whales: Assessing the effectiveness of the 2011 federal regulations in advancing recovery goals" (2017) NOAA Tech Memo, NMFS-OPR-58 [Ferrera et al 2017].

[170] Canadian Press, "Feds ask boater to stay 200 metres from B.C.'s southern resident orcas," *CBC News* (26 October 2017), online: <http://www.cbc.ca/news/canada/british-columbia/feds-ask-boaters-to-stay-200-metres-from-b-c-s-southern-resident-orcas-1.4374269> (accessed Jan. 24, 2018).

[171] 50 Code of Federal Regulations § 224.103(e) (2010) ("Protective regulations for killer whales in Washington").

accounting for more than 40% of the observed variance in received levels.[172] In addition to some whale watching vessels continuing to travel at high speeds, including the "very fast" speeds defined by Houghton as 7 knots or greater, the fact that vessels leave their engines running to move out of the path of oncoming whales may account for the limitations in noise-reduction benefits that NOAA has observed since its distance regulations were adopted in 2011.[173] To address these issues, the emergency order must:

b) Prohibit travelling at excessive speeds by establishing a speed restriction of 6 knots maximum for commercial and recreational whale watching vessels within 1 km of Southern Resident killer whales, with the exception of those taking actions necessary to avoid an imminent and serious threat to a person, vessel, or the environment;

c) Issue direction for such vessels within 1 km of the whales to maximize the time that they remain stationary, with engines off; and

d) Require such vessels, when consistent with navigational safety, to shut off sonars and other underwater transducers within 1 km of the whales.

ii. Require evaluation and implementation, as appropriate, of measures to limit vessel-time spent in proximity to Southern Resident killer whales.

Other jurisdictions, such as Queensland, Australia[174], Mexico[175] and New Zealand[176], control the amount of vessel-time spent on target populations in various ways, including by limiting the times of day in which whale watching is allowed, restricting the amount of time that any individual vessel may remain in proximity to a whale or limiting the number of vessels that may be proximate to whales at one time. The emergency order should require that DFO, within one year of issuance, evaluate measures to control the amount of vessel-time spent by commercial and recreational boats in proximity to Southern Residents and, as appropriate, require their implementation.

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[172] Houghton, J et al, "The Relationship between Vessel Traffic and Noise Levels Received by Killer Whales (*Orcinus orca*)" (December 2, 2015) 10:12 *PLoS ONE* e0140119, online: <https://doi.org/10.1371/journal.pone.0140119>. On average, received levels rose about 7 decibels as mean vessel speeds increased from stationary to 6 knots.

[173] *See* Holt et al 2017, *supra* note 51 (noting significant reduction in time vessels remained stationary after adoption of regulation as possible factor).

[174] Queensland, Australia limits the number of whale watch boats that may be in proximity of whales to 3 at a time: *Nature Conservation (Wildlife Management) Regulation 2006* (Qld).

[175] Mexico regulates the total time that whale watching vessels may remain in proximity to Grey whales in Baja to 30 minutes: NORMA Oficial Mexicana, *Que establece lineamientos y especificaciones para el desarrollo de actividades de observación de ballenas, relativas a su protección y la conservación de su hábita*, NOM-131-SEMARNAT-2010 [Mexican Whale Watching Regulation]; see also: <http://rabenmexico.org/wp-content/uploads/2014/02/Reglamento-2013.pdf>.

[176] In New Zealand, in addition to speed and distance regulations the government imposes limits on the time that whale watching vessels may spend in proximity to dolphins through its permitting scheme: *Marine Mammals Protection Regulations 1992* (NZ), 1992/322 [New Zealand Marine Mammal Regulations].

iii. Use Minister of Fisheries and Oceans' power under s. 85 of SARA to designate enforcement officers to patrol Southern Resident critical habitat and other key foraging areas.

The success of the preceding measures depends greatly on effective enforcement. According to data compiled by Soundwatch, an independent U.S. boater education program, the presence of an official patrol vessel significantly influences private boater behavior. According to their data, non-compliance recorded during Washington Department of Fish and Wildlife presence amounted to only ~10-30% of the total incidence of non-compliance with NOAA's vessel approach regulations each year.[177] These data strongly suggest the need to maintain patrol boat presence in the vicinity of the whales.

Under SARA, enforcement officers can come from within the ranks of DFO or from outside. Subsection 85(1) provides the Minister with broad discretion to designate "any person" as an enforcement officer. DFO can reduce demand on its own enforcement staff by designating an existing non-governmental organization or community group to monitor whales and educate the public. Notably, subsection 85(4) of SARA allows the Minister to tailor the powers of a designated enforcement officer in any context. Thus it would be possible to focus the powers of a non-government partner on powers needed to effectively observe, record, and report non-compliance with the emergency order provisions and the existing prohibitions in SARA, without necessarily conveying authority to issue citations. Where relying on existing enforcement staff or working with non-government partners, the government must ensure that resources and funding are provided, sufficient to support daily monitoring throughout the full whale watching season.

iv. Establish a licencing system for commercial whale-watch operators that view Southern Resident killer whales in Canadian waters.

Licencing systems are an important tool in whale watching management, reporting, and enforcement, and are used in other jurisdictions, such as New Zealand[178], Australia[179] and Mexico[180], particularly in marine protected areas and where target species are depleted or endangered. DFO already uses a permitting system to manage whale watching in the Bay of Fundy and the Saguenay. In the present case, the emergency order should establish a licensing requirement for commercial whale watching vessels, with conditions that include, at minimum, carrying an active transponder, reporting on-whale time to DFO on a periodic basis, and complying with the applicable operational measures established in the emergency order. Failure to observe these conditions should result in withdrawal of the licence.

It is possible that the proceeds of a licencing scheme could be used to support the cost of additional monitoring and enforcement effort described above in 1(d).

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[177] Ferrara et al 2017, *supra* note 168. Private boaters exhibited higher rates of non-compliance with NOAA's vessel approach regulations than did commercial whale-watch operators: Soundwatch 2016, *supra* note 108.

[178] New Zealand Marine Mammal regulations, *supra* note 175, section 5, see also Parts 1 and 2.

[179] https://www.ehp.qld.gov.au/licences-permits/plants-animals/commercial-use-animals/whale_watching.html

[180] Mexican Whale Watching Regulation, *supra* note 174. See also: <http://rabenmexico.org/wp-content/uploads/2014/02/Reglamento-2013.pdf>.

b. Operational measures to reduce noise and disturbance from commercial vessels transiting key Southern Resident foraging areas

The Minister of Fisheries is primarily responsible under SARA for protecting Southern Residents. The Petitioners recognize that Transport Canada is generally responsible for regulating commercial vessel traffic under the Shipping Act. Thus, collaboration between DFO and Transport Canada on these measures will be important. However, the Governor in Council has broad authority under s. 80 of SARA to include any provision requiring the "doing of things" necessary to protect Southern Residents, including measures applicable to vessel traffic.

i. Introduce seasonal speed controls for commercial vessels transiting Haro Strait and waters adjacent to the key Southern Resident foraging areas in Juan de Fuca Strait.

Results from the 2017 speed reduction trial in Haro Strait indicate a net reduction in received sound pressure levels within high-value habitat for Southern Residents. Within the compulsory pilotage area,[181] the emergency order should establish a speed control zone within Haro Strait for commercial vessels (as described below), applying the same boundaries used during the 2017 trial and restricting vessels to a speed no greater than the 11 knot limit used during the trial. For most vessels, as the speed trial has shown, this measure can be imposed without incurring the fees of an additional pilot.

Additionally, the emergency order should establish speed controls for Vancouver and Victoria traffic proximate to the important foraging areas identified in Juan de Fuca Strait. Because these areas occur west of the pilot station at Brotchie Ledge (see Figure 5), such speed reductions are unlikely to result in additional pilotage fees. Speed controls in Juan de Fuca Strait should be evaluated, in the manner of the 2017 speed trial, within the first 12 months of application of the emergency order and then adaptively modified as needed, given the comparatively greater distances between the outbound shipping lane and some of the nearer-shore foraging habitat in this area.

