Characterizing boater interaction with southern resident killer whales in their Critical Habitat

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INTRODUCTION

- Critical habitat has been identified for southern resident killer whales (SRKW) in Canada and the United States under the Species at Risk Act and Endangered Species Act, respectively (Figure 1).
- Straitwatch is a marine mammal stewardship program operating in the inshore waters around Vancouver Island, British Columbia, Canada (Figure 2).
- The Straitwatch water-based program ranges overlap entirely with Critical Habitat identified for both the northern and southern resident killer whale (NRKW & SRKW respectively) (Figure 3).
- Straitwatch has operated within the Critical Habitat of the SRKW since 2007.
- Straitwatch's main functions include:
  - Educating boaters about how to reduce their impact following the "Be Whale Wise Marine Wildlife Viewing Guidelines for Boaters, Paddlers and Viewers (BWW) (Figure 4) (DFO. 2011; Cetus. 2011). Note Straitwatch makes contact with an average of 15 recreational vessel operators per day.
  - Monitoring vessel activity around marine mammals (primarily killer & humpback whales).

Research has demonstrated that certain **Interactions** between vessels and killer whales can impact the behaviour of killer whales (Table 1). These impacts include:

- avoidance behaviour & changes in behaviour which include the cessation of feeding, resting, and social behaviours (Lusseau et al. 2009; Williams et al. 2006; Williams et al. 2009);
- abandonment of nursing areas, alteration of travel patterns, or relocation to other areas (NMFS. 2009; DFO. 2008); and,
- interference with the whales ability to communicate, navigate and echolocate and in some extreme cases damage their ability to hear (Holt el al. 2009; Williams et al. 2002; Erbe. 2002).

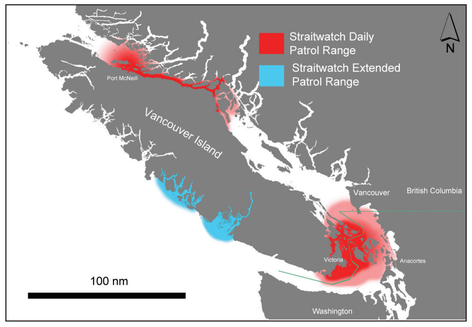

Figure 2 - Straitwatch Patrol Range

Figure 3 - Straitwatch monitoring vessel

	Travel pattern	Surface behaviour	Energetic requirements	Acoustic
Within 100 meters	- Change in mean directiveness. Takes 13% longer to go same distance when vessel(s) - within 100 meters. [3] - Path is less direct. [4]	- increased Surface Active Behaviours (SAB). [5] [6] - increased SABs especially when the vessel is motoring vs. stopped[6] - most SABs are tail slaps which are visual and acoustic communication tools & may be performed when the animal is disturbed. [7] - the min approach distance of 100m may be insufficient to prevent behavioral response in whales. [1] [2]	- increased energetic requirements due to increased dives, socializing, SABs & erratic swimming. [5] [6] - whales tend to switch from important feeding activities to lower energy states such as travelling. [8] [2] - loss of potential energy acquisition of 28% [8]	- decreased energy acquisition as noise impairs whales ability to forage. [9] - presence of vessel noise results in increased call duration and an increase in call source level. [1]
Speed > 7knots within 400 meters		- faster moving boat elicits the greatest change in whale behaviour when the vessel is within 400 m. [4] [7] - vessels travelling greater than 7 knots within 200 m elicit SABs[7]		- sound level of vessels travelling > 7 knots at 400m is equal to a slow vessel paralleling whales at 100m[9] - vessels travelling at > 20 knots are audible at 16km and can mask killer whale calls at 14km [7]
Parked in the path	- travel path considerably less direct (17% longer.). [8] - whales successively increased the mean angle between surfacings by 90% when vessels leap frogged/parked in the path[8]		- predator avoidance behaviour employed by whales results in increased energy requirements coupled with reduced time spent foraging [9]	

Williams et al. 2002[4], Lusseau 2006[5], Noren et al. 2009[7], Constantine et al. 2004[4], Williams et al. 2009[4], Erbe 2002[7], Lusseau et al. 2009[3], Williams et al. 2006[1], Williams and Ashe 2007[7], Holt et al. 2009[7]

Table 1: Impacts to killer whales resulting from vessel interactions

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RESEARCH OBJECTIVE

- To use the Straitwatch monitoring data to quantify the extent by which the BWW guidelines are exceeded, both spatially and temporally, by vessels operating around the SRKWs in their Critical Habitat.
- To provide an indirect measure of the frequency and location of **Interactions** between vessels and the SRKWs capable of changing the behaviour of the SRKW.

