Reducing Disturbance from Vessels to Southern Resident Killer Whales: Assessing the Effectiveness of the 2011 Federal Regulations in Advancing Recovery Goals

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U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

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1. INTRODUCTION

Southern Resident Killer Whale Status

In 2005, Southern Resident killer whales were listed as endangered under the Endangered Species Act (ESA) (70 FR 69903, November 18, 2005) and three primary threats to their survival were identified: prey availability, high levels of contaminants, and disturbance from vessels and sound. Despite an active research and recovery program, an updated status review under the ESA completed in 2016 concluded that these whales should remain listed as endangered (NMFS 2016a). They have also been listed as Endangered in Canada under the Species at Risk Act (Fisheries and Oceans Canada 2017). This small killer whale population has fluctuated in size but has remained fairly consistent over the last decade (from 83 whales in 2002 to 78 whales as of the end of December 2016) (Figure 1.1). Southern Resident killer whales (Southern Residents) occur in the coastal waters from southeast Alaska to California (NMFS 2008; Hanson et al. 2013; NWFSC unpubl. data) (Figure 1.2).

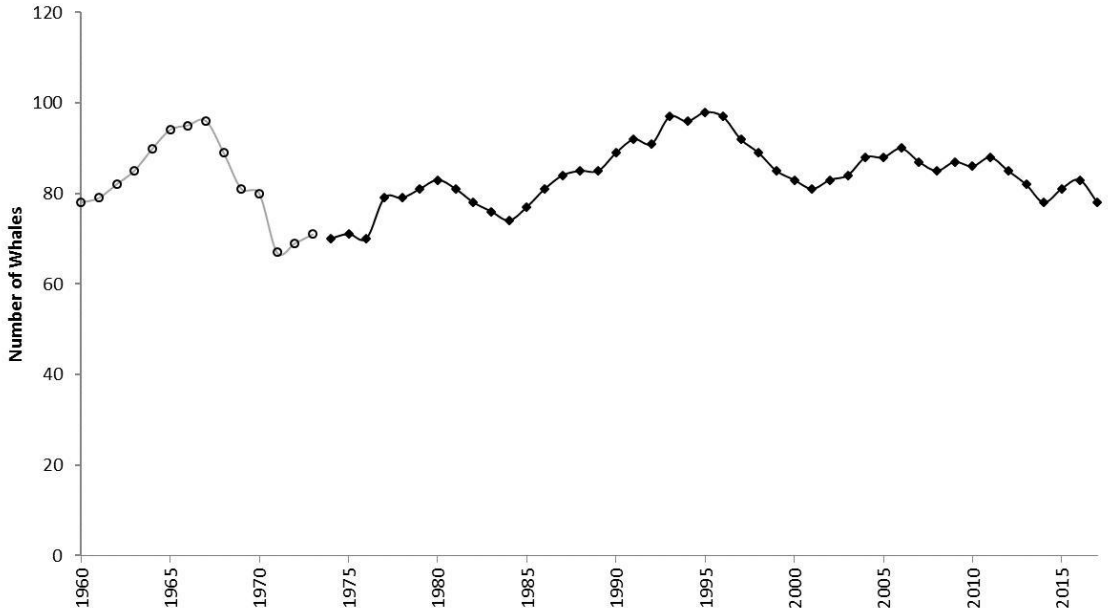

Figure 1.1. Population size and trend of Southern Resident killer whales, 1960 to 2017. Data from 1960 to 1973 (open circles, gray line) are number projections from the matrix model of Olesiuk et al. (1990). Data from 1974 to 2016 (diamonds, black line) were obtained through photo-identification surveys of the three pods (J, K, and L) in this community and were provided by the Center for Whale Research (unpubl. data) and NMFS (2008).

Since their listing, a number of actions have been taken to improve our understanding of threats to Southern Residents and to address those threats, protect habitat, and support recovery of the whales. In 2006, critical habitat was designated and consisted of three specific areas: (1) the Summer Core Area in Haro Strait and waters around the San Juan Islands, (2) Puget Sound, and (3) the Strait of Juan de Fuca (71 FR 69054, November 29, 2006). On February 24, 2015, NOAA

Fisheries announced in a 12-month finding on a petition to revise the critical habitat designation that the action was warranted. In the Federal Register notice, NMFS outlined the next steps for collecting and analyzing data, and for developing a proposed rule to revise critical habitat expected in 2017 (80 FR 9682).