As with the seasonal whale watching closures in proposed measure 1.a.i, speed control measures should apply on a seasonal basis from May 1 through November 30, which corresponds to the historic inshore presence of Southern Resident killer whales. Alternatively, the emergency order, for greater precision, can define the start of the season each year based on whale presence, using reported whale sightings as well as the real-time passive acoustic networks established in the region or its own systems, since the Southern Residents sometimes arrive well after May 1.

The speed reductions should apply to all commercial vessels, including tankers, container ships, tugs and barges, while they are transiting the speed control zones in Haro Strait and Juan de Fuca Strait, except as is necessary for navigational safety.

[181] The "compulsory pilotage area" is an area in which vessels of a certain size are required, for navigational safety, to operate with an assigned local pilot. Some commercial vessels following the Traffic Separation Scheme do not require pilots, since pilotage requirements generally apply only to vessels over 350 registered gross tons.

In addition, the emergency order should direct DFO to consider, in consultation with Transport Canada, within the next 18 months, whether to implement a speed reduction for commercial vessels proximate to all or part of the proposed critical habitat area (Figure 4). As Swiftsure Bank supports year-round occurrence of Southern Residents, speed reduction measures in this area would need to be applied year-round.[182]

Speed restrictions can also address the risk of vessel strikes. There is a recent precedent for a speed restriction for vessels to protect an endangered whale population: a Notice to Shipping announced by DFO and Transport Canada in August 2017 to protect North Atlantic Right Whales in the Gulf of St. Lawrence from ship strikes, due to increasing evidence of mortalities from strikes.[183] The measure was taken urgently, on a precautionary basis, while DFO and Transport Canada worked to better understand the problem.[184] In this case, there is ample evidence that a speed restriction is required to reduce disturbance of Southern Residents, and it would also help address the newly recognized threat of vessel strikes.

ii. Direct lateral displacement within existing shipping lanes to reduce acoustic exposure in key foraging areas.

The emergency order should promote the lateral displacement of vessels following the Traffic Separation Scheme in Juan de Fuca, Haro, and Georgia Straits by directing vessels to travel as close to the seaward side of their established lanes, away from core feeding refuges, as consistent with navigational safety.[185] Such placement puts the vessel as far away as is safely possible from those foraging areas given the present location of shipping lanes. This form of lateral displacement is immediately actionable and costless to industry. By re-locating the noise source, the measure would moderately reduce received sound pressure levels, particularly at higher frequencies, within most of the core foraging areas adjacent to the shipping lanes.[186] To enable compliance with this measure, DFO, in collaboration with Transport Canada, should provide for education and outreach to vessels and pilot associations. Further, within eighteen months of the

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[182] Habitats of Special Importance 2017, *supra* note 41. See also the discussion of designation of additional critical habitat in section 1 above.

[183] Canadian Coast Guard Central and Arctic Region, Broadcast Notice Q1189/2017 details, GULF OF ST. LAWRENCE / Speed reduction in the gulf [sic] of St. Lawrence du [sic] to increased presence of right whales (11 Aug 2017), online: <http://www.marinfo.gc.ca/en/avisradio/detail.asp?region=Q&annee=2017&no_avis=1189>.

[184] Ministers LeBlanc and Garneau described the speed restriction as a "precautionary measure", taken as part of efforts "to do everything possible to prevent further whale deaths: Transport Canada, "Statement by Ministers Garneau and LeBlanc on actions taken to address the deaths of whales in the Gulf of St. Lawrence" (11 Aug 2017), online: <https://www.canada.ca/en/transport-canada/news/2017/08/statement_by_ministersgarneauandleblanconactionstakentoaddressth.html>. The restriction was imposed on an urgent basis, with science advice following afterwards: Fisheries and Oceans Canada, Terms of Reference: Science Advice on Timing of the Mandatory Slow-Down Zone for Shipping Traffic in the Gulf of St. Lawrence to Protect North Atlantic Right Whale, Zonal Science Response Process – Atlantic Region, (Nov 2017), online: <http://www.dfo-mpo.gc.ca/csas-sccs/Schedule-Horraire/2017/11_00-eng.html>.

[185] In proposing this measure, we are not requesting an extension of piloting requirements beyond the area of their current application.

[186] DFO Evaluation 2017, *supra* note 116.

order's issuance, DFO should evaluate the extent of compliance and consider what further steps, if any, should be taken for improvement.

iii. Quiet commercial vessels servicing local routes in Southern Resident critical habitat

The emergency order should establish requirements for quiet ship design and maintenance, focusing at minimum on vessels that contribute most significantly to underwater noise within Southern Resident critical habitat. Recent studies by JASCO and others indicate that vessels servicing local routes, including passenger ferries and tugboats, contribute significantly to noise budgets in the Salish Sea and in some areas, such as Georgia Strait and Haro Strait, are dominant contributors to underwater noise, notwithstanding the comparatively small number of vessels in their fleets.[187] As with the other measures above directed at commercial vessel traffic, DFO and Transport Canada should collaborate in the implementation and enforcement of these measures.

The emergency order should require that all Canadian companies with commercial vessels that serve local routes within Southern Resident critical habitat, including passenger, shipping, and shipping support vessels, adhere to the following measures:

a) *Incorporate underwater noise reduction as a design criteria for new builds and procurements, and for retrofits of propulsion systems or other equipment that contribute significantly to underwater noise, for all such vessels in their fleets;*[188]
b) *Measure noise levels for all such vessels in their fleets, either by using the Port of Vancouver Underwater Listening Station or by using other platforms consistent with ISO standards;*
c) *Undertake hull and propeller cleaning and maintenance during scheduled drydocks for all such vessels; and*
d) *Identify and implement quieting design solutions in the vessels with the highest relative noise output (e.g., ships falling within the loudest quartile, as determined through the noise measurement proposed at 3(b) above) within five years of issuance of the emergency order.*[189]

[187] MacGillivray et al, *supra* note 100; Bassett, C et al, "A vessel noise budget for Admiralty Inlet, Puget Sound, Washington (USA)" (2012) 132 *Journal of the Acoustical Society of America* 3706.
[188] These measures build upon the underwater noise performance indicators set forth in the Green Marine Environmental Program, a voluntary green certification program for the industry: https://www.green-marine.org/.
[189] This last provision is necessary both to promote action and to ensure that new builds and certain retrofits are not delayed. Noise reduction taken under measure (1) could be used to satisfy this provision.

DFO, in collaboration with Transport Canada, should also consider whether the same provision should also apply to foreign companies that operate such vessels, as well as companies that operate ocean-going vessels, and that fall within Canadian jurisdiction.[190]

Design and engineering solutions have been identified by many sources, including the International Maritime Organization, as an essential element in reducing underwater noise from commercial ships.[191] It has been estimated that conventional quieting measures can reduce broadband source levels in new commercial builds by 3-10 decibels, with additional reductions available through more extensive or less conventional designs.[192] Quieting solutions are also available for retrofits, with some relatively inexpensive technology, such as propeller boss cap fins, showing evidence of reduced propeller cavitation and significant noise reduction.[193]

As an additional benefit, the use of some quieting technologies can increase the fuel efficiency of ships. A recent study of Maersk container vessels demonstrated that an extensive retrofit achieved a roughly 10 percent improvement in fuel efficiency while also reducing the noise that the ships produced by 6-8 decibels (varying by frequency).[194]

c. Measures to address the cumulative impact of vessel traffic

The acoustic environment of the Salish Sea that includes the critical habitat of the Southern Residents is already highly degraded relative to pre-industrial conditions. The Recovery Strategy and Action Plan require actions to ensure that anthropogenic disturbance does not prevent the recovery of southern and northern resident populations, and call for regulations and other measures to "reduce or eliminate" their physical and acoustic disturbance.

The Scientific Committee of the International Whaling Commission has repeatedly recommended an initial global target for the reduction of shipping noise of 3 dB (decibels) within 10 years and 10 dB within 30 years, relative to current levels. The goal is to reverse the

[190] It should be noted that Transport Canada is presently developing noise management measures for commercial shipping pursuant to the Ocean Protection Plan. Apart from the emergency order, DFO should work with Transport Canada on developing measures to reduce noise from large commercial vessels that transit through the Salish Sea, most of which are foreign-owned and foreign-flagged.

