The Call of the Sea Wolf

The Case for Expanding the Critical Habitat of the Endangered Southern Resident Killer Whale

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Disclaimer

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Executive Summary

Southern Resident killer whales are an endangered population of orcas living in the transboundary coastal waters of southwestern BC and the U.S. Pacific Northwest. They hold significant ecological and cultural value for communities in and around the Salish Sea. The survival of this population is threatened by decreasing prey availability, environmental contamination, and underwater noise from vessel traffic. With only 74 individuals remaining, timely and meaningful action to protect this population is of critical importance. However, Canada's legislation intended to protect endangered species like the Southern Resident killer whale, the Species at Risk Act, has proven to be insufficient. Development projects in and around salmon habitat, like the proposed Roberts Bank Terminal 2 expansion, enabled by the shortcomings of the Species at Risk Act, continue to place pressure on this critically endangered population.

This report seeks to identify the limitations of the Species at Risk Act, especially as it applies to the critical habitat of Southern Resident killer whales. As the primary food source of Southern Resident killer whales, Chinook salmon also face threats to their survival. While not listed under the Species at Risk Act, I present an argument for including the Fraser River watershed and the salmon that rely on its rivers, as part of Southern Resident killer whale critical habitat. By doing so, Chinook salmon may be offered additional protections in their freshwater spawning and rearing grounds, including stemming further habitat loss and degradation. This expansion would also honour the legal definition of critical habitat under the Species at Risk Act and set a precedent for upholding ecological connectivity within complex predator-prey relationships.

Introduction

The Southern Resident killer whale (SRKW) is perhaps the single most iconic species of southwestern British Columbia and the U.S. Pacific Northwest. SRKWs play an important ecological role in the Salish Sea. Whales have been regarded as “ecosystem engineers”, serving to cycle nutrients, stabilize food webs, and feed hundreds of marine species upon their death (Cartagenia- Matos et al., 2021). The removal of apex predators like killer whales in marine systems can have cascading effects across multiple trophic levels either directly or indirectly (Kiszka et al., 2015).

Coast Salish peoples hold traditional ecological knowledge relating to SRKWs (Biedenweg, 2023) that has been developed over time through deep familial, spiritual, and historical relationships. For instance, the Lummi Nation recognizes SRKWs as relatives, honouring SKRWs with the traditional name *Sk’aliCh’elh* (Indian Country Today, 2019). Similarly, Nuu-chah-nulth Peoples refer to killer whales as kakawin, or family members (Parks Canada, 2023). The SRKW is the emblem featured on Tulalip flags, now flying throughout the Marysville School District in Washington State (Last Real Indians, 2021). In non-Indigenous cultures, the SRKW occupies an important symbolic role in coastal communities. From Miga, the orca-like Olympic mascot created for the 2010 Vancouver Olympic Games (Olympics, n.d.) to the international coverage of charismatic individuals like Luna (Norman, 2014; Orca Network, n.d.) and Tahlequah (Knoth, 2019), SRKWs are intimately woven into the cultural fabrics of the Salish Sea.

Figure 1. Miga, the orca-like mascots for the 2010 Vancouver Olympic Games. Flickr.com/photos/39460517@N03.

The decline of the SRKW population is not a new phenomenon. Starting in the 1960s and 1970, a live-capture fishery contributed to the relocation or death of nearly 60 whales for the zoo and aquarium trade (Colby, 2013; Centre for Whale Research, n.d.). A SRKW named Tokitae, also known as Lolita, was captured in 1970 at the age of four (Ballard, 2023). There is hope that after spending 53 years in captivity, Tokitae will be released back into the Salish Sea and reunite with her mother and pod in Puget Sound (Ballard, 2023). However, the sea Tokitae will be returning to has changed significantly in her absence: salmon populations are in decline and SRKW distribution patterns are changing in response (Stewart et al., 2023); vessels are larger, faster, and there are more of them; inbreeding depression has reduced diversity within the SRKW genetic pool (Kardos et al., 2023); a host of new chemicals have been introduced to the environment; the list goes on. The rapidly changing environment of the Salish Sea will continue to affect SRKWs.

While it is estimated that historical SRKW populations boasted approximately 200 individuals (National Oceanic and Atmospheric Administration, 2021), only 74 whales remain in the wild (Figure 2; National Oceanic and Atmospheric Administration, 2014; Centre for Whale Research, n.d.). The population is organized into three distinct units: the J, K, and L pods (Figure 2). The SRKW was listed as endangered in Canada in 2003 under the Species at Risk Act (SARA;

Fisheries and Oceans Canada, 2007). Following this, SRKWs were recognized as endangered in the United States in 2005 under the Endangered Species Act (ESA; National Marine Fisheries Service, 2008). Despite these legal protections, few measures to reduce the threats to their survival have been implemented.

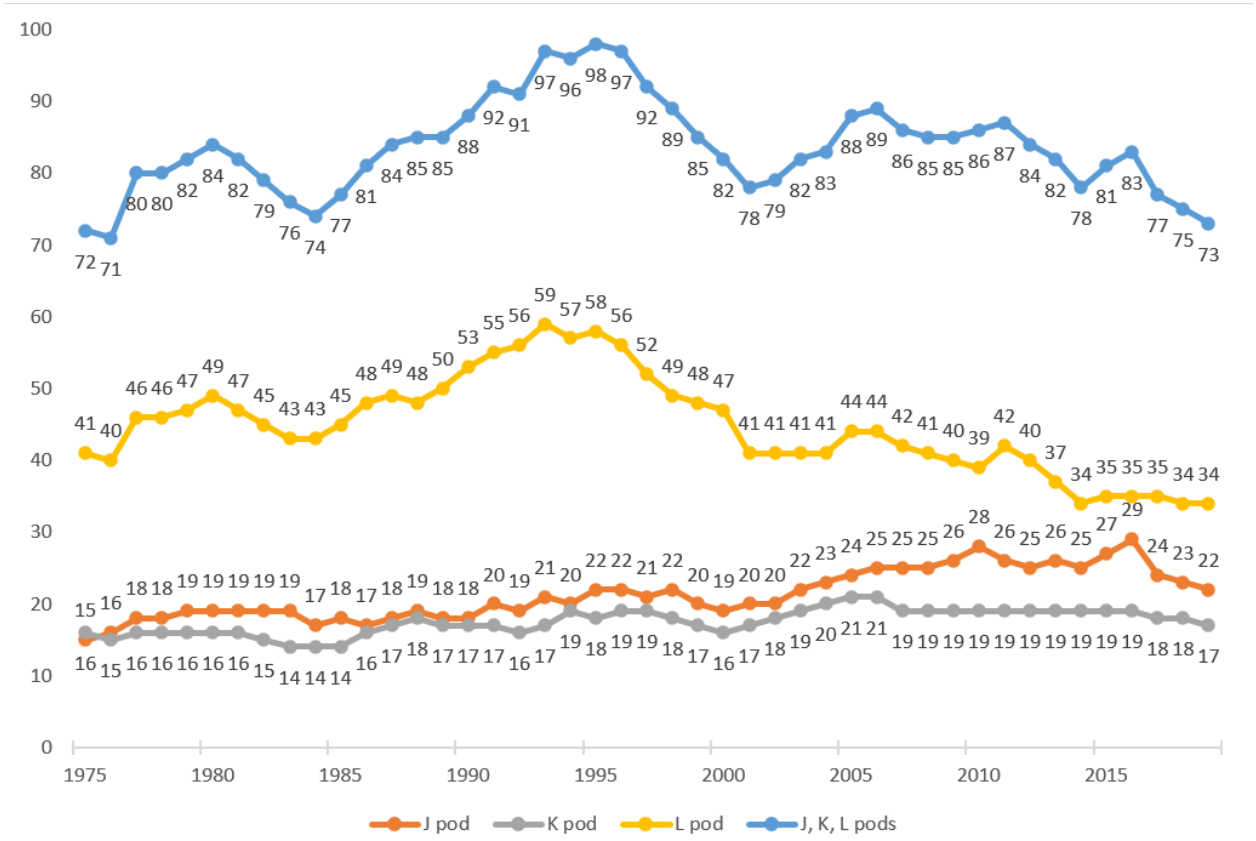

Figure 2. The SRKW population for the J, K, and L pods as of July 1 of each year from 1975 to 2020. Data source: Centre for Whale Research, 2020.

A transboundary species, SRKWs move between the Salish Sea in the summer and the coastal waters of Vancouver Island and the western US states at other times of the year. Chinook salmon are the primary food source of SRKWs (Hanson et al., 2021; Ford et al., 2016) and have influenced their foraging strategies and social behaviors in turn (Ford et al., 2000). SRKWs are long-lived mammals that invest significant energy in their offspring. They have a matrilineal cultural structure (Brent et al., 2015), with the oldest females leading pods and passing knowledge on to younger individuals. One way this knowledge transmission is demonstrated is in patterns of hunting success, with observations of SRKW males with a living mother capturing and consuming more prey than males without (Tennessen et al., 2023). The cultural richness of SRKWs can, in part, be attributed to females undergoing menopause, a rare

mechanism of evolutionary fitness where the presence of a post-reproductive female imparts greater survival of her offspring (Brent et al., 2015).

SRKWs are one of the most studied marine mammals in the world (Pawluk et al., 2019), resulting in a comprehensive understanding of the challenges to their recovery. While the list of threats to this population are extensive, the three main threats to SRKWs are environmental contamination, vessel noise and disturbance , and decreased prey availability. It is important to note that these threats do not operate in isolation, but are cumulative, compounding, regional in effect, and synergistic (Lacy et al., 2017).

Environmental Contamination

Southern Resident and Transient killer whales were discovered to be the most PCB-contaminated marine mammals in the world, surpassing concentrations found in the St. Lawrence belugas by 2-3 times (Ross et al. 2000). Polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs) have been identified as particularly hazardous to apex predators and species with a long lifespan, like the SRKW, due to their ability to bioaccumulate in tissue (Cullon et al., 2009). Although banned in Canada in 1977 (Government of Canada, n.d.) and 2016 (with some exemptions; Pollution Tracker, n.d.), respectively, Kim et al. (2022) found PCBs and PBDEs in coastal marine sediments in British Columbia, and warn that when sediments are disturbed, contaminants may re-enter the food web. Persistent organic pollutants (POPs), including PCBs and PBDEs, can remain in marine environments for many years after a substance is banned (Kim et al., 2022), creating a lag time between legal prohibitions and their intended effects.