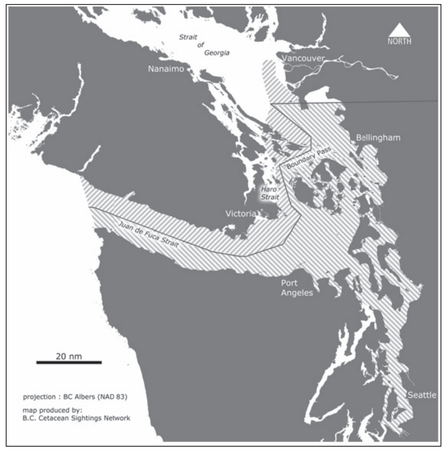

Figure 1 - Southern Resident Killer Whale Critical Habitat

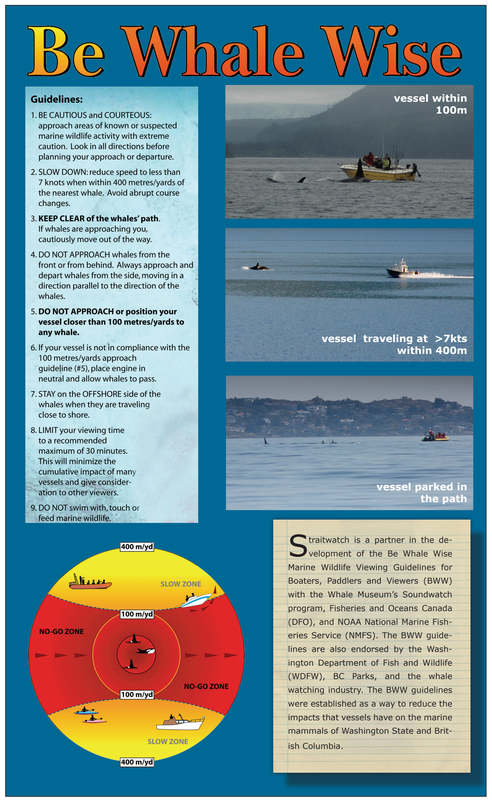

Figure 4 - Be Whale Wise Marine Wildlife Viewing Guidelines for Boaters, Paddlers and Viewers

METHODS

Straitwatch collects monitoring data in the form of ***Vessel Counts*** and ***Incident Scans*** (Figure 5) throughout their monitoring zones within the SRKW Critical Habitat. The Straitwatch crew endeavours to follow a single **Focal Group** throughout the day; a **Focal Group** that is chosen early in the day, such that the data reported here gives a reasonable representation of vessel interactions experienced by any particular group of SRKW in their Critical Habitat.

- ***Vessel Counts***: Using radar, ranger finders and chart plotter to measure distances, we record the number, sector (e.g. private, ecotour, shipping etc.) and activity (e.g. whale oriented, transiting, fishing etc.) of vessels within 1 km of a **Focal Group** of whales**.** Counts are conducted every 30 minutes.
  - In 2010 Straitwatch began to record the number of vessels within 400 meters of the **Focal Group** of whales.
- ***Incident Scans***: Using radar, range finders and chart plotter to measure distances, record the number of **Interactions** between vessels and whales. Scan are 20 minutes in length, with a Vessel Count occurring at the beginning and end of each scan.

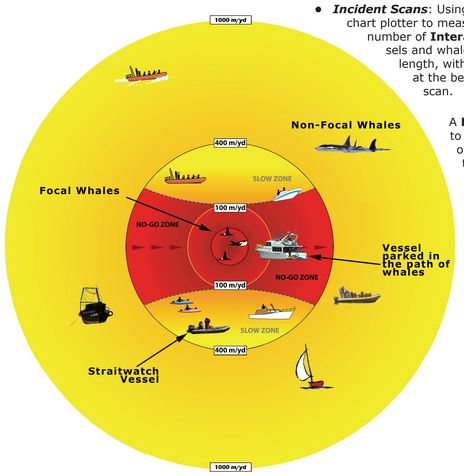

Figure 5 - Vessel Counts and Incident Scans

A **Focal Group** is considered to be a focal animal and any other whales within 400 meters of that whale that are travelling together.