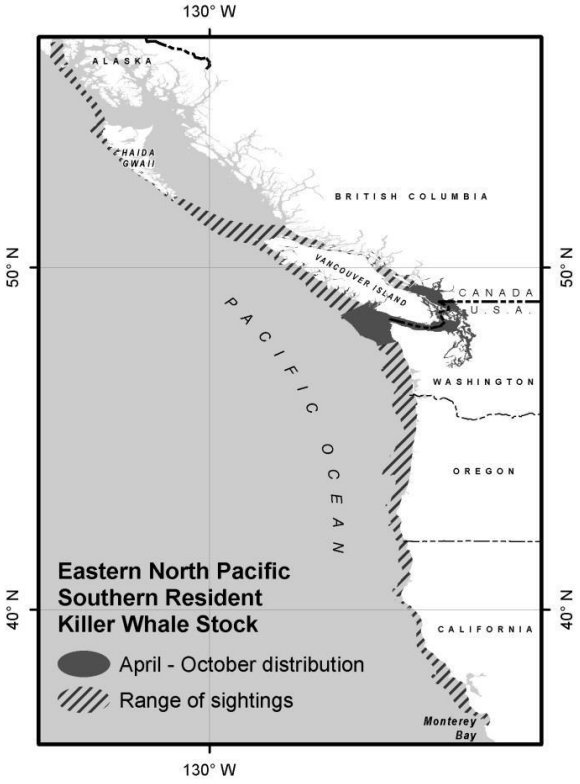

Figure 1.2. Geographic range of Southern Resident killer whales. Reprinted from Carretta et al. (2014).

In 2008, NMFS issued the final recovery plan for Southern Residents to identify actions to address factors that may be limiting recovery, including quantity and quality of prey, toxic chemicals that accumulate in top predators, and disturbance from vessels and sound (NMFS 2008). Oil spills and disease were also identified as potential risk factors. Despite efforts to study these whales over the last 40 years, we are unsure which threats are most significant to the survival and recovery of the species. It is likely that these threats are acting together to threaten the killer whales. Below are very brief descriptions of the primary threats. More detailed information is provided in the recovery plan (NMFS 2008) with additional updates provided in the most recent ESA 5-year review (NMFS 2016a).

Prey Quality & Quantity

Southern Residents consume a variety of fish species (Ford et al. 1998, 2000; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016), but salmon, specifically Chinook salmon, are identified as their primary prey (Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016).

Recently, Ford et al. (2016) found evidence of diet diversification at the end of summer toward coho salmon for all years analyzed (coho salmon contributed to over 40% of their diet in late summer). Chum salmon, sockeye salmon, and steelhead made up relatively small contributions during this seasonal sampling. In the fall, Southern Residents consume significant amounts of chum salmon. Salmon along the West Coast face a number of threats and have declined in numbers from historical levels. Several of the salmon runs consumed by the whales are also listed as threatened or endangered under the ESA, and there are concerns about sufficient salmon abundance, quality of prey, and interference from vessels and noise with the whales' ability to find and capture prey. Ongoing salmon recovery efforts are important to secure a sustainable food supply for the whales into the future.

Contaminants

Since research on the effects of environmental contaminants on Southern Residents began in the early 1990s, it has been widely known that persistent organic pollutants (POPs) or "legacy contaminants" are of particular concern to the whales. High concentrations of PCBs, DDTs, and PBDEs have been detected in the blubber and scat of the whales (Ross et al. 2000; Krahn et al. 2007, 2009; Lundin et al. 2015; Mongillo et al. 2016). POPs have been linked to serious health concerns in humans and wildlife, including immune and endocrine disruption, cancer, decreased reproduction, and increased calf mortality (Reijnders 1986; de Swart et al. 1996; Reddy et al. 2001; Schwacke et al. 2002; Fonnum et al. 2006; Ylitalo et al. 2005; Buckman et al. 2011; Lundin et al. 2016; Mongillo et al. 2016). To address the threat of pollution, NMFS has worked closely with the Puget Sound Partnership (PSP) and U.S. Environmental Protection Agency (EPA) to identify actions to restore Puget Sound (PSP 2016) and reduce exposure, monitor long-term contaminant levels, and determine the risks posed by POPs in Southern Residents (Gockel and Mongillo 2013).