The accumulation of anthropogenic chemicals in SRKWs can result in neuro- and immunotoxicity (Ross et al., 2000), and impairs reproduction and lactation (Mongillo et al., 2012). Contaminants may also pass from mother to offspring *in utero* (Lee et al., 2022), therefore placing young SRKWs at an increased risk of negative health effects (Krahn et al., 2009). Concerns of contamination also extend to oil spills, the possibility of which will continue to increase due to the expansion of oil-related development (e.g. marine ports, pipelines) and transport (Lundin et al., 2018) in the Salish Sea region.

Underwater noise and vessel disturbance

SRKWs, like all toothed whales, communicate vocally and echolocate. The frequencies at which they do so range from 1000-20 000 Hz and 40 000-100 000 Hz, (Burnham et al., 2023). This frequency range can overlap with frequencies of marine vessels transiting the Salish Sea (Viers et al., 2016). Therefore, the SRKWs' ability to hunt, navigate, and communicate can be hindered in the presence of vessels e, especially near shipping lanes (Joy et al., 2019). Additionally, loss of acoustic space (i.e. reduction in the area over which whales hear and can be heard) is amplified in the summer months when vessel traffic in the Salish Sea increases (Burnham et al., 2023).

As part of a suite of threat reduction measures initiated in 2019 to support recovery, Transport Canada implemented an interim order prohibiting vessels to approach within 400m of any killer whale (Government of Canada, 2023). In addition to proximity, the speed of vessels also impacts their sound intensity (i.e. volume). In response, the Vancouver Fraser Port Authority's Enhancing Cetacean Habitat and Observation (ECHO) program launched voluntary slow-down trials in 2017. ECHO has identified a decrease in sound intensity of up to 55% in their Haro Strait, Boundary Pass and Swiftsure slowdown locations during their 2021 trials (Vancouver Fraser Port Authority, 2023). The program also boasts a participation rate of 90% or higher from 2020 to 2022 (Vancouver Fraser Port Authority, 2023). Currently, Transport Canada provides reimbursements for those who participate in ECHO and subsequently incur additional pilotage costs (Vancouver Fraser Port Authority, 2023). However, there is no guarantee that the ECHO program would continue its trials should Transport Canada withdraw its financial support, participants no longer wish to comply, or that ECHO will consider additional vessel traffic resulting from development projects in the Salish Sea (Aladina et al., 2022).

Transport Canada has created several Interim Sanctuary Zones and Speed-Restricted Zones to minimize vessel noise in and around important SRKW foraging grounds (Government of Canada, 2023). However, there has been a lack of enforcement by federal authorities to adequately document and fine violators.

The Marine Mammal Desk program run by the Canadian Coast Guard seeks to minimize whale-vessel collisions by alerting vessels of nearby individuals or pods in real-time (Government of Canada, 2020). However, certain federal agencies such as the Canadian Navy, are exempt from participating in the Marine Mammal Desk program or abiding by SARA for concerns relating to national security (Species at Risk Act, s. 83(1)). Furthermore, as of January 2023, the Canadian Armed Forces have resumed live-fire training in the Salish Sea following a

ban of the practice in 2019 (Canadian Broadcasting Corporation News, 2023). Canadian military operations are also authorized to manipulate open-source hydrophone data collected to monitor underwater activity, including the movement and vocalizations of SRKWs (Juniper, 2014). The U.S. Navy is currently conducting underwater detonations in the region following a renewal of a contract granted by NOAA, among other activities that may harass, harm, or kill SRKWs (Duhamel, 2020). Under the pretense of national security, governments are enabling military activities that affect legally protected species at risk, in addition to blocking necessary data collection to determine the extent to which these activities are harmful to SRKWs and other marine species.

Decreased Prey Availability

Pacific salmon species have been referred to as the "lifeblood" of the Pacific coast (Cousteau, 2012), illustrating their cultural and ecological significance for human and non-human species. Chinook salmon (*Oncorhynchus tshawytscha*), with their large body size and high lipid content, are among the most coveted Northeastern Pacific salmon species (Atlas et al., 2022) and are the primary prey for SRKWs. While some Chinook populations are listed as threatened or endangered under the ESA (National Oceanic and Atmospheric Administration, 2023), no such designations or protections exist for Chinook on the Canadian side of the border. Nevertheless, several southcoast populations have been deemed threatened or endangered following COSEWIC assessments (Alidina et al., 2022).

Chinook salmon have two primary life history strategies in the Northeast Pacific: "stream-type", typified by juveniles spending their first year of life in freshwater environments; and "ocean-type" which migrate out to sea within their first year of life (Narum et al., 2010). After spending 4-5 years feeding and growing in the North Pacific, adult Chinook return to their natal rivers to spawn between 5-7 years old. The run timing of populations (e.g. when adults return to their natal rivers to spawn) has important implications for the lipid content present in adults. Early or 'spring' Fraser River Chinook salmon, which return to spawn in the spring months, have been shown to have up to 70% more lipid and 30% more calories than fall Chinook Fraser River populations (Lerner & Hunt, 2023). However, the divergence in their life histories, in addition to differences in adult migration patterns and ocean distribution, exposes Chinook salmon to a suite of threats spanning both the freshwater and marine environments (Atlas et al., 2022).

Fraser River Watershed

The Fraser River in British Columbia is among the world's greatest salmon producing rivers (Slaney et al.,1996). With headwaters in the Rocky Mountains and a watershed that drains one quarter of the province, the Fraser River and its tributaries support all five species of Pacific salmon and produced 50% of Canada's wild Pacific salmon (Levy & Northcote, 1982; Northcote & Atagi, 1997; FRAP, 1999). For SRKWs, Fraser River Chinook are a particularly important prey population. Previous studies have found a significant relationship between SRKW vital rates and Chinook salmon abundance (Velez-Espino, 2014). In recent years, declining Chinook populations have left SRKWs in an energetic deficit (Couture et al., 2022) with a notable decline in SRKW body condition (Stewart et al. 2021, Fearnbach et al., 2018) and reproductive output (Wasser et al., 2017).

By the turn of the 21st century, the Fraser River watershed had experienced significant land conversion that turned vital salmon habitat into a mosaic of degraded conditions. In the Lower Fraser River, which all Fraser Chinook populations use as a migratory corridor, forests were diminished to one-tenth of their original extent, and wetlands were reduced by 71,000 hectares (Scott et al., 2020). Industrialization, urbanization, agricultural activities, and other land-use practices have transformed the landscape into fragmented and degraded habitats with poor water quality (Ross & Randhir, 2022). Over 85% of floodplain habitat that supported salmon populations has been lost, and 1200 in-stream barriers such as dams, floodgates, and culverts prevent salmon from accessing 2,224 kilometers (64%) of streams (Finn et al., 2021). These important habitats would have been used by juvenile salmon populations from throughout the Fraser River watershed. However, salmon today have access to just 101 square kilometers of floodplain habitat in the Lower Fraser, which has contributed to ongoing salmon declines in this part of the province (Finn et al., 2021).

Southern Resident Killer Whales and Chinook Salmon

Fraser River Chinook are exposed through different life stages to a wide variety of contaminants, including agro-forestry pesticides, municipal and industrial wastewater discharges, surface runoff from roadways, chemical spills from vessels, railcars and vehicles, and atmospherically deposited pollutants from distant sources. These contaminants can harm salmon where they are released, or drift downstream (Harris et al., 2008; Tierney et al., 2008). Critical habitat for SRKWs also lies downstream at the mouth of the Fraser River estuary in the Salish Sea, which highlights their vulnerability to contaminant accumulation from their food web (e.g. Fraser Chinook salmon; Ross et al., 2013; Johannessen et al., 2015).

The number of Chinook salmon a SRKW needs to consume to meet its energy and nutrient requirements can vary with the age and size of both whale and prey,) as well as throughout the year (Lerner and Hunt, 2023). Chinook salmon can make up more than 80% of SRKWs' diet in the summer months (Hanson et al., 2010). However, fewer high-fat Chinook salmon require SRKWs to increase their foraging effort, requiring more energy to search for food that is lower in calories and fat (Lerner and Hunt, 2023). In these circumstances, Chinook that contain lower lipid levels (i.e. most southern stocks in the fall) necessitate SRKWs to consume more salmon. Many south coast fall salmon stocks are shelf rearing (i.e. having a nearshore-rearing distribution) and by extension, ingest more PCBs and PBDEs (Cullon et al., 2009, Holbert et al 2023). The declining populations of Fraser Chinook, especially in the spring and early summer means that SRKWs are spending more time foraging outside of their historic summer feeding grounds (Stewart et al., 2023). The lack of Chinook salmon has also impacted SRKW behavior, with the whales exhibiting less surface activities like breaching and fin slapping when prey availability is low (Bubac et al., 2020). Other metabolic challenges are experienced in the absence of prey, including failed pregnancy (Wasser et al., 2017).

Jurisdictional Challenges: Compounding Threats to Recovery

Despite the scientific agreement on the three primary drivers threatening SRKWs, these threats are often addressed individually. This may be partially attributed to the high levels of fragmentation within the transboundary network tasked with protecting this species (Pedersen, 2022). This network is informally organized into coalitions and alliances of industry and NGOs, many of which focus on single issues (e.g. vessel noise) and only regularly communicate with groups within their specified coalitions and alliances. While this appears to be a somewhat reactionary response to the low levels of affinitive trust throughout the network, this approach does not support a holistic response to SRKW recovery, and instead encourages siloed interactions, initiatives, and recovery measures. This is further compounded by other barriers impeding effective collaboration, including the international border between Canada and the United States (see Pedersen, 2022, for more details on this).

Species at Risk Act

The Species at Risk Act is Canada's only federal legislation protecting endangered species. Adopted in 2002, the objectives of the SARA are: "to prevent wildlife species in Canada from disappearing, to provide for the recovery of wildlife species that are extirpated (no longer exist in the wild in Canada), endangered, or threatened as a result of human activity, and to manage species of special concern to prevent them from becoming endangered or threatened" (Government of Canada, n.d., para. 4).