Interactions were identified in the scientific literature and grouped by incident type and distance of vessels from a **Focal Group** of whales such that the following three categories were considered in the analysis:

1. Vessels within 100 meters of whales;
2. Vessels travelling at speed greater than 7 knots within 400 meters of whales;
3. Vessels parked in the path of whales.

(see Figure 4 for examples).

RESULTS

- The average number of vessels within 1 km of any **Focal Group** of SRKWs during the summer months of 2007 to 2010 is 9.4 (Figure 6). *Note, there are most often numerous **Focal Group** on scene and a comparable number of vessels around each group.*
- The average number of vessels within 400 meters of a SRKW **Focal Group** during the summer of 2010 is 5.4 (Figure 7). It`s worth noting that a 400 meter radius circle around the **Focal Group** represents 20% of the area compared to a 1km radius circle. Which means that 53% of the vessels are concentrated in 20% of the area that is closest to the **Focal Group**.
- Throughout the summer months the SRKWs experience an average of 62.5 interacations with vessels each day (Table 2).
- These interactions peak in July and August when any particular SRKW **Focal Group** will likely experience over 100 interactions per day, with many days over 200 interactions with vessels (Table 2).
- Many of the areas identified by the highest rates of interactions also coincide with the zones in which the SRKWs spend the most time (Figure 8). It is worth noting that the waters within 1/2 nautical mile of shore of San Juan Island (at the center of figure 8) that are set aside as a voluntary no-go zone confer a significant benefit and lower the interactions with vessels compared to adjacent zones.

The rates of interactions we are reporting here might be considered a minimum, as:

- there are other conditions that cause whales to change their behaviour that we don't capture (e.g. acoustic);
- vessel interactions may cause negative effects that don't illicit a change in whale behaviour;
- Straitwatch only records incidents that we are positive occurred – we likely miss some interactions; and,
- Straitwatch is only able to observe vessel/SRKWs interactions for 12 hours of the day.

	May	June	July	August	September	All Months
AVG	8.5	8.1	9.3	10.6	8.8	9.4
MEDIAN	8.0	7.0	8.0	10.0	7.0	49.0
MAX	15.5	30.5	41.5	49.0	34.5	8.0
STANDARD DEVIATION	3.3	5.1	5.8	6.5	6.5	6.1

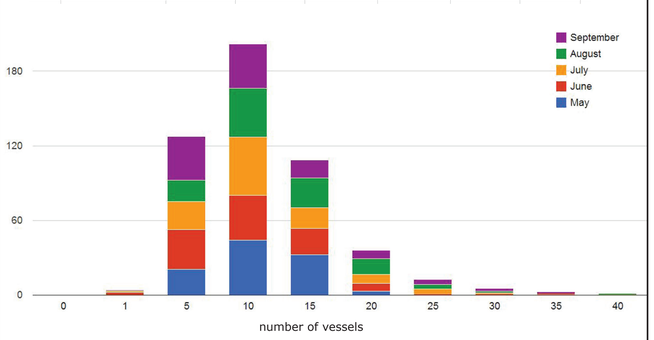

Figure 6 - Vessel Counts - histogram of vessels within 1 km of whales (with summary statistics)

ABSTRACT

A population of killer whales (Orcinus orca) ranging in British Columbia and Washington state Southern resident killer whales (SRKW) are listed as endangered in Canada (under the Species at Risk Act (SARA)) and the United States (under the Endangered Species Act) (SARA. 2011; NOAA. 2011). This population of killer whale faces a variety of threats, including reductions in prey populations, high levels of toxins, disturbance from vessels and acoustic disturbances (DFO. 2008). It is highly likely that these threats are cumulative, interactive, and synergistic. Further, this population is the focus of a significant whale watching industry and also attracts viewers from a high number of recreational vessels in the region.

The Be Whale Wise Marine Wildlife Guidelines for Boaters, Paddlers and Viewers (BWW) (DFO. 2011; Cetus. 2011), were established with input from scientists, government, non-governmental organizations and industry to reduce the threat caused by vessel disturbance. Numerous studies have linked situations where vessels exceed the BWW guidelines to changes in whale behaviour, including: swimming faster; adopting less predictable travel paths; making shorter or longer dive times; moving into open water; and, altering normal patterns of behaviour at the surface (Constantine et al. 2004; Holt et al. 2009; Lusseau. 2006; Lusseau et al. 2009; Noren et al. 2009; Williams et al. 2002; Williams et al. 2006; Williams and Ashe. 2007; Williams et al. 2009).