[191] *E.g.*, International Maritime Organization, *Guidelines for the reduction of underwater noise from commercial shipping to address adverse impacts on marine life*, UN Doc IMO/MEPA.1/Circ.833 (2014); Southall, BL et al, "Underwater noise from large commercial ships—International collaboration for noise reduction" in J Carlton, P Jukes & CY Sang, eds, *Encyclopedia of Maritime and Offshore Engineering* (2017).

[192] Spence, JH & RW Fischer, "Requirements for reducing underwater noise from ships" (2017) 42:2 *IEEE Journal of Oceanic Engineering* 388; *see also* Leaper, R; M Renilson & C Ryan, "Reducing underwater noise from large commercial ships: Current status and future directions" (2014) 9:1 *Journal of Ocean Technology* 51 [Leaper et al 2014].

[193] *See*, *e.g.*, Leaper et al 2014, *supra*; Hemmera Envirochem, "Vessel quieting design, technology, and maintenance options for potential inclusion in EcoAction Program" (2016) prepared for Vancouver Fraser Port Authority ECHO Program.

[194] Gassmann, M et al, "Underwater noise comparison of pre- and post-retrofitted MAERSK G-class container vessels" (2017) MPL TM-616. Propeller boss cap fins were added during the retrofit, and the noise reduction was achieved despite the addition of significant container capacity.

upward trend (+3 dB/ decade) in deep-water ambient noise pollution during the second half of the 20th century, largely attributable to commercial shipping. Bioacousticians and Southern Resident experts have recommended a noise reduction target for the Salish Sea that is greater than the global target recommended by the Scientific Committee of the IWC.[195]

Immediate action is required to ensure that the acoustic environment in Southern Resident critical habitat is not degraded further, while also embarking on a reduction of noise levels. Thus, the emergency order should:

i. **Mandate that no net increase in overall noise levels shall occur relative to 2016 levels; and**

ii. **Require that DFO, in collaboration with Transport Canada, within 18 months, develop and adopt a set of noise reduction targets that are biologically relevant and meaningful to the recovery of the Southern Residents.**

VI Timing of the Ministers' recommendation

Canada is currently engaged in several domestic and international processes with tight timelines, including: renegotiation of the Pacific Salmon Treaty, the expected COSEWIC listing of several Southern BC Chinook populations, the joint Fisheries and Oceans Canada (DFO) Chinook Strategic Planning Initiative, the Wild Salmon Policy, and DFO's annual Integrated Fisheries Management Plan (IFMP) consultations. Many of the key decisions must be made, and put into action, before June 2018. The time for action is now; Canada must take the right steps over the course of the coming months to ensure the survival and recovery of the Southern Resident killer whales.

In light of the imminent threats to their survival and recovery, as well as the time limited opportunity to act to impact this year's fisheries management cycle, the Petitioners require that you recommend an emergency order to the Governor in Council under s. 80(2) no later than Thursday, March 1, 2018. In the absence of a response, the Petitioners will have to consider whether legal action is necessary to address this urgent situation.

[195] Bain, D et al, Letter from scientists to Prime Minister and Ministers re: Reducing underwater noise in the Salish Sea (12 April 2017), online: <https://www.documentcloud.org/documents/3553862-Scientists-Statement-Salish-Sea-12-April-2017x.html>.

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January 30, 2018

The Honourable Dominic LeBlanc
Minister of Fisheries and Oceans Canada

The Honourable Catherine McKenna
Minister of Environment and Climate Change
and Minister Responsible for Parks Canada

Dear Ministers LeBlanc and McKenna:

Re: Actions to address threats to Southern Resident Killer Whales

The David Suzuki Foundation, Georgia Strait Alliance, Natural Resources Defense Council, Raincoast Conservation Foundation and World Wildlife Fund Canada have requested that I provide a letter bearing on the rationale for and urgency of management actions to address threats to Southern Resident Killer Whales. I presented my opinions on this matter at the Southern Resident Killer Whale Protection Symposium in Vancouver in October 2017, at the Biennial Marine Mammal Conference in Halifax in October 2017, and at the Workshop on the Availability of Prey for Southern Resident Killer Whales at the University of British Columbia (UBC) in November 2017. These opinions are summarized below.

<u>My Experience and Expertise</u>

I am Director of the Cetacean Research Program at Ocean Wise (formerly the Vancouver Aquarium), a position I have held since 2001. I am also adjunct professor in the Department of Zoology at the University of British Columbia. Prior to my employment at Ocean Wise, I spent a year as a marine mammal research scientist at Fisheries and Oceans Canada.

With respect to Southern Resident Killer Whales in particular, I co-chaired the Resident Killer Whale Recovery Team that produced the Recovery Strategy for Southern Resident Killer Whales in 2011. More recently, I served on a panel that drafted the Resident Killer Whale Recovery Action Plan.

Throughout 28 seasons of field research I have studied the ecology and behavioural and population biology of killer whales in British Columbia and Alaska. Highlights of this research included discovering substantial differences in the echolocation behaviour of fish-eating and mammal-eating killer whales, determining that at least nine genetically-discrete but geographically-overlapping populations of killer whales inhabit the northeastern Pacific Ocean, and showing that two populations of fish-eating resident killer whales avoid inbreeding through an elaborate clan-based mating system.

My current field research on the Southern Resident Killer Whales uses drone-based aerial photogrammetry to precisely measure the length, shape and width of individually identified killer whales. Comparison of these measurements within and between seasons enables my collaborators and me to detect pregnancies, to estimate growth rates, and to compare variation in body condition with variation in prey abundance.

In addition to my research duties, I serve on several advisory panels and committees. These include the Port of Vancouver's ECHO Program Advisory Working Group (and Acoustics Technical Committee); the

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Port of Prince Rupert's Sustainability and Marine Mammal Stewardship Committees; Green Marine's Acoustics Technical Group; and Environment Canada's Species at Risk Advisory Committee. A copy of my CV is appended to this letter.

Basis for the Opinions Presented

The opinions presented here are informed by experiences and expertise gleaned throughout my career and specifically through: leading and participating in field studies of Southern, Northern and Southern Alaskan Resident Killer Whales; observations made in the course of those studies; familiarity with the scientific and conservation literature pertaining to Southern resident and other killer whale populations; active participation in scientific and recovery planning conferences, symposia and workshops; participation in recovery teams, expert advisory groups and panels; and membership in both an academic community at UBC and a broad international community of research collaborators.

Southern Resident Killer Whale Population Trends

When last seen in the late summer and fall of 2017, the Southern Residents numbered only 76 individuals, their lowest level in more than three decades. The population has previously been as low as 70 following live captures efforts from 1962-1974, when 47 were removed for display in oceanariums and aquariums. Their numbers increased from 1975 until the mid-1990s, fell for 6 years, increased slightly until 2005 and has declined since.

Following a recent "baby boom" of nine calves live born beginning in December 2014 and ending in 2016, the Southern Residents have suffered a series of setbacks. Three calves that initially survived have since died (J54 and J55 in 2016, J52 in 2017). The addition of six surviving calves to the population has been more than offset by the deaths of 11 other population members in the same period. One particularly alarming recent trend is high mortality of reproductive-aged females. Two died in 2014 (J32, carrying a near-term fetus, and L53) and two in in 2016 (J28 and J14). Reproductive-aged resident females are of course essential for population growth and generally have very low mortality rates in resident killer whales. Another concerning observation is that one of the three southern resident pods (K pod) has not produced any surviving calves since 2011.

Threats and Vital Rate Drivers

The Resident Killer Whale recovery strategy of 2011 identifies three principal threats to resident killer whales: contaminants (including oil spills), prey depletion, and anthropogenic noise and disturbance. Since the release of the Strategy, and based on several lines of evidence, most researchers believe that reduced prey availability in the summer foraging areas of Southern Resident Killer Whales, and anthropogenic noise and vessel disturbance that reduces foraging efficiency, are the most significant causal factors in the recent declines of the population and represent the greatest obstacles to the population's recovery.