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC), an independent scientific advisory body, was created in 1977 following a recommendation from federal, provincial, and territorial Wildlife Directors (VanderZwaag and Hutchings, 2005). It is COSEWIC that performs assessments of potential species at risk according to the International Union on the Conservation of Nature (IUCN) guidelines (Waples et al., 2013). COSEWIC assessments held no legal weight until the adoption of the SARA, where COSEWIC's official role, responsibilities, and structure were outlined.

Process

At the beginning of the listing process, a species is recommended for assessment by COSEWIC by the Species Specialist Subcommittees or the Aboriginal Traditional Knowledge Subcommittee (COSEWIC, 2021). Once assessed, COSEWIC can either terminate further action by designating a species "not at risk", or advance the listing by sending a recommendation to the Minister of Environment. The Minister then has 90 days to respond, which may result in either a normal or extended consultation period. The findings from the consultation period are passed to the Governor in Council who can accept or reject a proposed listing, or send the listing back to COSEWIC for additional assessment. If a species listing is accepted, it can be designated a "species at risk" under one of the following four categories: extirpated, endangered, threatened, or special concern. At this point, the species is now legally protected by SARA measures.

For species listed under the designation of special concern, a proposed Management Plan must be developed within three years for newly listed species and five years for previously listed species (s. 65). For threatened, extirpated, and endangered species, a proposed Recovery Strategy (s. 37) must be developed within two years for the first two categories and one year for the latter. Recovery strategies must include (if feasible): the identification of threats to a listed

species, the identification or critical habitat or a series of studies which will inform critical habitat should sufficient information be unavailable, measures to implement the recovery strategy, and a date by which subsequent action plans must be completed (VanderZwaag & Hutchings, 2005). Once Recovery Strategies have been finalized, an Action Plan must be developed (s. 47). Action Plans must include: identification of and list of proposed measures to protect critical habitat, measures to implement the Recovery Strategy, recovery monitoring methods, and a list of the socio-economic costs and benefits of the Action Plan. No definitive timeline is required (VanderZwaag & Hutchings, 2005). This process is summarized in Figure 3.

Additional legal mechanisms that can be triggered are under sections 79 and 80. Under section 79, all projects that may affect listed species must conduct a review under the Canadian Environmental Assessment Act (CEAA), while section 80 provides an opportunity for emergency orders to be enacted if the minister feels that the species faces imminent threats to its survival or recovery.

Listing of Southern Resident Killer Whales under SARA

SRKWs were first assessed by COSEWIC in 1999 (Baird,1999), resulting in a designation of threatened. Following a second assessment in 2001, the status of SRKWs was changed to endangered (COSEWIC, 2001), which led to their subsequent listing under SARA in 2003 (Fisheries and Oceans Canada, 2022). SRKWs were reassessed again in 2008 where their status of endangered was confirmed by COSEWIC (2008). As defined by SARA, the legal designation of endangered applies to species “facing imminent extirpation or extinction” (s. 2). COSEWIC gave the following reasons for their decision to designate the SRKW as endangered:

> “The population is small and declining, and the decline is expected to continue. Southern Residents are limited by the availability of their principal prey, Chinook salmon. There are forecasts of continued low abundance of Chinook salmon. Southern Residents are also threatened by increasing physical and acoustical disturbance, oil spills and contaminants.” (p. iii).”

In 2018, after NGOs petitioned for an emergency order under SARA, the federal government announced that SRKWs faced an “imminent threat” to their survival. This “imminent threat” ruling is a legal component of SARA that obligates the government to act given the heightened risk of extinction.

Shortcomings of SARA

Here, I provide a comprehensive overview of the shortcomings of SARA as it currently exists and its shortcomings in furthering the recovery of SRKWs. Specifically, I outline the challenges associated with species listings, accountability mechanisms, and limitations of critical habitat as a protection concept.

Species Listing

Not all species are equally considered for listing under SARA. For instance, marine fish species are underrepresented in the total list of protected species with only 9% proposed species of marine fish being approved for listing under SARA compared to 84% of the total proposed species between 2004 and 2006 (Mooers et al., 2007). This is especially true for fish species that are economically valued like Atlantic bluefin tuna, Pacific salmon, and steelhead (Thornhill Verma, 2022). The SARA consultation period for marine fish is significantly longer than for other species of concern, with the average decision time exceeding four years, perhaps in part due to the political and industry opposition for listing commercially valued species under SARA (McDevitt-Irwin, 2015). During these extended periods of consultation, marine fish received no additional protections (McDevitt-Irwin, 2015).

Marine fish species may also experience bias for listing when compared to their terrestrial counterparts due to the decision-making body that is legally responsible for upholding SARA. Compared to their terrestrial counterparts, which fall under provincial jurisdiction, marine fish, even those that require freshwater for reproduction, are a federal responsibility (Mooers et al., 2007). This current arrangement of jurisdiction places the Department of Fisheries and Oceans (DFO), the federal agency responsible for fisheries and marine species in Canada, in the position to single-handedly implement the protections mandated by SARA (Mooers et al., 2007). This prevents other government agencies that may be able to assist in conservation activities that do not have the jurisdiction to enforce SARA. Furthermore, the legal structure of SARA allows for some political discretion during the proposal for the listing process (Turcotte et al., 2021). It is the Governor in Council who makes the ultimate decision to list, not list, or obtain additional information or assessment from COSEWIC (Findlay et al., 2009). The fact that the outcome of the listing process is determined by political entities rather than scientific or Indigenous experts “allows for biases to creep in and means that many species go unprotected” (Turcotte et al., 2021, p. 1476).

Accountability

There is a distinct lack of accountability mechanisms within SARA and its subsequent Action Plans. The absence of a specified timeline to achieve outlined recovery measures are especially clear in the "Action Plan for the Northern and Southern Resident Killer Whale" (Fisheries and Oceans Canada, 2017). In Table 1 (p. 4), titled "Measures to be undertaken by Fisheries and Oceans Canada", only 10 of the 17 listed recovery measures had a definitive timeline (e.g. 5 years). The other seven recovery measures, which are mostly related to monitoring various aspects of the population or their environment, are listed as "ongoing" with no date specified for when these actions will be considered complete. Indeed, the report makes note that "a timeline listed as 'ongoing' indicates the importance of that measure to be conducted regularly for the foreseeable future" (p. 4), but never makes clear to what end such activities are being pursued. Additionally, the Action Plan explicitly states that the plan for recovery is expected to exceed 25 years, but that "completion dates [for recovery measures] are not specified" (p. 26).

Vague and ambiguous language within SARA creates opportunities for inadequate protection of a species at risk. For instance, section 80(1) and (2) of SARA states: "The Governor in Council may…make an emergency order to provide for the protection of a listed wildlife species… 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". Once again, it is a political entity that makes the decision regarding what species deserve additional protections. In addition, there is no legal definition of "imminent threats" provided, and thus, it is entirely up to the discretion of the minister to define this term for themselves. This ambiguity of language allows for the manipulation of SARA and emergency orders to fit the needs of the political climate, whether that be in favour or not of protecting a species that is embedded within a larger economic and social context. The ability of political actors to manipulate SARA reflects a critical shortcoming of this legislation: it is written so as to not hold governments accountable to the same legal standards that it demands of its citizens (Pasternak and Walters, 2023). I will discuss the implications of this for SRKWs in more detail below.

Critical Habitat

SARA defines critical habitat for aquatic species as the "... spawning grounds and nursery, rearing, food supply, migration and any other areas on which aquatic species depend directly or indirectly in order to carry out their life processes, or areas where aquatic species formerly occurred and have the potential to be reintroduced" Fisheries and Oceans Canada, 2017, s.

2(1)). However, a 2016 analysis of SARA critical habitat by Bird and Hodges reminds us "laws are only as good as their implementation" (p. 1). The authors found that 62.9% of SARA-listed species lack a critical habitat designation, with all marine mammals and fish having no or partial critical habitat included in their listing. Thus, the concept of critical habitat appears to bear little to no legal weight, as the definition is not upheld for more than half of listed species.

Critical habitat has been the focus of several lawsuits against the Canadian federal government, including a 2010 action spearheaded by Ecojustice illustrating the failures of DFO to uphold the critical habitat requirements of the SRKW (David Suzuki Foundation et al., v. Minister of Fisheries and Oceans & Minister of Environment, 2010). This case led to a landmark decision by Justice Russell that re-affirmed critical habitat as a multi-dimensional legal definition, which now includes chemical and acoustic environments, and not just "a place on a map" (CFAX, 2010, 3:34). Furthermore, the judgment emphasized that critical habitat must be legally protected by the federal government, and initiatives by provincial governments, environmental organizations, and community groups are not sufficient to fulfill the requirements of SARA (David Suzuki Foundation et al., v. Minister of Fisheries and Oceans & Minister of Environment, 2010). A subsequent appeal by DFO was defeated in 2012 (Raincoast Conservation Foundation, 2012). Despite these legal victories, violations under this aspect of SARA continue with no meaningful repercussions or accountability.

In the case of SRKWs, whose primary food source is Chinook salmon, critical habitat would logically extend to Chinook-bearing watersheds, such as the Fraser River and its tributaries. However, this is not the case, as the current critical habitat for the SRKW is restricted to only marine waters (Figure 4). This is not a novel critique, as SARA has been challenged from its outset by critics who state that there is not enough protection for endangered species habitat (Agnolin & Loverock, 2002). As it currently stands, SRKW habitat only includes areas utilized by SRKWs. It does not consider where their prey reproduce, rear, or the full extent of their migration.

There are several limitations in the enforcement of the critical habitat designation to protect SRKW habitat. SARA states that "no person shall destroy any part of the critical habitat of any listed endangered species or of any listed threatened species… if the critical habitat is on federal land, in the exclusive economic zone of Canada or on the continental shelf of Canada" (Species at Risk Act, s. 58(1)). Thus, protections for critical habitat on non-federal land, such as on private property, do not exist. They should, however, exist in the exclusive economic zone of Canada, "rang[ing] from 12 to a maximum of 200 nautical miles from [shore]" (Fisheries and Oceans Canada, 2011, p.1), which includes current SRKW critical habitat. Furthermore, section

61(1) makes it clear that “no person shall destroy any part of the critical habitat of a listed endangered species or a listed threatened species that is in a province or territory and that is not part of federal lands”. However, section 61(1.1) provides an exemption, asserting that the above requirements do not apply to aquatic species. Aquatic and marine species are afforded significantly less protection than terrestrial species, thus highlighting an important power asymmetry within SARA.