From 2007 to 2011, the Victoria, BC based Straitwatch program has educated boaters about whale watching guidelines and has monitored the type and level of vessel interactions with SRKW throughout the area identified as critical habitat by the responsible Canadian and US agencies (DFO.2008). Monitoring data collected by Straitwatch measures both the number of vessels following a focal group of SRKW and a rate of vessel operator non-compliance with the BWW guidelines. These data characterize the interactions of SRKW with vessels both spatially and temporally throughout their critical habitat and provide management with a tool to identify where and when management actions would be most effective.

CONCLUSION

- A growing body of scientific literature has noted that **these types of interactions** between SRKW and vessels has resulted in both **increased energy requirements** and **decreased opportunities for energy acquisition**.
- The impacts of these interactions are very likely **confounding the impacts** felt by SRKWs **in lean Chinook salmon years** (Ford et al. 2009), especially in the context of the **high toxin loads carried by SRKW.**
- **Monitoring and mitigating vessel impacts**, especially during times of low Chinook abundance, remains **an important component of the recovery** of SRKWs, and can help improve upon their foraging success.
- **Areas set aside for SRKWs** to experience reduced numbers of vessel interactions (**especially important foraging areas** (Ashe and Williams. 2007)) **may confer a significant benefit.**
- **Efforts by NOAA NMFS** to extend the approach distance to 200 yards and keep the path ahead of the whales clear of vessel traffic should be commended and are an important component to reducing vessel impacts on SRKW.
- Finally, it is worth noting that most individual operators within **the commercial whale watching industry** are highly **compliant with the BWW Guidelines**. However, the **size of the industry** means that even infrequent mistakes by individual commercial operators can translate to **frequent interactions with SRKW.** Work on **educating private vessel operators is of utmost importance** and should continue to remain a high priority.

	May	June	July	August	September	All Months
AVG	5.9	4.3	5.6	6.0	4.5	5.4
MEDIAN	5.0	4.0	5.0	5.0	4.0	4.0
MAX	17.0	18.0	27.0	22.0	17.0	27.0
STANDARD DEVIATION	3.5	3.3	4.2	4.0	3.4	3.9

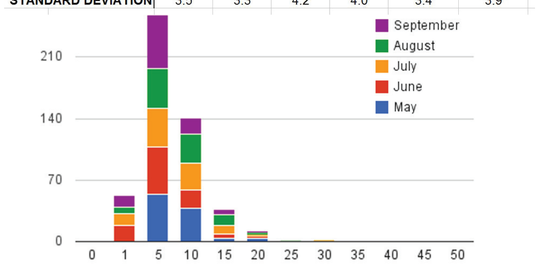

Figure 7 - Vessel Counts - histogram of vessels within 400 meters of whales (with summary statistics)

	May	June	July	August	September	All Months
AVG	13.8	54.9	66.0	112.2	65.6	62.5
MEDIAN	0.0	36.0	36.0	72.0	36.0	72.0
MAX	72.0	216.0	288.0	900.0	396.0	900.0
STD DEV	23.4	63.9	63.9	166.7	80.5	79.7

Table 2 : Daily interactions between vessels and SRKWs

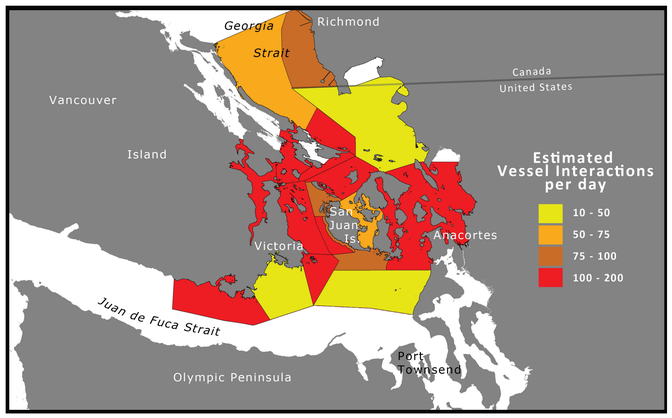

Figure 8: Interactions between vessels and SRKWs by location
(an estimate of the expected # of interactions if a group of whales spent an entire day in a particular zone)

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