The Case for Long and Short-Term Measures to Increase Prey Availability

Many factors contribute to variability in the run size of Chinook salmon stocks. Efforts to rebuild and restore diverse stocks to reduce that variability and to increase overall Chinook production have been underway for many years. Although these efforts have been primarily intended to support fisheries and conserve threatened Chinook stocks, maintaining and accelerating them provides the best hope for the

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recovery and long-term survival of Southern Resident Killer Whales. In the meantime, the small size of the Southern Resident population, its declining trend, increases in its mortality rates and declines in its fecundity rates indicate an urgent precautionary need to increase its access to salmon in the short term.

Travel Routes and Foraging Areas

Southern Resident Killer Whales tend to use consistent travel routes in the Salish Sea, and tend to expend much of their foraging effort in the same areas. These routes and foraging areas are well known to commercial whale watch operators and researchers alike. For example, Southern Residents coming into the Strait of Juan de Fuca from open water to the west in the spring or summer typically forage along the Vancouver Island shoreline as far as Sooke or Race Rocks, and then travel quickly across Haro Strait, often to the vicinity of Salmon Bank. They forage there and along the West side of San Juan Island to Turn Point and then travel across Boundary Pass to forage either along the southwest side of Pender Island in Swanson Channel or along the south side of Saturna Island. In the former case they often eventually pass through Active Pass into the Strait of Georgia, in the latter they may make their way past East Point into the Strait of Georgia. In either case, they often travel across the Strait to forage from Point Roberts to the mouth of the Fraser River. Although they may take salmon anywhere along their travel routes and may turn back the way they came at any time before they reach the Fraser, the fact that they intensify their efforts in consistent locations provides management opportunities, as discussed below. Southern Resident travel routes and specific foraging areas are less consistent and/or less well understood west of the Strait of Juan de Fuca, but Swiftsure Bank is known to be visited frequently by the population year round.

Impacts of Vessel Proximity, Noise and Fishing on Foraging Efficiency

When foraging actively, Southern Residents usually spread out individually or in small groups, swim relatively slowly and echolocate actively. When they detect Chinook salmon they dive and a chase ensues. This chase is often highly energetic and may last for several minutes. In many cases the salmon is chased to the surface, and pursued rapidly just underneath it. If the whale has to alter course during a chase to avoid a boat, the salmon may escape. Such escapes can be difficult to detect positively by a boat-based observer, but are apparent when viewed from above, as with a drone. Many studies have demonstrated that anthropogenic noise such as that generated by power vessel has a masking effect on echolocation and reduces the range over which prey can be detected. The impact of this masking effect on foraging rates is likely to be most severe when prey are sparse, making long detection ranges especially important.

Sport fishing for Chinook is popular in the Salish Sea and is often concentrated in the Southern Residents' principal foraging areas, as described above. This fishing effort has several negative consequences for Southern Residents. First, salmon fishing vessels directly compete with the whales and reduce local salmon availability. Second, whales that pursue salmon near fishing vessels will abort chases from time to time, as described above. Third, noise from the vessels' engines, and potentially their sounders as well, reduce the whales' echolocation efficiency. Finally, Southern Residents moving towards or across a foraging site often alter course to avoid passing through aggregations of fishing boats. This displacement does not always occur and may be a consequence of one or all of the first three factors, but it is nonetheless evidence of a negative interaction.

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Practical Short-Term Measures to Increase Prey Availability

In view of the foraging patterns and behaviours described above and the anthropogenic factors known or believed to affect foraging efficiency, several short-term measures are available to increase the Southern Resident Killer Whales' access to salmon, as listed below. Some of these measures are untested and the magnitude of the benefits they will achieve is uncertain. However, given that the rationale for each measure is clear and the state of the population is dire, a precautionary approach is warranted. I know that these and other measures are receiving careful consideration by your Ministries. I commend you for that but also urge you to maintain momentum on this file and move to implementation as soon as possible.

- Fishing restrictions that increase the terminal run size of select Fraser Chinook stocks should be implemented. Stocks should be selected based on their projected importance to the whales, taking into account run size, run timing and fish size/quality.
- Fishing should be restricted or closed on the Southern Residents' key foraging sites, and whale watching should be restricted in these sites as well.
- Minimum approach distances to Southern Resident killer whales should be increased to reduce noise, disturbance and interference with foraging.
- The number of boats approaching Southern Resident killer whales at any given time should be reduced, for the same reasons as above. One way that this could be accomplished in the short term is by limiting the amount of time any given vessel can spend with whales. In the longer term, licensing commercial whale watching vessels and capping their numbers would also help.

Measuring the Efficacy of Mitigation Efforts

All of the above protective measures will take significant resources to implement and enforce and some will cause hardship or lost opportunity to certain people. It therefore goes without saying that the efficacy of each protective measure should be carefully monitored and the measures should be adjusted over time as indicated. Monitoring could be done efficiently and effectively by programs such as Straitwatch and Soundwatch, both of which have well-established expertise monitoring whale watching vessels and have staff that can identify individual Southern Resident Killer Whales and accurately record their behaviours.

Finally, I would be pleased to provide further input on the opinions and observations presented here and welcome any opportunities to assist further.

Sincerely,

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EDUCATION

• B.Sc.(hon.). 1980. Biology major, mathematical science minor. University of Guelph. *(standing: distinction)*

• M.Sc. 1993. Zoology. University of British Columbia. Thesis title: Echolocation in wild killer whales (*Orcinus orca*). Supervisors: J.K.B. Ford, J.N.M. Smith.

• Ph.D. 2000. Zoology. University of British Columbia. Thesis title: Population structure and mating patterns of killer whale populations in the northeastern Pacific, as revealed by DNA analysis. Supervisors: J.K.B. Ford, J.N.M. Smith. (s*tanding: category 1*).

PRESENT POSITION

Senior Scientist & Director, Marine Mammal Research Program, Vancouver Aquarium Marine Science Centre (from Aug. 2001)

Adjunct Professor, Department of Zoology, University of British Columbia (from Jan. ’02)

PROFESSIONAL ACTIVITIES

Member and Working Group Co-Chair, Species at Risk Advisory Committee (appointed April 2017)

Chair: *Workshop on Establishing Appropriate Metrics for the Management of Underwater Noise for Southern Resident Killer Whales* (May1-3, 2017, Vancouver)

Advisor & Underwater Noise Working Group Member: ECHO Program, Port of Vancouver. (appointed 2014)

Member, Green Marine Acoustics Working Group. (appointed Jan 2015)

Member: Resident and Transient Killer Whale Recovery Action Planning Teams, Fisheries and Oceans Canada. (from 2011)

Member: Alaska Scientific Review Group, US National Marine Fisheries Service (2002-2012)

Co-Chair: Resident Killer Whale Recovery Team. (appointed Mar. 2004).

Convener: *International Symposium on Fisheries Depredation by Killer and Sperm Whales: Behavioural Insights/Behavioural Solutions.* (Oct. 2-5, 2006, Pender Island, British Columbia).

Board Member: Johnstone Strait Killer Whale Interpretive Centre Society (since 2001)

Member: South West Alaska Sea Otter Recovery Team (2005-2011)

Co-Convener*: Symposium on Identification and Conservation of Culturally Distinct Mammal Populations*. Ninth International Mammalogical Congress. (July 31-Aug. 5, 2005, Sapporo, Japan).

Co-Chair: Scientific and Technical Advisory Council on Offshore Oil and Gas. University of Northern British Columbia/ British Columbia Ministry of Energy, Mines and Resources (2003-2004)

Advisor: Vancouver Foundation, Animal Welfare Advisory Committee (2001-2010)

Co-Investigator and Project Leader: Western Alaskan Killer Whale Project. A study of ecology, genetics, and bioacoustics of killer whales in the eastern Aleutian Islands. (2001-2006).

Co-Chair: *Fourth International Orca Symposium* (Chizé, France Sept. 23-28, 2002).

Co-Chair: *International Symposium on Marine Mammal Culture* (Vancouver, Nov. 28, 2001).