Critical habitat can also be superseded by prohibition orders. Typically, “SARA makes it illegal to destroy any part of the critical habitat of [a species at risk] and may impose restrictions on development and construction” (Government of Canada, n.d., para. 3). However, in the case of Northern and Southern Resident killer whales “a SARA Critical Habitat Order was made under subsections 58(4) and (5), which invokes the prohibition in subsection 58(1) against the destruction of the identified critical habitat” (Fisheries and Oceans Canada, 2017, p. iv). The Critical Habitat Order was issued in 2009 (Canada Gazette, 2018a), granting government and industry permission to develop within designated SRKW critical habitat. Given the nature of marine development, additional industrial activities directly impact SRKWs through increased noise (e.g. vessel traffic, drilling) and potential for environmental contamination (e.g. oil spills). I will discuss the implications of the Critical Habitat Order in further detail below.

Ongoing SARA Violations for the SRKW

In November 2016, Kinder Morgan received the federal government’s conditional approval to expand the Transmountain pipeline (Tasker, 2016). The Trans Mountain expansion (TMX) project runs parallel to the existing pipeline, betweenEdmonton, Alberta, and its terminus s in Burnaby, British Columbia (Figure 5). Federal support for the project was granted following a National Energy Board (NEB) review process that concluded the TMX was in the best interest of Canadians and should be approved (National Energy Board, 2016). The project was assessed by the NEB, completed under the National Energy Board Act (NEBA) and the Canadian Environmental Assessment Act (CEAA). A successful 2016 legal challenge resulted in a secondary review for the TMX. Following another successful legal challenge in 2018, successive government actions were granted approval that legal challenges failed to overturn.

In May of 2016, a mandate was issued for a federal Review Panel to examine the Roberts Bank Terminal 2 expansion project (RBT2; Review Panel for Roberts Bank Terminal Project, 2020). Constructing RBT2 (108 ha) would require the construction of a new marine

terminal, road, and rail infrastructure, in addition to expanding the existing causeway and tug basin (Review Panel for Roberts Bank Terminal Project, 2020).

In current government and media narratives, the TMX and RBT2 have been portrayed as two separate developments. However, at the time the TMX had received federal approval, the RBT2 had already been proposed (Vancouver Fraser Port Authority, n.d.). 2016 was also the year that Canada's Oceans Protection Plan (OPP), a multi-billion dollar initiative to protect Canadian marine life and coastlines, was introduced. Critics of the OPP suggest it also served a pro-oil agenda and provided reassurance for the TMX approval. Dogwood Initiative spokesperson Kai Nagata noted "the idea of improving spill response [through the OPP] pales in comparison next to the exponential risk when you add another 400 oil tankers a year to these waters" (MacMahon & Kretzel, 2016, para. 7).

In April 2023, RBT2 received federal approval, despite the finding of the Impact Assessment Agency's review panel that concluded the adverse and cumulative effects would impact SRKWs and Fraser River Chinook salmon from project construction and operation, including ongoing shipping. Prior to approval, a dozen academic scientists with expertise in the subject matter sent a letter identifying the ongoing habitat destruction incurred to species reliant on the estuary, including threatened Fraser River Chinook and SRKWs. Opposition from industry unions, local communities, NGOs, and Indigenous Nations further added to voices opposing the project. RBT2 is currently awaiting provincial approval prior to construction (Britten, 2023). However, legal challenges have been filed and outstanding SARA permits necessary for construction have not been issued.

According to a legal analysis by Rehberg-Bessler and Jeffries (2019), "marine shipping was not considered within the original scope of the [TMX] project by the NEB, so the environmental assessment for marine shipping was not in accordance with the requirements of CEAA, but rather took place under the public interest category of NEBA" (p. 144). As noted above, oil spills were identified as one of the risks for the COSEWIC designation of endangered, yet their fair evaluation remains absent from federal assessment of shipping projects. One of the main justifications for this decision, according to the NEB, was "even if the Project does not proceed, the intensity of commercial and recreational traffic along the shipping route is predicted to increase in the future" (2016, p. xii). Whether shipping traffic in the Salish Sea was expected to increase over time or not, it could be argued that dismissing this threat violates SARA and its critical habitat provisions.

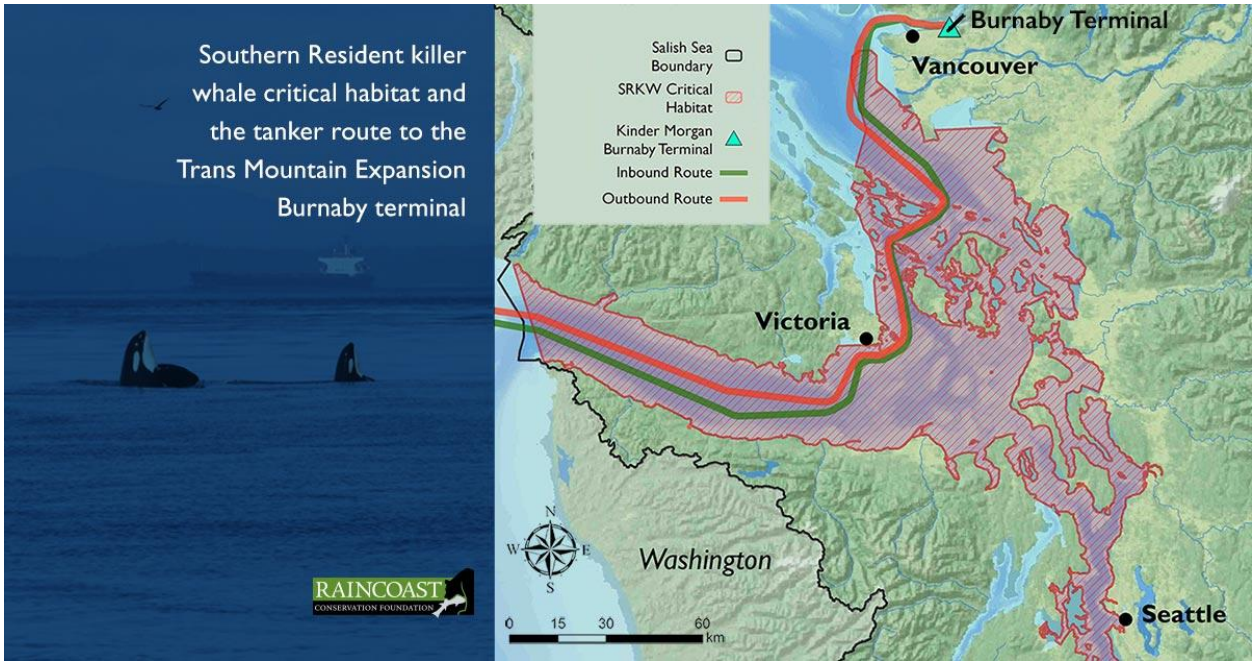

Figure 3. The TMX project terminal in Burnaby, British Columbia (originating from Edmonton, Alberta) and proposed inbound and outbound shipping routes through Southern Resident killer whale critical habitat. Source: Raincoast Conservation Foundation, 2019.

Furthermore, the Salish Sea is a transboundary body of water shared by Canada and the United States. The United States has no political recourse for development projects proposed by Canada, and vice versa, despite the fact that development will inherently impact water, lands, and ecosystems across the international border (Gaydos et al., 2015). This shortcoming reflects the preference for maintaining political sovereignty (i.e. control over one's own land and economy) over holistic species or ecosystem management.

According to section 80(4) of SARA, an

> "emergency order may…in the case of an aquatic species, identify habitat that is necessary for the survival or recovery of the species in the area to which the emergency order relates, and include provisions requiring the doing of things that protect the species and that habitat and provisions prohibiting activities that may adversely affect the species and that habitat".

In 2018, an emergency order filed by NGOs for SRKWs was rejected by the Governor in Council citing "the measures, considered together, will contribute to abating the imminent

threats to the survival and recovery of the SRKW" (Canada Gazette, 2018b, para. 5). In other words, the Governor in Council deemed the measures taken to protect the SRKW up to that point were sufficient, despite the loss of eight individuals in just two years (Figure 1; Centre for Whale Research, 2020).

The Case for Expanding SRKW Critical Habitat

British Columbia is one of three provinces without provincial endangered species legislation (Cox, 2020), placing all responsibility for preserving biodiversity in the province on the shoulders of the federal government. According to a 2020 study on the critical habitat of the southern mountain population of woodland caribou (*Rangifer tarandus caribou*) in British Columbia, this is an insufficient arrangement. Palm et al. (2020) found that only five years after 909 square kilometers of critical habitat for caribou was identified under SARA, the area was logged. This occurred on provincial lands. While the provinces that do have additional species at risk legislation report varying degrees of success, they have created a multi-jurisdictional framework that supports species protection across multiple levels of government. British Columbia's absent legislation does not support this approach, and BC's species at risk suffer as a result.

With the understanding that the SRKW's primary food source, Chinook salmon, is unlikely to be listed under SARA due to reasons discussed above, I propose that this species may receive some protection by expanding the critical habitat of SRKWs to include the Fraser River watershed and its Chinook salmon tributaries. This expansion would be in line with what is already stated in SARA regarding critical habitat requirements, which includes protecting food supply (Fisheries and Oceans Canada, 2017). Figure 4 is a map of four key Chinook watersheds that feed into SRKW critical habitat, including the Fraser River tributaries, which are entirely Canadian jurisdiction and highlighted in green.

Chinook salmon serve as one of three leverage points for improving the likelihood of SRKW recovery. As previously discussed, the major threats to SRKWs (i.e. decreased prey availability, noise and disturbance from vessel traffic, environmental contamination) can be synergistic and cumulative in effect. In other words, the interaction of individual threats results in an overall effect that is greater than the sum of the individual effects. With multiple threats, the threshold for withstanding any one threat is likely to be lower. Given that there is no way of removing anthropogenic chemicals from a large body of water like the Salish Sea, there is little to be done in terms of pre-existing environmental contaminants other than to wait for these

substances to naturally break down over time. Moreover, there is no clear evidence suggesting that vessel noise and traffic is forecasted to decrease in the near future, especially with approvals for both RBT2 and TMX. Therefore, the obvious point of leverage for SRKW conservation is to increase prey availability through the protection of Fraser River Chinook salmon.

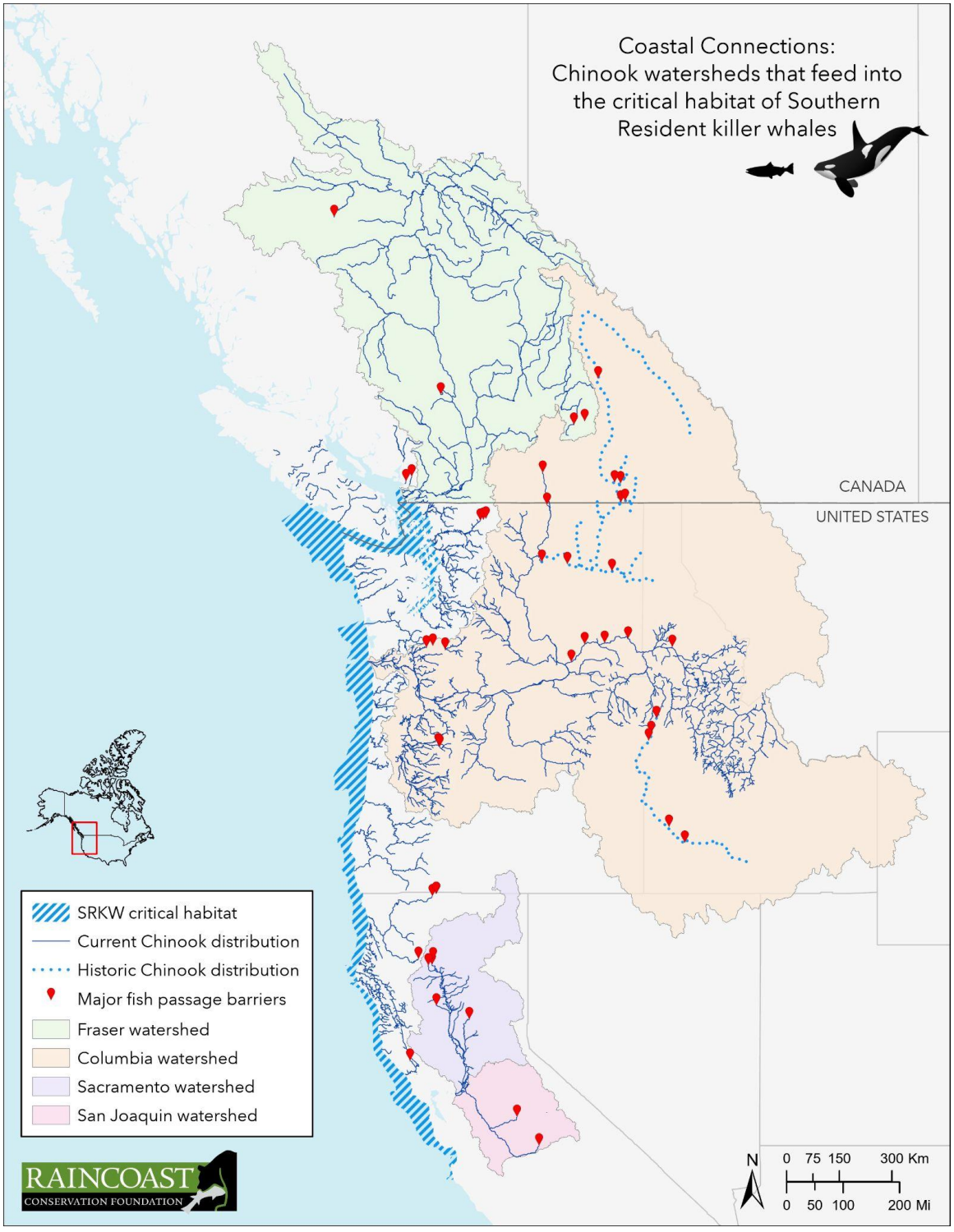

Figure 4. The Chinook salmon watersheds of British Columbia and the U.S. Pacific Northwest that feed into the critical habitat of Southern Resident killer whales. Source: Raincoast Conservation Foundation, 2023.

This is the starting point from which I build this argument. Below, I discuss the relevance of ecological connectivity, consider the protections a designation of freshwater critical habitat would afford Chinook salmon populations, and explore the Nicola watershed as a case study site for potential habitat restoration.

Ecological Connectivity

The continued development of the Fraser River watershed from intensive logging, industrial, urban and agricultural operations, among other activities, has significantly altered and damaged the ecological connectivity between freshwater, terrestrial and marine ecosystems. Ecological connectivity can be defined as the connections between various, and often fragmented, environments on a landscape, allowing biodiversity to move between these environments (Parks Canada, 2023). Ecological connectivity is especially important to species that spend various points in their life in both marine and freshwater environments, and further rely on the functioning of terrestrial watersheds to sustain their freshwater life cycle.

By extending SRKW critical habitat into the freshwater environment of the Fraser River watershed, the corresponding legal protection accorded to these habitats could limit destructive land use activities and increase the protection of remaining spawning and rearing habitat. This coupled protection could reduce mortality of Chinook salmon populations and increase the likelihood of adult Chinook migrating through SRKW critical habitat in the marine environment, where the whales would have increased prey availability and foraging opportunities. Further, it would provide legal recognition of the importance of marine-freshwater-terrestrial connectivity and the role that multiple ecosystems play in salmon and SRKW viability.

Critical Habitat Protections for Chinook Salmon

The ongoing destruction and degradation of critical habitat for Canada's species at risk, including that of SRKWs, is an obvious violation of SARA. What is currently missing from the discussion surrounding SRKW critical habitat is that stronger protections within current SRKW critical habitat would still be insufficient to increase prey availability. Section 73(1) of SARA states "the competent minister may enter into an agreement with a person, or issue a permit to a person, authorizing the person to engage in an activity affecting a listed wildlife species, any part of its critical habitat or the residences of its individuals". Critical habitat protection would elevate salmon prioritization, prohibit development of riparian areas, and constrian activities

that affected water quality, water quantity and instream features. Furthermore, should developments affecting freshwater salmon habitat be proposed, they would be required to undergo a permitting process to do so. This process would apply to harmful agricultural and logging activities, residential or industrial construction, the development of new roads, dams, or dykes, and activities that affected water quality, quantity and physical stream features. Extending SRKW critical habitat to Chinook spawning grounds would embed a priority to review development projects through the lens of salmon habitat, taking a more proactive, rather than reactive, approach to endangered species conservation.

Additionally, it is a minister that is responsible for approving or vetoing development projects within specified critical habitat for species at risk. However, the absolute authority of political actors within both the listing and permitting process is a critical shortcoming of the SARA. Instead, future revisions to SARA should consider creating an independent body of scientific and Indigenous experts to determine what activities and protections are appropriate for any given species at risk.

In addition to SARA critical habitat designations, Canada has international commitments to uphold. Canada co-signed the Pacific Salmon Treaty (PST), first signed in 1985, with the United States which recognizes the importance of salmon to each nation (Pacific Salmon Commission, n.d.). According to a letter written to Canada's Minister of Environment Canada in 2022, "Canada manages Harrison River [a COSEWIC-assessed threatened stock] Chinook salmon under an international Pacific Salmon Treaty obligation to meet a minimum escapement goal of 75,100 spawners. This goal has not been met in nine of the last ten years" (para. 13). Given that the PST was not intended for the purposes of conservation and is not a legally binding document, the consequences of failing to meet specified targets have thus far been minimal. However, the informal implications (e.g. negative press, international reputation) associated with not meeting PST standards may be leveraged as a way to provide additional support for the case of expanding SRKW critical habitat. Indeed, the SRKW governance network is already keenly aware of, and therefore reactive to, regulatory risk (i.e. the probability and consequences of a partner exposing an organization to sanctions from a third party by failing to comply with the rules of a network; Pedersen, 2022). The PST offers a unique opportunity to create change through informal social mechanisms, rather than legal ones.

Proposed critical habitat expansion: Nicola Watershed

The Nicola Watershed, centered around the community of Merritt, is the spawning ground for stream-type Fraser Chinook (4-2) which have been assessed by COSEWIC as an endangered population. Stream-type Chinook, (i.e. salmon that return to their natal streams in the spring and early summer), contain significantly higher fat deposits compared to ocean type (i.e. fall-run) fish (Cullon et al., 2009; Lerner & Hunt, 2023), and therefore are a more energy-dense food source for nutritionally-stressed SRKWs. The decline of this unique population has been attributed to a variety of factors, including overexploitation, habitat loss, and altered streamflow regimes as a result of water extraction for agriculture and hotter, drier summers as a result of climate change (Warkentin et al. 2021). Expanding critical habitat for SRKWs into the Nicola River watershed, the rearing grounds of SRKWs' most energy-dense yet most at-risk food source, could reduce Chinook mortality and increase prey abundance. This approach would be a novel way of addressing the widely recognized threat of food availability for the nutritionally-stressed whales.

Conclusion

Perhaps the most uncomfortable shortcoming of SARA, and conservation in Canada more broadly, is that the current system in place to preserve biodiversity has been ineffective in stopping destruction and degradation of critical habitat from extractive and development activities. For many BC species, such as woodland caribou, spotted owl, and SRKWs, this has resulted in unprecedented rates of decline and arguably functional extinction. Additionally, the loss of critical habitat and associated ecosystems has escalated the effects of climate change and the biodiversity crisis. This extensive loss of habitat has implications for thousands of other species that will require COSEWIC assessments and elicit public calls for listing under SARA .

As indicated by its name, SARA extends protections only to individual species rather than to communities or ecosystems. Indeed, Favaro et al. (2014) argue that Canada's endangered species legislation so rarely yields recovery that the only feasible way to conserve a species is to "actively prevent [them] from becoming at-risk in the first place" (p.1).

While this may be a feasible approach in some cases (e.g. keystone and indicator species), it does not encourage holistic understandings of multi-species interactions, food webs, habitat, or social-ecological contexts. Biodiversity is not simply a resource to extract, but is fundamentally intertwined with community, sovereignty, spirituality, culture, and wellbeing (Pasternak & Walters, 2023).

Where do we go from here?