EMPLOYMENT HISTORY (past 25 years)

April 2001-Aug. 2001	Research Scientist, Conservation Section, Canadian Department of Fisheries and Oceans, Pacific Biological Station.
Sept. 2000-March 2001	Population Geneticist, Species at Risk Program, Marine Mammal Section, Canadian Department of Fisheries and Oceans, Pacific Biological Station.
1992-2000	Teaching Assistant in introductory biology, population ecology, statistics, vertebrate zoology, and evolutionary genetics at the University of British Columbia.
1990-2000	Co-founder and partner: Pacific Ecological Research (consulting company, emphasis on population modeling, marine population inventories, and conservation research).
1989-1990	Research Technician, Marine Mammal Section, Pacific Biological Station, Canadian Department of Fisheries and Oceans.

RESEARCH INTERESTS

I am interested in the conservation of small populations, inter- and intra-specific variation in animal social systems, mechanisms of sympatric and parapatric speciation, and the effects of competition and predation on population structure. My research focuses on a complex of sympatric and parapatric populations of killer whales off the west coast of British Columbia and Alaska. My M.Sc. project was a comparative study of two sympatric ecotypes: a fish-eating *resident* form and a mammal eating *transient* form. I described differences in echolocation use by the two forms that reflect the avoidance responses of their prey, and I examined the effects of these differences on the maintenance of population segregation.

My Ph.D. research was a conservation-oriented study of population structure and mating systems based on DNA analysis. With the assistance of colleagues from Alaska, British Columbia, and France, I used custom-designed pneumatic darts to collect skin biopsies from 300 photo-identified killer whales. Some of my key findings based on the analysis of mitochondrial and nuclear (microsatellite) DNA are as follows: (1) residents and transient are discrete populations that are sufficiently genetically isolated to speciate sympatrically; (2) since the separation of resident and transient lineages, each has divided by fission into at least three genetically differentiated parapatric subpopulations; (3) acoustic repertoire similarity and relatedness of resident pods are strongly correlated, implying that new pods also arise by fission rather than by the coalescence of emigrants; (4) matings rarely if ever occur within resident pods, but instead occur during temporary associations between pods; (5) most matings occur between pods from different *acoustic clans* from the same subpopulation (an acoustic clan is a group of pods with similar vocal dialects); and (6) this mating pattern maintains low inbreeding levels in relation to the size of resident subpopulations.

Afer completing my PhD I conducted field work on Bigg's killer whales in the Aleutian Islands for seven years before shifting to the central and southern coastal areas of British Columbia. This change in field sites allowed me to examine relationships between ecological specialization and sympatric and parapatric population segregation in detail, and also to link a long-standing interest in ecological factors and evolutionary processes favouring population segregations of killer whales with more applied research on the conservation and recovery of those same populations. I also broadened my focus to include other marine species characterized by small or fluctuating population size and/or disjunct population distributions, including sea otters and Pacific white-side dolphins. This new research emphasizes the role of top level marine predators in shaping life history traits of their prey species.

My most recent field project is a study of changes in the body condition of resident killer whales in relation to fluctuations in the abundance of the their principal prey. For this study, body condition is inferred from aerial photographs taken with an un-manned hexacopter. My most recent laboratory study is an inter-populational comparison of genetic diversity at the MHC locus in killer whales.

SCIENTIFIC CONTRIBUTIONS

Papers (peer-reviewed)

Apprill, A., Miller, C.A., Moore, M.J., Durban, J.W., Fearnbach, H., Barrett-Lennard, L. 2017. Extensive core microbiome in drone-captured whale blow supports a framework for health monitoring. American Society for Microbiology 2(5): e0019-17.

Heise, K., Barrett-Lennard, L., Chapman, R., Dakin, T., Erbe, C., Hannay, D., Merchant, N., Pilkington, J., Thornton, S., Tollit, D. and Vagle, S., 2017. Proposed Metrics for the Management of Underwater Noise for Southern Resident Killer Whales. Coastal Ocean Report Series Volume 2017/2 (31 pp). DOI: 10.25317/CORI20172

Vergara, V. and Barrett-Lennard, L., 2017. Call Usage Learning by a Beluga (Delphinapterus leucas) in a Categorical Matching Task. International Journal of Comparative Psychology, 30:1-20.

Heise, K.A. and Barrett-Lennard, LG. 2016. New Paradigm for Underwater Noise Management in Coastal Areas: Acoustic Compensation. Proceedings of Meetings on Acoustics. 27: 032001.

Durban, J.W., Fearnbach, H., Barrett-Lennard, L.G. 2016. No Child Left Behind: Pregnancy loss in killer whales. Natural History 124 (8), 14-15

Esteban, R., Verborgh, P., Gauffier, P., Giménez, J., Martín, V., Pérez-Gil, M., Tejedor, M., Almunia, J., Jepson, P.D., García-Tíscar, S. and Barrett-Lennard, L.G., 2016. Using a multi-disciplinary approach to identify a critically endangered killer whale management unit. Ecological Indicators, 66: 291-300.

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Heise, K., Yurk, H., Nordstrom, C. and Barrett-Lennard, L., 2016. A Permanent Soundscape Monitoring System for the Care of Animals in Aquaria. *In* The Effects of Noise on Aquatic Life II (pp. 455-459). Springer New York.

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Morin, P.A., Parsons, K.M., Archer, F.I., Avila-Arcos, M.C., Barrett-Lennard, L.G., Dalla Rosa, L., Duchene, S., Durban, J.W., Ellis, G.M., Ferguson, S.H., Ford, J.K., Ford, M.J., Garilao, C., Gilbert, T.P., Kaschner, K., Matkin, C.O., Petersen, S.D., Robertson, K.M., Visser, I.N., Wade, P.R., Ho, S.Y.W., Foote, A.D. 2015. Geographic and temporal dynamics of a global radiation and diversification in the killer whale. Molecular Ecology 24:3964-3979. DOI:10.111/mec.13284

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Barrett-Lennard, L., Heise, K. 2011. Killer Whale Conservation: The perils of life at the top of the food chain. Whalewatcher (Journal of the American Cetacean Society) 40(1) 58-62.

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Guinet, C., Domenici, P., de Stephanis, R., Barrett-Lennard, L.G., Verborgh, P. 2007 Killer whale predation on bluefin tuna: exploring the hypothesis of the endurance-exhaustion technique. Marine Ecology Progress Series 147:111-119.

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Matkin, C.O., Barrett-Lennard, L.G., Ellis, G. 2002. Killer whales and predation on Steller sea lions. *In* Demaster, D., Atkinson, S. *(eds)* Steller Sea Lion Decline: Is it Food II? 61-66. University of Alaska Sea Grant College Program, Volume AK-SG-02-02.

Yurk, H., Barrett-Lennard L.G., Ford, J.K.B. and Matkin C.O. 2002. Cultural transmission within maternal lineages: Vocal clans in resident killer whales in Southern Alaska. Animal Behaviour 63:1103-1119.

Barrett-Lennard, L.G., Deecke, V.B., Ford, J.K.B., Yurk, H. 2001. A sound approach to the study of culture. Behavioural and Brain Sciences. 24:325-326.

Barrett-Lennard, L.G., Ellis, G.M. 2001. Population structure and genetic variability in northeastern Pacific killer whales: towards an assessment of population viability. Canadian Scientific Advisory Secretariat, Department of Fisheries and Oceans Document 2001/065. URL: http://www.dfo-mpo.gc.ca/csas/Csas/publications/ResDocs-DocRech/2001/2001_065_e.htm.

Guinet, C. Barrett-Lennard, L.G., Loyer, B. 2000. Coordinated attack behaviour and prey sharing by killer whales at Crozet Archipelago: strategies for feeding on negatively-buoyant prey. Marine Mammal Science 16:829-834.

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Ford, J.K.B., Ellis, G.M., Barrett-Lennard, L.G., Morton, A.B., Palm, R.S., and Balcomb, K.C. 1998. Dietary specialization in two sympatric populations of killer whales (*Orcinus orca*) in Coastal British Columbia and adjacent waters. Canadian Journal of Zoology 76:1456-1471.