It is clear from this examination that SARA can be disregarded by the federal government based on political and economic rationale. We are now left to ponder the following questions:

- What is the value of SARA if it can be selectively applied, overridden, or altered in the name of political or economic development?
- Are there ways to make this legislation more robust, effective, and inclusive?
- How might designations of critical habitat be used more responsibly, and what actions do we need to take to get there?
- How can we hold political institutions accountable when they fail to enact or abide by the laws and regulations governing Canada, specifically as they relate to biodiversity and species conservation?
- How might we develop new frameworks to value and protect at risk species?

SARA's definition of critical habitat is limited in terms of its ecological and geographic scale and scope. In the case of SRKWs, it should include freshwater habitats, such as Fraser River watershed and its tributaries, that are vital to Chinook salmon survival. Without these habitats, Fraser River Chinook salmon will further decline, as will the prey base for SRKWs to forage on within their critical habitat.

The next steps to address these inadequacies may include writing a submission to COSEWIC identifying the scientific rationale for expanding critical habitat into the Fraser River watershed and its freshwater tributaries, particularly those that support stream-type Chinook salmon. Critical habitat for Resident killer whales was updated following a 2010 legal challenge where the definition was expanded to include key biological and geophysical attributes including water quality and acoustic disturbance. As such, the precedent for updating the critical habitat definition has been set, indicating there is an opportunity for legislation such as SARA to be improved in order to better achieve its goal of species recovery.

Conventional systems of habitat protection are relegating the intangible value of biodiversity to a monetary asset. We protect biodiversity as if it were a market commodity, with the cost-benefit analyses of listing a species under SARA prioritizing short term economic value over long term well being. Other ways of knowing, being and valuing may illuminate future paths toward biodiversity conservation.

To achieve this vision, we must expand our notions of authority beyond those who have traditionally occupied seats of power in the colonial euro-centric world, and consider what true inclusivity in environmental governance could look like. Gitxsan scholar Janna Wale summarizes this perspective well: "...when decisions related to [environmental] policy are made by the same people using the same knowledge systems and predisposition towards extraction that has fuelled the [biodiversity] crisis in the first place, how can we expect different outcomes?" (p. 6, 2023). It may be time to consider that by employing this single, narrow worldview, different outcomes are unlikely to be achieved.

Acronyms

Acronym	Full name
SRKW	Southern Resident killer whale
SARA	Species at Risk Act
ESA	Endangered Species Act
PCB	Polychlorinated biphenyl
PBDE	Polybrominated diphenyl ether
POP	Persistent organic pollutant
ECHO	Enhancing Cetacean Habitat and Observation
DFO	Department of Fisheries and Oceans
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
IUCN	International Union on the Conservation of Nature
TMX	Trans Mountain Expansion
NEB	National Energy Board
NEBA	National Energy Board Act
RBT2	Roberts Bank Terminal 2

References

Agnolin, J., & Loverock, K. (2002). Scientists criticize endangered species bill. *Alternatives Journal*, *28*(1), 4-5.

Aladina, H., Barrett-Lennard, L., & Jasny, M. August 9, 2022. Draft conditions for RBT2 referring to Enhancing Cetacean Habitat and Observation (ECHO) Program.

Ashley, K., Bailey, R., Chalifour, L., Gayeski, N., Giles, D., Kehoe, L… & Stanford, J. 2022, February 7. Letter from scientists regarding Roberts Bank Terminal 2. https://fraserestuary.scienceletter.ca/letter/.

Atlas, W. I., Sloat, M. R., Satterthwaite, W. H., Buehrens, T. W., Parken, C. K., Moore, J. W., ... & Potapova, A. (2023). Trends in Chinook salmon spawner abundance and total run size highlight linkages between life history, geography and decline.

Baird, R. W. (1999). Status of killer whales in Canada. *Contract report to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), Ottawa*.

Ballard, J. 2023, March 30. Lolita the orca is returning home to Puget Sound after more than 50 years in captivity. https://www.cbc.ca/news/canada/british-columbia/lolita-orca-captivity-release-puget-sound-1.6796282.

Biedenweg, K., Anderson, L., Hatfield, S. C., Hollender, R., Kintner, L., & Trimbach, D. J. (2023). Seeking consilience: Traditional ecological knowledge and Western social science contributions to orca conservation knowledge. *Journal for Nature Conservation*, *72*, 126364.

Bird, S. C., & Hodges, K. E. (2017). Critical habitat designation for Canadian listed species: slow, biased, and incomplete. *Environmental Science & Policy*, *71*, 1-8.

Brent, L. J., Franks, D. W., Foster, E. A., Balcomb, K. C., Cant, M. A., & Croft, D. P. (2015). Ecological knowledge, leadership, and the evolution of menopause in killer whales. *Current biology*, *25*(6), 746-750.

Brennae, M. (Host). (2019, June). Trans Mountain approval could decimate endangered killer whales and climate, according to RCF. In *CFAX 1070*. iHeart Radio. https://www.raincoast.org/2019/06/misty-macduffee-on-cfax-1070-on-the-approval-of-the-trans-mountain-pipeline/.

Britten, L. 2023, April 20. Fed approve major expansion B.C. container port despite environmental, labour opposition. https://www.cbc.ca/news/canada/british-columbia/delta-container-expansion-approval-1.6817357.

Bubac, C. M., Johnson, A. C., & Otis, R. (2021). Surface behaviors correlate with prey abundance and vessels in an endangered killer whale (Orcinus orca) population. *Marine Ecology*, *42*(1), e12626.

Burnham, R. E., Vagle, S., Thupaki, P., & Thornton, S. J. (2023). Implications of wind and vessel noise on the sound fields experienced by southern resident killer whales Orcinus orca in the Salish Sea. *Endangered Species Research*, *50*, 31-46.

Canada Gazette. 2018a, December 18. Critical habitat of the killer whale (Orcinus orca) Southeast Pacific Southern Resident Population Order. https://gazette.gc.ca/rp-pr/p2/2018/2018-12-26/html/sor-dors278-eng.html.
Cartagena-Matos, B., Lugué, K., Fonseca, P., Marques, T. A., Prieto, R., & Alves, F. (2021). Trends in cetacean research in the Eastern North Atlantic. *Mammal Review*, *51*(3), 436-453.

Canada Gazette. 2018b, November 14. Order declining to make an Emergency Order for the protection of the Killer Whale Northeast Pacific Southern Resident Population. https://gazette.gc.ca/rp-pr/p2/2018/2018-11-14/html/si-tr102-eng.html.

Cartagena-Matos, B., Lugué, K., Fonseca, P., Marques, T. A., Prieto, R., & Alves, F. (2021). Trends in cetacean research in the Eastern North Atlantic. *Mammal Review*, *51*(3), 436-453.

Canadian Broadcasting Corporation News. 2023, January 14. Canadian Armed Forces to resume live-fire training off coast of Vancouver Island following marine mammal study. https://www.cbc.ca/news/canada/british-columbia/canadian-armed-forces-gunnery-training-marine-mammals-bc-1.6714558.

Centre for Whale Research. 2020, December 31. Southern Resident Killer Whale Population. https://www.whaleresearch.com/pop.

Colby, J. (2013). The Whale and the Region: Orca Capture and Environmentalism in the New Pacific Northwest. *Journal of the Canadian Historical Association*, *24*(2), 425-454.

COSEWIC. (2021). COSEWIC Assessment Process, Categories, and Guidelines. https://cosewic.ca/images/cosewic/pdf/Assessment_process_criteria_Nov_2021_en.pdf

Cousteau, J. M. 2012, February 16. Salmon: Lifeblood of the Pacific Northwest. https://divermag.com/salmon-lifeblood-of-the-pacific-northwest/.

Couture, F., Oldford, G., Christensen, V., Barrett-Lennard, L., & Walters, C. (2022). Requirements and availability of prey for northeastern pacific southern resident killer whales. *Plos one*, *17*(6), e0270523.

Cox, S. 2020, August 8. British Columbia's looming extinction crisis. https://thenarwhal.ca/bc-extinction-crisis/.

Cullon, D. L., Yunker, M. B., Alleyne, C., Dangerfield, N. J., O'Neill, S., Whiticar, M. J., & Ross, P. S. (2009). Persistent organic pollutants in Chinook salmon (Oncorhynchus tshawytscha): implications for resident killer whales of British Columbia and adjacent waters. *Environmental Toxicology and Chemistry: An International Journal*, *28*(1), 148-161.

David Suzuki Foundation, Dogwood Initiative, Environmental Defense Canada, Greenpeace Canada, International Fund for Animal Welfare, Raincoast Conservation Society, Sierra Club of Canada, & Western Canada Wilderness Committee v. Minister of Fisheries and Oceans, Minister of Environment. (Federal Court of Canada, 2010, December 7).

Duhamel, F.X. 2020, November 17. U.S. environmental organization says no 'meaningful changes' were incorporated into new regulations. https://www.cbc.ca/news/canada/british-columbia/u-s-renews-navy-s-right-harm-marine-mammals-1.5802652.

Favaro, B., Claar, D. C., Fox, C. H., Freshwater, C., Holden, J. J., & Roberts, A. (2014). Trends in extinction risk for imperiled species in Canada. *PLoS One*, *9*(11), e113118.

Fearnbach, H., Durban, J. W., Ellifrit, D. K., & Balcomb, K. C. (2018). Using aerial photogrammetry to detect changes in body condition of endangered southern resident killer whales. *Endangered Species Research*, *35*, 175-180.

Findlay, C. S., Elgie, S., Giles, B., & Burr, L. (2009). Species listing under Canada's species at risk act. *Conservation Biology*, *23*(6), 1609-1617.

Finn, R. J., Chalifour, L., Gergel, S. E., Hinch, S. G., Scott, D. C., & Martin, T. G. (2021). Quantifying lost and inaccessible habitat for Pacific salmon in Canada's Lower Fraser River. *Ecosphere*, *12*(7), e03646.

Fisheries and Oceans Canada. 2017. Action Plan for the Northern and Southern Resident Killer Whale (Orcinus orca) in Canada. Species at Risk Act Action Plan Series. Fisheries and Oceans Canada, Ottawa.

Ford, J. K., Ellis, G. M., & Balcomb, K. C. (2000). *Killer whales: the natural history and genealogy of Orcinus orca in British Columbia and Washington*. UBC press.

Ford, M. J., Hempelmann, J., Hanson, M. B., Ayres, K. L., Baird, R. W., Emmons, C. K., ... & Park, L. K. (2016). Estimation of a killer whale (Orcinus orca) population's diet using sequencing analysis of DNA from feces. *Plos one*, *11*(1), e0144956.