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Books

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Reports

Barrett-Lennard, L.G., Heise, K.A. 2004. Influences of ecology, cultural traditions and social organization on the genetic population structure and systematics of killer whales. Invited background paper for Workshop on Shortcomings of Cetacean Taxonomy in Relation to Needs of Conservation and Management, La Jolla, Ca. Apr. 28-29, 2004. Available at *http://swfsc.nmfs.noaa.gov/CMBC_reg/Barrett-LennardHeise.pdf* and summarized in NOAA Tech. Mem. NOAA-TM-SWFSC-363. US. Department of Commerce. 39 pp. + figs.

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Barrett-Lennard, L.G., Durban, J., Fearnbach, H. 2016 Assessment of Resident Killer Whale Body Condition Using Aerial Photogrammetry and Possible Implications for Salmon Management. Salish Sea Ecosystem Conference. (Vancouver Apr. 13-15, 2016).

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Barrett-Lennard, L.G., Rechsteiner, E.U; Birdsall, C., Sandilands,D., Smith, I.U., Phillips, A.V. The Blessing and Curse of Opportunistic data: a novel method of estimating volunteer observer effort. Twentieth Biennial Conference on the Biology of Marine Mammals (Dunedin, NZ. Dec. 9-13, 2013)

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Lachmuth, C., Barrett-Lennard, L.G. Estimation of southern resident killer whale exposure to exhaust emissions from whale-watching vessels and potential adverse health effects and toxicity thresholds. Nineteenth Biennial Conference on the Biology of Marine Mammals (Tampa Nov. 27-Dec. 2, 2011)

Parsons, K. Barrett-Lennard, L.G. et al. Population structure & conservation of killer whales in the northern North Pacific. Nineteenth Biennial Conference on the Biology of Marine Mammals (Tampa Nov. 27-Dec. 2, 2011)

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Barrett-Lennard, L.G. Killer whales of the eastern north Pacific. Invited presentation. National Science Museum Symposium on Western North Pacific killer whales: Evaluation of their Status and perspectives for conservation. (Tokyo, Japan Feb. 16-17, 2006).

Barrett-Lennard, L.G., Matkin, C.O., Ellifrit, D.K. The role of transient killer whales in structuring marine mammal communities in the Aleutian Islands: insights from predation hotspots. Marine Science in Alaska Symposium (Anchorage Jan. 22-25, 2006).

Barrett-Lennard, L.G., Matkin, C.O., Ellifrit, D.K., Durban, J., Mazzuca, L. Black and white versus gray: estimating kill rates, consumption rates, and population-level impacts of transient killer whales feeding on gray whales. Sixteenth Biennial Meeting of the Society for Marine Mammalogy. (San Diego Dec. 12-16, 2005).

Durban, J., Ellifrit, D., Matkin, C.O., Barrett-Lennard, L.G. (et al.). Mammal-killer whales around SW Alaska: transient or persistent? Sixteenth Biennial Meeting of the Society for Marine Mammalogy. (San Diego Dec. 12-16, 2005).

Heise, K.A., Barrett-Lennard, L.G. Culturally significant units (CSUs) as a conservation tool for unique populations. Sixteenth Biennial Meeting of the Society for Marine Mammalogy. (San Diego. Dec. 12-16, 2005).

Krahn, M.M., Herman, D.P., (et al), Barrett-Lennard, L.G., (et al.). Feeding ecology of eastern north Pacific killer whales from fatty acid, stable isotope, and organochlorine contaminant profiles of biopsy samples. Sixteenth Biennial Meeting of the Society for Marine Mammalogy. (San Diego Dec. 12-16, 2005).

Kuker, K.J., Barrett-Lennard, L.G. Sea otter behaviour: looking for answers…did killer whales cause the western Alska sea otter decline? Sixteenth Biennial Meeting of the Society for Marine Mammalogy. (San Diego Dec. 12-16, 2005).

Barrett-Lennard, L.G. The culturally significant unit: definition, identification and conservation. Ninth International Mammalogical Congress. (Sapporo, Japan July 31-Aug 5, 2005).

Vergara, V. and Barrett-Lennard, L.G. Ontogeny of stereotyped mixed calls in a beluga (*Delphinapterus leucas*) calf. 41st Animal Behavior Society Conference. (Oaxaca, Mexico June 13-16, 2004).

Barrett-Lennard, L.G. Low mtDNA variation in social odontocetes revisited: insights from killer whale behaviour and population structure. Fifteenth Biennial Meeting of the Society for Marine Mammalogy. (Greensboro, N.C. Dec. 14-19, 2003).

Fung, C., Barrett-Lennard, L.G. Adaptive evolutionary divergence in sympatric killer whale (*Orcinus orca*) ecotypes. Fifteenth Biennial Meeting of the Society for Marine Mammalogy. (Greensboro, N.C. Dec. 14-19, 2003).

Vergara, V., Barrett-Lennard, L.G. Vocal development in a captive beluga *(Delphinapterus leucas*) calf. Fifteenth Biennial Meeting of the Society for Marine Mammalogy. (Greensboro, N.C. Dec. 14-19, 2003).

Barrett-Lennard, L.G. Natural history of killer whales. Invited presentation. Whales and Ocean Ecosystems Symposium (Santa Cruz, Ca. April 11-14, 2003).

Barrett-Lennard, L.G. Dietary specialization in killer whales in western Alaska. Marine Science in the Northeast Pacific Symposium (Anchorage, Ak. Jan. 13-17, 2003)

Barrett-Lennard, L.G. Social determinants of population structure in killer whales: insights from association patterns, genetics and acoustics. Fourth International Orca Symposium (CEBC-CNRS, Villiers en Bois, France. Sept. 23-28, 2002). *(expanded version of paper published in conference proceedings).*

Barrett-Lennard, L.G. Whale of an appetite. Invited lecture, Saving our Seas Forum, Monterey Bay Aquarium, Monterey, California (April 24, 2002).

Barrett-Lennard, L.G. Extreme population segregation in killer whales: the roles of inbreeding avoidance, song, and traditions. Invited Presentation. Sixteenth Annual Conference of the European Cetacean Society (Liège, Belgium April 7-11, 2002).

Barrett-Lennard, L.G., Ford, J.K.B., Ellis, G.M., Matkin, C.O. Mating patterns and inbreeding avoidance in non-dispersing resident killer whales. Fourteenth Biennial Meeting of the Society for Marine Mammalogy. (Vancouver Nov. 29-Dec. 3, 2001).

Ross, P.S., Ellis, G.M., Jeffries, S., Calambokidis, J., Barrett-Lennard, L.G. Pacific killer whales (*Orcinus orca*): sentinels of a contaminated planet Fourteenth Biennial Meeting of the Society for Marine Mammalogy. (Vancouver Nov. 29-Dec. 3, 2001).

Barrett-Lennard, L.G. A Propensity for Isolationism: Culture and Population Segregation in Killer Whales. International Workshop on Culture in Marine Mammals (Vancouver Nov. 28, 2001).

Yurk, H., Barrett-Lennard, L.G. and Ford J.K.B. The role of culture in long-term maintenance of kinship groups in a killer whale population. XXVII International Ethological Conference. (Tübingen, Germany Aug. 22-29, 2001)

Barrett-Lennard, L.G. Critical factors influencing the viability and recovery prospects of threatened killer whale populations. Invited seminar, Pacific Biological Station, Nanaimo, British Columbia. (May 9, 2001).

Barrett-Lennard, L.G. Population segregation, kin group fidelity, and mating patterns in northeastern Pacific killer whales. Invited seminar, University of Alaska, Anchorage. (April 10, 2001).

Barrett-Lennard, L.G. Conservation of unique sub-populations. Conservation Lunch Series Seminar, Departments of Forestry and Zoology, University of British Columbia. (Mar. 29, 2001).

Barrett-Lennard, L.G. Population segregation and mating patterns in eastern Pacific killer whales: a genetic analysis. Invited seminar, Pacific Biological Station, Nanaimo, British Columbia. (Oct. 2, 2000).

Yurk, H., Barrett-Lennard, L.G., Ford, J.K.B. The essence of killer whale societies: culturally maintained kinship groups in a hierarchically structured community. Animal Social Complexity and Intelligence Conference (Chicago Academy of Sciences). (Chicago. Aug 23-26, 2000).