Gaydos, J. K., Thixton, S., & Donatuto, J. (2015). Evaluating threats in multinational marine ecosystems: a Coast Salish First Nations and tribal perspective. *PloS one*, *10*(12), e0144861.

Government of Canada. N.d. About the Species at Risk Act. https://www.canada.ca/en/environment-climate-change/services/environmental-enforcement/acts-regulations/about-species-at-risk-act.html.

Government of Canada. 2020, January 14. Canadian Coast Guard opens the first Marine Mammal Desk to better protect Southern Resident Killer Whales and other cetaceans. https://www.canada.ca/en/canadian-coast-guard/news/2021/01/canadian-coast-guard-opens-the-first-marine-mammal-desk-to-better-protect-southern-resident-killer-whales-and-other-cetaceans.html.

Government of Canada. 2023, June 1. Interim Order for the protection of killer whales (Orcinus orca) in the waters of Southern British Columbia.

https://tc.canada.ca/en/interim-order-protection-killer-whale-orcinus-orca-waters-southern-british-columbia

Government of Canada. N.d. Species at Risk public registry. https://species-registry.canada.ca/index-en.html#/species?sortBy=commonNameSort&sortDirection=asc&pageSize=10&keywords=turtle.

Government of Canada. 2017, June 14. Toxic substances list: PCBs. https://www.canada.ca/en/environment-climate-change/services/management-toxic-substances/list-canadian-environmental-protection-act/polychlorinated-biphenyls.html.

Hanson, M. B., Baird, R. W., Ford, J. K., Hempelmann-Halos, J., Van Doornik, D. M., Candy, J. R., ... & Ford, M. J. (2010). Species and stock identification of prey consumed by endangered southern resident killer whales in their summer range. *Endangered Species Research*, *11*(1), 69-82.

Hanson, M. B., Emmons, C. K., Ford, M. J., Everett, M., Parsons, K., Park, L. K., ... & Barre, L. (2021). Endangered predators and endangered prey: Seasonal diet of Southern Resident killer whales. *PLoS One*, *16*(3), e0247031.

Harris, K. A., Dangerfield, N., Woudneh, M., Brown, T., Verrin, S., & Ross, P. S. (2008). Partitioning of current-use and legacy pesticides in salmon habitat in British Columbia, Canada. *Environmental Toxicology and Chemistry: An International Journal*, *27*(11), 2253-2262.

Holbert, S., Colbourne, K., Fisk, A. T., Ross, P. S., MacDuffee, M., Gobas, F. A., & Brown, T. M. Polychlorinated Biphenyl and Polybrominated Diphenyl Ether Profiles Vary with Diet and Migratory Distribution Among 10 Chinook Salmon (Oncorhynchus Tshawytscha) Stocks in the North Pacific Ocean. *Available at SSRN 4516228*.

Indian Country Today. 2019, August 28. Southern Resident Killer Whales given Lummi name in traditional ceremony. https://ictnews.org/the-press-pool/southern-resident-killer-whales-given-lummi-name-in-traditional-ceremony?redir=1.

Johannessen, S. C., Macdonald, R. W., Burd, B., van Roodselaar, A., & Bertold, S. (2015). Local environmental conditions determine the footprint of municipal effluent in coastal waters: A

case study in the Strait of Georgia, British Columbia. *Science of the Total Environment*, *508*, 228-239.

Joy, R., Tollit, D., Wood, J., MacGillivray, A., Li, Z., Trounce, K., & Robinson, O. (2019). Potential benefits of vessel slowdowns on endangered southern resident killer whales. *Frontiers in Marine Science*, *6*, 344.

Juniper, K. 2014, August 26. Sharing Ocean Data. https://www-static01.oceannetworks.ca/sharing-ocean-data.html.

Kardos, M., Zhang, Y., Parsons, K. M., Kang, H., Xu, X., Liu, X., ... & Li, S. (2023). Inbreeding depression explains killer whale population dynamics. *Nature Ecology & Evolution*, *7*(5), 675-686.

Kim, J. J., Delisle, K., Brown, T. M., Bishay, F., Ross, P. S., & Noël, M. (2022). Characterization and interpolation of sediment polychlorinated biphenyls and polybrominated diphenyl ethers in resident killer whale habitat along the coast of British Columbia, Canada. *Environmental Toxicology and Chemistry*, *41*(9), 2139-2151.

Kiszka, J. J., Heithaus, M. R., & Wirsing, A. J. (2015). Behavioural drivers of the ecological roles and importance of marine mammals. *Marine Ecology Progress Series*, *523*, 267-281.

Knoth, J. M. (2019). *Anthrozoology, Anthropomorphism, and Marine Conservation: A Case Study of Southern Resident Killer Whale, Tahlequah, and her Tour of Grief* (Doctoral dissertation).

Krahn, M. M., Hanson, M. B., Schorr, G. S., Emmons, C. K., Burrows, D. G., Bolton, J. L., ... & Ylitalo, G. M. (2009). Effects of age, sex and reproductive status on persistent organic pollutant concentrations in “Southern Resident” killer whales. *Marine Pollution Bulletin*, *58*(10), 1522-1529.

Last Real Indians. 2021, December 21. Invisible no more: Talulip flag soars at every Marysville School District campus by Michael Rios. https://lastrealindians.com/news/2021/12/2/invisible-no-more-tulalip-flag-soars-at-every-marysville-school-district-campus-by-michael-rios.

Lacy, R. C., Williams, R., Ashe, E., Balcomb III, K. C., Brent, L. J., Clark, C. W., ... & Paquet, P. C. (2017). Evaluating anthropogenic threats to endangered killer whales to inform effective recovery plans. *Scientific reports*, *7*(1), 14119.

Lee, K., Alava, J. J., Cottrell, P., Cottrell, L., Grace, R., Zysk, I., & Raverty, S. (2022). Emerging Contaminants and New POPs (PFAS and HBCDD) in Endangered Southern Resident and Bigg's (Transient) Killer Whales (Orcinus orca): In Utero Maternal Transfer and Pollution Management Implications. *Environmental science & technology*, *57*(1), 360-374.

Lerner, J. E., & Hunt, B. P. (2023). Seasonal variation in the lipid content of Fraser River Chinook Salmon (Oncorhynchus tshawytscha) and its implications for Southern Resident Killer Whale (Orcinus orca) prey quality. *Scientific Reports*, *13*(1), 2675.

Levy, D. A., & Northcote, T. G. (1982). Juvenile salmon residency in a marsh area of the Fraser River estuary. *Canadian Journal of Fisheries and Aquatic Sciences*, *39*(2), 270-276.

Lundin, J. I., Ylitalo, G. M., Giles, D. A., Seely, E. A., Anulacion, B. F., Boyd, D. T., ... & Wasser, S. K. (2018). Pre-oil spill baseline profiling for contaminants in Southern Resident killer whale fecal samples indicates possible exposure to vessel exhaust. *Marine pollution bulletin*, *136*, 448-453.

McDevitt-Irwin, J. M., Fuller, S. D., Grant, C., & Baum, J. K. (2015). Missing the safety net: evidence for inconsistent and insufficient management of at-risk marine fishes in Canada. *Canadian Journal of Fisheries and Aquatic Sciences*, *72*(10), 1596-1608.

MacMahon M., & Kretzel, L. 2016, November 7. Critics fear feds' ocean response plan precursor to pipeline.
https://vancouver.citynews.ca/2016/11/07/ocean-protection-plan-unveiled-vancouver/.

Mongillo, T. M., Holmes, E. E., Noren, D. P., VanBlaricom, G. R., Punt, A. E., Neill, S. M., ... & Ross, P. S. (2012). Predicted polybrominated diphenyl ether (PBDE) and polychlorinated biphenyl (PCB) accumulation in southern resident killer whales. *Marine Ecology Progress Series*, *453*, 263-277.

Mooers, A. O., Festa-Bianchet, M., & Hutchings, J. A. (2007). Biases in legal listing under Canadian endangered species legislation. *Conservation Biology*, *21*(3), 572-575.

Narum, S. R., Hess, J. E., & Matala, A. P. (2010). Examining genetic lineages of Chinook salmon in the Columbia River Basin. *Transactions of the American Fisheries Society*, *139*(5), 1465-1477.

National Energy Board. 2016, May. Transmountain Pipeline Expansion Project. https://iaac-aeic.gc.ca/050/documents/p80061/114562E.pdf

National Oceanic and Atmospheric Administration. 2023, May 10. https://www.fisheries.noaa.gov/species/chinook-salmon.

Norman, E. S. (2014). *Governing transboundary waters: Canada, the United States, and Indigenous communities*. Routledge.

Northcote, T. G., & Atagi, D. Y. (1997). Pacific salmon abundance trends in the Fraser River watershed compared with other British Columbia systems. *Pacific salmon and their ecosystems: status and future options. Springer, New York, New York, USA. http://dx. doi. org/10.1007/978-1-4615-6375-4_14*, 199-219.

Olympics. N.d. Vancouver 2010 Mascot. https://olympics.com/en/olympic-games/vancouver-2010/mascot.

Orca Network. N.d. Whale Tales - L98 Luna - Tsuxiit. https://www.orcanetwork.org/orca-resource-center/4tz7p3zbjhk7xb8y6cha6j0bnt2w9e?rq=luna.

Pacific Salmon Commission. N.d. The Pacific Salmon Treaty. https://www.psc.org/about-us/history-purpose/pacific-salmon-treaty/.

Palm, E. C., Fluker, S., Nesbitt, H. K., Jacob, A. L., & Hebblewhite, M. (2020). The long road to protecting critical habitat for species at risk: The case of southern mountain woodland caribou. *Conservation Science and Practice*, *2*(7), e219.

Parks Canada. 2023, April 27. Southern Resident Killer Whale research project. https://parks.canada.ca/pn-np/bc/pacificrim/nature/recherche-research/erds-srkw.

Parks Canada. 2023, June 21. What is ecological connectivity? https://parks.canada.ca/nature/science/conservation/connectivite-connectivity.

Pasternak, A., & Walters, K.E. 2023. Rights of Nature: Pathways to legal personhood for the Fraser River Estuary. Raincoast Conservation Foundation. Sidney BC Canada. ISBN 978-1-9993892-9-1. raincoast.org/reports/fraserpersonhood/.