Barrett-Lennard, L.G. Cultural displacement and ecological speciation in killer whales. Zoology Graduate Student Symposium, University of British Columbia. (Apr.1, 2000).

Barrett-Lennard, L.G. Ecological character displacement of foraging specializations in the killer whale: phylogeny in the making? Symposium on Marine Mammal Phylogenies (invited participant). Thirteenth Biennial Meeting of the Society for Marine Mammalogy. (Maui. Nov. 29-Dec. 3, 1999).

Ross, P.S., Ellis, G.M., Ikonomou, M.G., Barrett-Lennard, L.G., Addison, R.F. Toxic chemicals in free-ranging Pacific killer whales (*Orcinus orca*): a tale of sex, age and metabolism. Thirteenth Biennial Meeting of the Society for Marine Mammalogy. (Maui. Nov. 29-Dec. 3, 1999).

Matkin, C.O., Saulitis, E.L., Ellis, G.M, Barrett-Lennard, L.G. The AT1 group of transient killer whales in southern Alaska: a unique population in decline. Thirteenth Biennial Meeting of the Society for Marine Mammalogy. (Maui. Nov. 29-Dec. 3, 1999).

Barrett-Lennard, L.G. Population segregation, kinship, and mating patterns in British Columbian and Alaskan killer whales. Invited seminar, Biological Sciences Department. Humboldt State University. (Oct. 1, 1999).

Barrett-Lennard, L.G. Inbreeding avoidance in the absence of dispersal. Invited seminar, Zoology Department, University of Toronto. (Feb. 10, 1999).

Barrett-Lennard, L.G. Intraspecific niche partitioning and behavioural character displacement. Invited seminar, Zoology Department, University of Toronto (Feb. 8, 1999).

Barrett-Lennard, L.G. Sex, fraternization, and division of the resource pie: patterns of relatedness in killer whale populations. Biodiversity, Ecology, and Evolution Seminar Series, University of British Columbia. (Sept. 30, 1998).

Barrett-Lennard, L.G. Sympatric mammal-eating and fish-eating killer whale (*Orcinus orca*) populations: cultural differences limit or prevent gene flow. Annual Meeting of the Society for the Study of Evolution. (Vancouver June 20-24, 1998).

Jurk, H., Barrett-Lennard, L.G., Ford, J.K.B. et al. Clan structure of resident killer whales in Prince William Sound Alaska: acoustic and genetic evidence. Twelfth Biennial Conference on the Biology of Marine Mammals. (Monaco Jan. 20-24, 1998).

Barrett-Lennard, L.G. Why short term studies are a complete waste of time. Simon Fraser University / University of British Columbia Annual Ecology Retreat. (Squamish, British Columbia. Nov. 8-9, 1997).

Barrett-Lennard, L.G., Ford, J.K.B., Ellis, G.M., Matkin, C.O. Mitochondrial DNA diversity within and between three sympatric ecological forms of killer whale (*Orcinus orca*). Annual Meeting of the Society for Conservation Biology. (Victoria June 6-9, 1997).

Barrett-Lennard, L.G. The mixed blessing of echolocation: sonar and the maintenance of population segregation in killer whales. Eleventh Biennial Conference on the Biology of Marine Mammals. (Orlando Dec.14-18, 1995).

Heise, K.A., Barrett-Lennard, L.G., Saulitis, E.L. Killer whale predation and the decline of Steller sea lions in Alaska. Eleventh Biennial Conference on the Biology of Marine Mammals. (Orlando. Dec.14-18, 1995).

Barrett-Lennard, L.G., Smith, T.G., Ellis, G.M. A new cetacean biopsy sampling system. International Symposium on Marine Mammal Genetics. (La Jolla. Sept. 22-24, 1994).

Barrett-Lennard, L.G. Echolocation by fish-eating and mammal-eating killer whales. Annual Meeting of the Animal Behavior Society. (Davis 24-29 July, 1993).

GRADUATE COURSES

Graduate-level courses taken during M.Sc. and Ph.D. studies: biomathematics, field ecology, biological oceanography *(aud*.), advanced ecology, theoretical population dynamics, underwater acoustics (*directed studies*), molecular genetics, population genetics (*aud*.), conservation genetics (*aud*.). *Non-credit courses taken during graduate studies:* Instructional Skills Workshop (Sept.-Oct. 1996, Faculty Development Program, University of British Columbia; non-credit); Recent Advances in Conservation Genetics (Aug. 10-23, 1997, Conservation and Research Centre, Smithsonian Institution).

OTHER RELEVANT QUALIFICATIONS

Canadian Coast Guard Small Craft Training Certificate (2002), Transport Canada Small Vessel Operator's Proficiency Certificate (2008), Transport Canada Marine Emergency Duties A3 certification (2008).

REFERENCES

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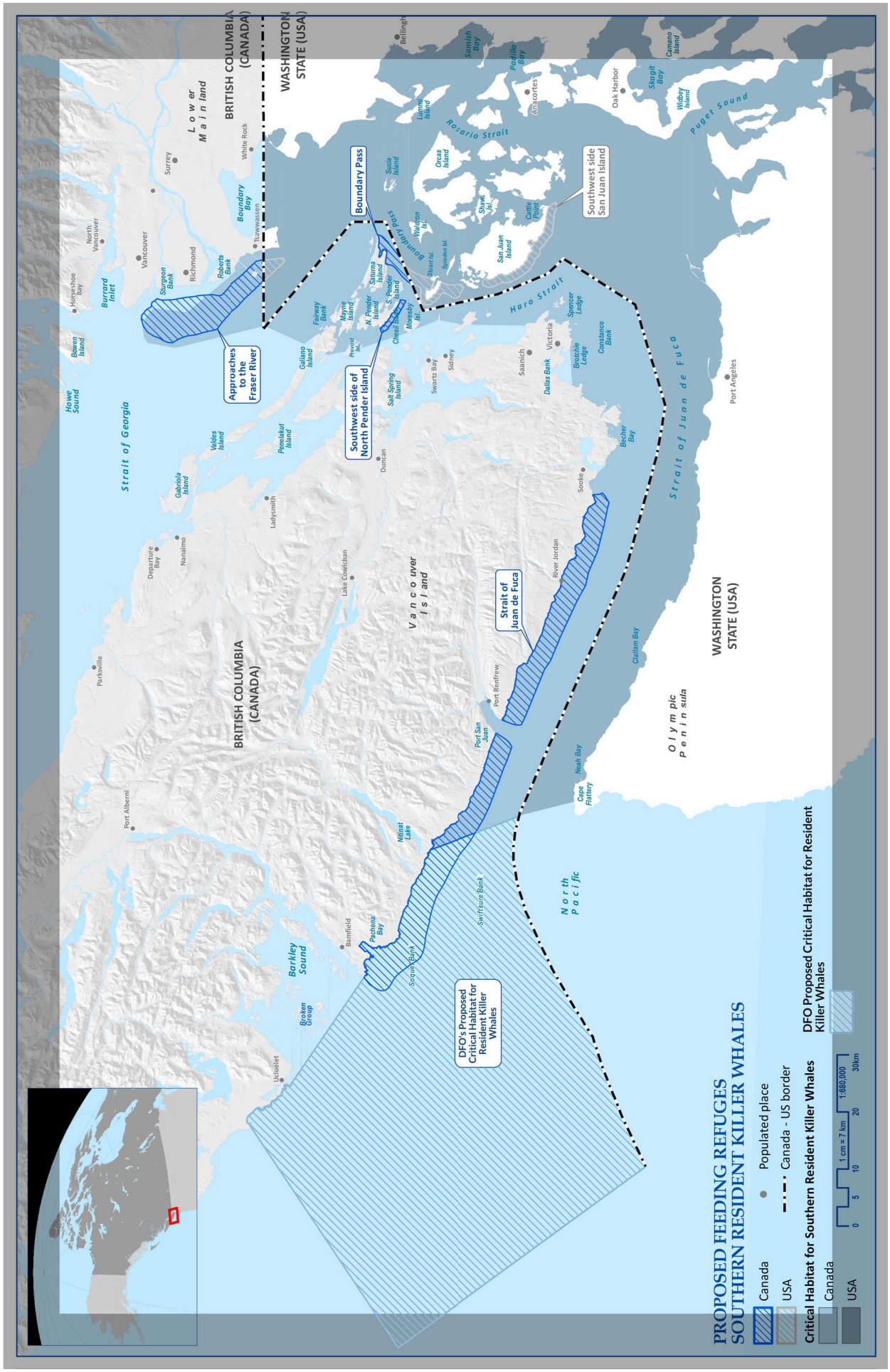
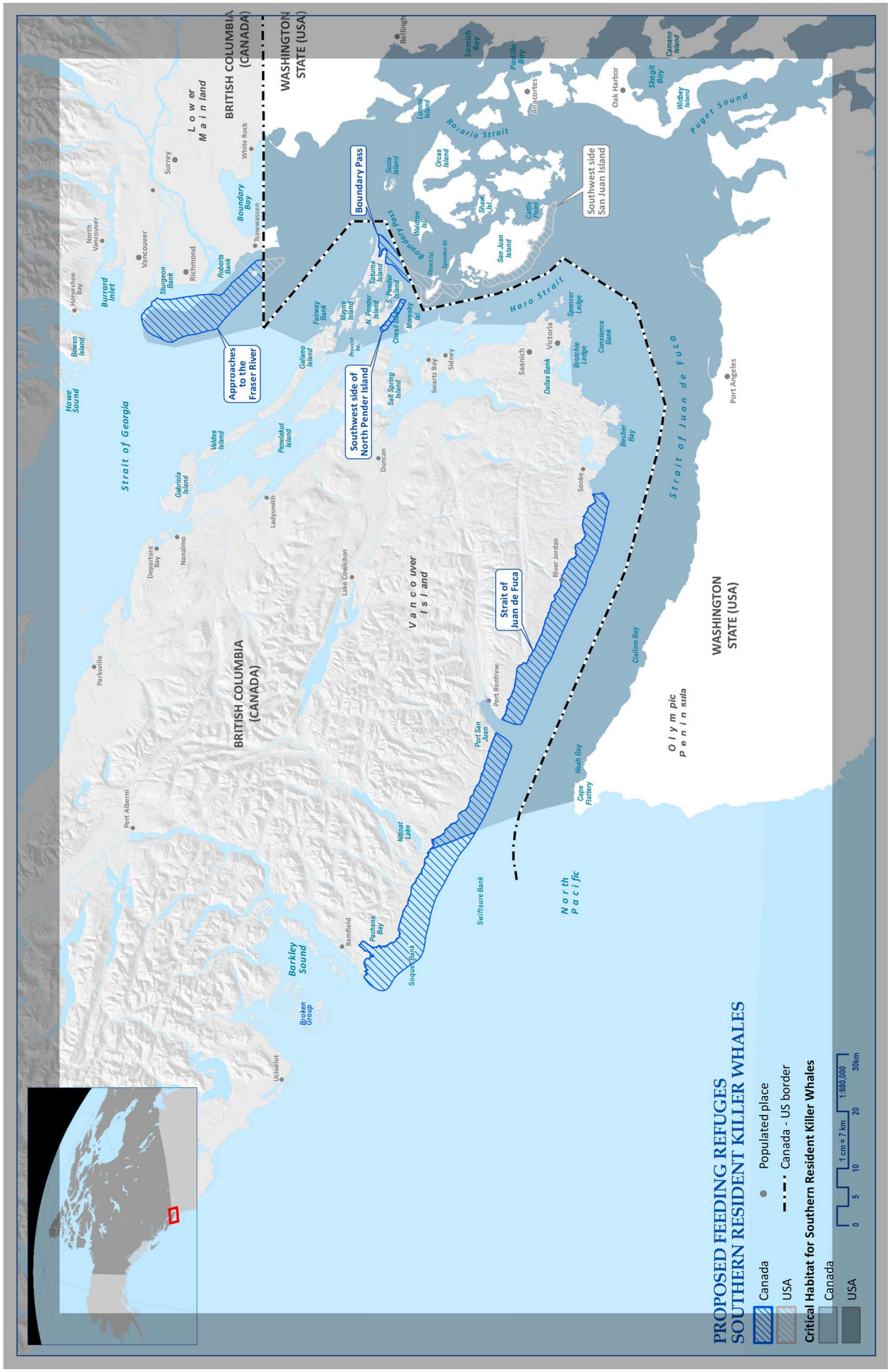
Dr. John K.B. Ford. (Marine Mammal Research Program Leader, Fisheries and Oceans Canada and Adjunct Professor, University of British Columbia). Pacific Biological Station, 3190 Hammond Bay Road, Nanaimo, BC V9R-5K6, Canada. *phone*: (250) 729-8375. *email*: FordJo@pac.dfo-mpo.gc.ca.

Dr. Andrew Day (Director, Coastal Ocean Research Institute & VP of Research, Vancouver Aquarium Marine Science Centre) Address: PO Box 3232, Vancouver, B.C., V6T 3X8, Canada. Phone (604) 659 3400. Email: Andrew.Day@vanaqua.org.

Appendix B


PROPOSED FEEDING REFUGES
SOUTHERN RESIDENT KILLER WHALES
Canada
USA
Populated place
Canada - US border
Critical Habitat for Southern Resident Killer Whales
DFO Proposed Critical Habitat for Resident Killer Whales
Canada
USA
1 cm = 7 km
1:680,000
0 5 10 20 30km
DFO's Proposed Critical Habitat for Resident Killer Whales
Approaches to the Fraser River
Southwest side of North Pender Island
Boundary Pass
Southwest side San Juan Island
Strait of Juan de Fuca
BRITISH COLUMBIA (CANADA)
WASHINGTON STATE (USA)
Strait of Georgia
Vancouver Island
Lower Mainland
Olympic Peninsula
North Pacific
Haro Strait
Rosario Strait
Puget Sound
Howe Sound
Barkley Sound
Juan de Fuca Strait

Appendix C


PROPOSED FEEDING REFUGES
SOUTHERN RESIDENT KILLER WHALES
Canada
USA
Populated place
Canada - US border
Critical Habitat for Southern Resident Killer Whales
Canada
USA
0 5 10 20 30km
1 cm = 7 km
1:680,000
BRITISH COLUMBIA (CANADA)
WASHINGTON STATE (USA)
Approaches to the Fraser River
Boundary Pass
Southwest side of North Pender Island
Strait of Juan de Fuca
Southwest side San Juan Island
Strait of Georgia
Haro Strait
Rosario Strait
Puget Sound
Boundary Pass
Swiftsure Bank
Barkley Sound
Vancouver Island
Lower Mainland
Olympic Peninsula
North Pacific
Howe Sound
Vancouver
Victoria
Nanaimo
Duncan
Sooke
Port Angeles
Port Renfrew
Port San Juan
Neah Bay
Cape Flattery
Clallam Bay
Sequim Bay
Pachena Bay
Ucluelet
Tofino
Port Alberni
Parksville
Ladysmith
Gabriola Island
Penelakut Island
Galiano Island
Saturna Island
S. Pender Island
N. Pender Island
Mayne Island
Fairway Bank
Chesil Bank
Moresby Isl.
Prevost Isl.
Salt Spring Island
Swartz Bay
Sidney
Saanich
Dallas Bank
Brotchie Ledge
Spencer Ledge
Constance Bank
Becher Bay
River Jordan
Lake Cowichan
Nitinat Lake
Bamfield
Broken Group
Sturgeon Bank
Roberts Bank
Boundary Bay
Tsawwassen
White Rock
Surrey
Richmond
North Vancouver
Horseshoe Bay
Burrard Inlet
Bowen Island
Sucia Island
Orcas Island
Shaw Isl.
Waldron Isl.
Stuart Isl.
Sandy Isl.
San Juan Island
Cattle Point
Lummi Island
Bellingham
Samish Bay
Padilla Bay
Anacortes
Oak Harbor
Skagit Bay
Camano Island
Widbey Island