Pawluk, K. A., Fox, C. H., Service, C. N., Stredulinsky, E. H., & Bryan, H. M. (2019). Raising the bar: Recovery ambition for species at risk in Canada and the US. *Plos one*, *14*(11), e0224021.

Pedersen, D. (2022). *Trust, Control, and Risk in the Salish Sea: A Case Study of the Transboundary Network Governing the Endangered Southern Resident Killer Whale*. McGill University (Canada).

Pollution Tracker, n.d. PBDEs. https://pollutiontracker.org/contaminants/pbdes/#:~:text=In%20Canada%2C%20regulations%20implemented%20in,penta%2DBDE%20in%20commercial%20mixtures.&text=As%20of%202016%2C%20prohibitions%20on,containing%20them%2C%20except%20manufactured%20items.

Raincoast Conservation Foundation. 2012, February 9. Appeal court affirms protection for killer whales. https://www.raincoast.org/2012/02/killer-whale-appeal/.

Ross, P. S., Ellis, G. M., Ikonomou, M. G., Barrett-Lennard, L. G., & Addison, R. F. (2000). High PCB concentrations in free-ranging Pacific killer whales, Orcinus orca: effects of age, sex and dietary preference. *Marine Pollution Bulletin*, *40*(6), 504-515.

Ross, P. S., Kennedy, C. J., Shelley, L. K., Tierney, K. B., Patterson, D. A., Fairchild, W. L., & Macdonald, R. W. (2013). The trouble with salmon: relating pollutant exposure to toxic effect in species with transformational life histories and lengthy migrations. *Canadian Journal of Fisheries and Aquatic Sciences*, *70*(8), 1252-1264.

Ross, E. R., & Randhir, T. O. (2022). Effects of climate and land use changes on water quantity and quality of coastal watersheds of Narragansett Bay. *Science of the total environment*, *807*, 151082.

Rehberg-Besler, N., & Jefferies, C. S. (2019). The Case for a Southern Resident Killer Whale Emergency Protection Order under Canada's Species at Risk Act. *Journal of Environmental Law and Practice*, *32*(2), 137-161.

Review Panel for the Roberts Bank Terminal 2 Project. 2020, March 27. Federal Review Panel Report for the Roberts Bank Terminal 2 Project. https://iaac-aeic.gc.ca/050/documents/p80054/134506E.pdf.

Scott, D., Dixon, R., & MacDuffee, M. 2020, March. Toward a vision for salmon habitat in the Lower Fraser River. https://www.raincoast.org/wp-content/uploads/2022/09/Vision-for-Salmon-Report-Raincoast-2020.pdf.

Slaney, T. L., Hyatt, K. D., Northcote, T. G., & Fielden, R. J. (1996). Status of anadromous salmon and trout in British Columbia and Yukon. *Fisheries*, *21*(10), 20-35.

Species at Risk Act of 2002. S.C. 2002, c. 29. https://laws-lois.justice.gc.ca/eng/acts/S-15.3/.

Stewart, J. D., Cogan, J., Durban, J. W., Fearnbach, H., Ellifrit, D. K., Malleson, M., ... & Balcomb, K. C. (2023). Traditional summer habitat use by Southern Resident killer whales in the Salish Sea is linked to Fraser River Chinook salmon returns. *Marine Mammal Science*.

Stewart, J. D., Durban, J. W., Fearnbach, H., Barrett-Lennard, L. G., Casler, P. K., Ward, E. J., & Dapp, D. R. (2021). Survival of the fattest: linking body condition to prey availability and survivorship of killer whales. *Ecosphere*, *12*(8), e03660.

Tasker, J.P. 2016, November 29. Trudeau cabinet approves Trans Mountain, Line 3 pipelines, rejects Northern Gateway. https://www.cbc.ca/news/politics/federal-cabinet-trudeau-pipeline-decisions-1.3872828#:~:text=Politics-,Trudeau%20cabinet%20approves%20Trans%20Mountain%2C%20Line%203%20pipelines%2C%20rejects%20Northern,markets%2C%20if%20they%20are%20constructed.

Tennessen, J. B., Holt, M. M., Wright, B. M., Hanson, M. B., Emmons, C. K., Giles, D. A., ... & Deecke, V. B. (2023). Divergent foraging strategies between populations of sympatric matrilineal killer whales. *Behavioral Ecology*, *34*(3), 373-386.

Tierney, K. B., Sampson, J. L., Ross, P. S., Sekela, M. A., & Kennedy, C. J. (2008). Salmon olfaction is impaired by an environmentally realistic pesticide mixture. *Environmental Science & Technology*, *42*(13), 4996-5001.

Thornhill Verma, J. 2022, November 26. The federal government is less likely to protect an at-risk fish if people like to eat it. https://thenarwhal.ca/dfo-fish-species-at-risk/.

Trans Mountain. N.d. Our history. https://www.transmountain.com/history.

Turcotte, A., Kermany, N., Foster, S., Proctor, C. A., Gilmour, S. M., Doria, M., ... & Bennett, J. R. (2021). Fixing the Canadian Species at Risk Act: identifying major issues and recommendations for increasing accountability and efficiency. *Facets*, *6*(1), 1474-1494.

Vancouver Fraser Port Authority. N.d. About the project. https://www.robertsbankterminal2.com/about-the-project/project-overview/.

Vancouver Fraser Port Authority. 2023, June. Summary report: 2022 Haro Strait and Boundary Pass voluntary ship slowdown. https://www.portvancouver.com/wp-content/uploads/2023/06/Haro-Strait-and-Boundary-Pass-Technical-Report-2022.pdf

Vanderzwaag, D. L., & Hutchings, J. A. (2005). Canada's marine species at risk: science and law at the helm, but a sea of uncertainties. *Ocean Development & International Law*, *36*(3), 219-259.

Veirs, S., Veirs, V., & Wood, J. D. (2016). Ship noise extends to frequencies used for echolocation by endangered killer whales. *PeerJ*, *4*, e1657.

Vélez-Espino, L. A., Ford, J. K., Araujo, H. A., Ellis, G., Parken, C. K., & Sharma, R. (2015). Relative importance of Chinook salmon abundance on resident killer whale population growth and viability. *Aquatic conservation: marine and freshwater ecosystems*, *25*(6), 756-780.

Wale, J. 2023, May. Bad Forecast: The Illusion of Indigenous Inclusion and Representation in Climate Change Adaptation Plans in Canada. https://yellowheadinstitute.org/indigenous-inclusion-climate-representation/.

Walters, C., English, K., Korman, J., & Hilborn, R. (2019). The managed decline of British Columbia's commercial salmon fishery. *Marine Policy*, *101*, 25-32.

Waples, R. S., Nammack, M., Cochrane, J. F., & Hutchings, J. A. (2013). A tale of two acts: endangered species listing practices in Canada and the United States. *BioScience*, *63*(9), 723-734.

Warkentin, L., Parken, C. K., Bailey, R., & Moore, J. W. (2022). Low summer river flows associated with low productivity of Chinook salmon in a watershed with shifting hydrology. *Ecological Solutions and Evidence*, *3*(1), e12124.

Wasser, S. K., Lundin, J. I., Ayres, K., Seely, E., Giles, D., Balcomb, K., ... & Booth, R. (2017). Population growth is limited by nutritional impacts on pregnancy success in endangered Southern Resident killer whales (Orcinus orca). *PLoS One*, *12*(6), e0179824.

Williams, R., Krkošek, M., Ashe, E., Branch, T. A., Clark, S., Hammond, P. S., ... & Winship, A. (2011). Competing conservation objectives for predators and prey: estimating killer whale prey requirements for Chinook salmon. *PloS one*, *6*(11), e26738.

Appendices

Appendices hold helpful but detailed information such as your survey question set or case studies that would only detract from your analysis and discussion if you included them in the main part of the paper. If you use this part of your report for a glossary of special terms be sure to list them alphabetically. Note that each Appendix starts on a new page.

Appendix A Case Studies

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Appendix B Setting up the Page Orientation

Sometimes your information is better represented in a matrix that spans horizontally. It's easy to insert landscape-oriented pages anywhere in your document. Here's how:

Step 1: Insert a SECTION BREAK before the page you want to be in landscape format. To do this, go to Page Layout (MS Word) or Layout (Mac) and click on the little down arrow next to "breaks." Select "next page." See Figure 1 for more details.

Step 2: Place your cursor somewhere in the middle of the new section. Then in the "page layout" section click on "orientation" and choose "landscape." See Figure 2 for more details.

Step 3: Sometimes the page numbering defaults. To fix this, double click on the page number to select it then right click to get the context menu. From the menu select "format page numbers" and click "continue numbering." See Figure 3 for more details.

Step 4: If you are inserting landscape oriented pages in the middle of your document you will want to revert to portrait orientation for the following pages. To do this follow Step 1 again and add another section break at the end of your landscape page. Change the page layout to portrait on the following page accordingly.

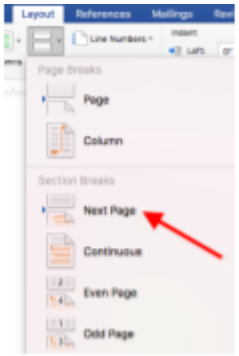

Figure 1. Insert a section break

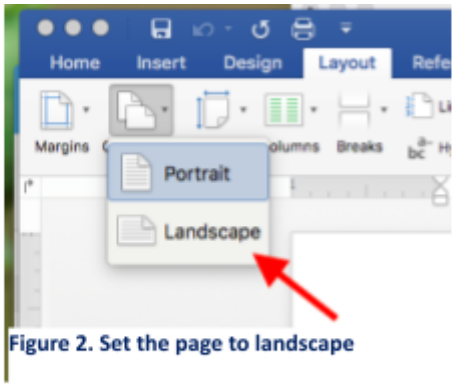

Figure 2. Set the page to landscape

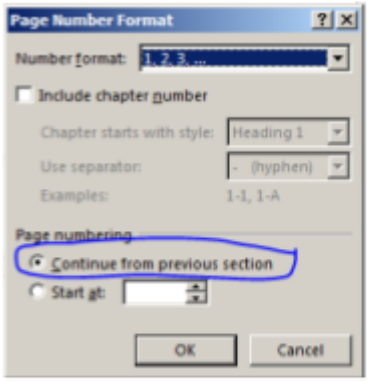

Figure 3. Make sure the page numbers are continuous.