Vessels & Sound

While in inland waters of Washington and British Columbia, killer whales are the principal target species for the commercial whale watch industry (Hoyt 2001; O'Connor et al. 2009) and encounter a variety of other vessels in their urban environment (e.g., recreational, fishing, ferries, military, shipping). Several main threats from vessels were listed in the Recovery Plan, including direct vessel strikes, the masking of echolocation and communication signals by anthropogenic sound, and behavioral changes (NMFS 2008). There is a growing body of evidence documenting effects from vessels on small cetaceans and other marine mammals (NMFS 2010; NMFS 2016a; NMFS In Press). Research has shown that the whales spend more time traveling and performing surface active behaviors and less time foraging in the presence of all vessel types, including kayaks, and that noise from motoring vessels up to 400m away has the potential to affect the echolocation abilities of foraging whales (Holt 2008; Lusseau et al. 2009; Noren et al. 2009; Williams et al. 2010). Individual energy balance may be impacted when vessels are present because of the combined increase in energetic costs resulting from changes in whale activity with the decrease in prey consumption resulting from reduced foraging opportunities (Williams et al. 2006; Lusseau et al. 2009; Noren et al. 2009; Noren et al. 2012). At the time of the whales' listing under the ESA, NMFS reviewed existing protections for the whales and developed recovery actions, including vessel regulations, to address the threat of vessels to killer whales.

Since their listing under the ESA in the U.S. and Species at Risk Act (SARA) in Canada, NMFS and the Canadian Department of Fisheries and Oceans (DFO) have worked together toward the recovery of Southern Residents. Canada released their own action plan in 2017 (DFO 2017) aimed at reducing threats to Northern and Southern Resident killer whales. The Canadian government has conducted several studies aimed at understanding the effects of vessel noise on Southern Residents and the impacts from increased shipping activity (RBT2 2013; SMRU Canada 2014). In November of 2016, the Government of Canada released their Oceans Protection Plan (OPP), which lists the priority issues faced by Canada as a coastal maritime nation. Canada will invest $1.5 billion over five years in coastal protections, including better understanding effects of shipping and improvements in recovery efforts for Southern Residents (Government of Canada 2017). To begin implementation of the OPP, DFO reviewed the effectiveness of recovery measures for Southern Resident killer whales noting the voluntary guidelines, disturbance charges leading to conviction in Canada, regulations in the U.S., and education and outreach, which may all contribute to reductions in acoustic and physical disturbance.

MMPA and ESA Prohibitions, Regulations, and NMFS Guidelines

The Marine Mammal Protection Act (MMPA) (16 U.S.C. 1361 *et seq.)* generally prohibits take of marine mammals. Section 3(13) of the MMPA defines the term take as "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." Except with respect to military readiness activities and certain scientific research activities, the MMPA defines the term harassment as "any act of pursuit, torment, or annoyance which: (i) has the potential to injure a marine mammal or marine mammal stock in the wild, [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment]."

Similar to the MMPA, the ESA generally prohibits the taking of endangered species. The ESA defines take to mean "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." The statute does not define the term "pursue" nor has NMFS adopted regulations defining pursuit. Under both the ESA and MMPA, there are no exceptions to the take prohibition for whale watching; therefore, wildlife viewing must be conducted in a manner that does not cause take. To promote responsible and sustainable marine animal viewing that avoids take, NMFS has worked with a variety of partners in multiple regions to develop numerous education programs, viewing guidelines, and regulations. These guidelines are available online at: http://www.nmfs.noaa.gov/pr/viewing.htm. The agency understands that whale watching enhances marine mammal conservation by increasing education and fostering stewardship and has worked with commercial whale watching industry and recreational boaters to promote responsible viewing that does not impact the whales. For particular species in specific locations, NMFS has promulgated regulations to provide additional protection to marine mammals that are the subject of wildlife viewing activities.

Since the 1990s there has been a transboundary effort between the U.S. and Canada to develop and periodically revise voluntary guidelines for viewing marine wildlife in the Pacific Northwest, with a specific focus on Southern Resident killer whales. NMFS and partners

developed the "Be Whale Wise" guidelines in 2002 to protect killer whales and all marine mammals, and they are available at www.bewhalewise.org and in Appendix A. The ESA listing identified vessel impacts as a primary threat to the whales and a growing body of scientific research documented impacts to the whales from vessel activities, particularly vessels in close proximity to the whales and not following the Be Whale Wise (BWW) guidelines. In addition, there is a transboundary industry association, formerly the Whale Watch Operators Association Northwest and now known as the Pacific Whale Watch Association (PWWA), made up of commercial operators from the U.S. and Canada, and they have created their own guidelines that include additional measures specific to industry operations (http://www.pacificwhalewatchassociation.com/).

Despite these guidelines and outreach efforts, concern remained that the level of disturbance caused by vessels surrounding these popular whales may still have harmful effects on individuals and the population. For example, NMFS received a number of complaints from the public during the listing and recovery planning processes, alleging that killer whales were routinely being disturbed by vessels attempting to closely approach and interact with the whales, particularly along the west side of San Juan Island. NMFS also received letters from the Marine Mammal Commission, members of the scientific research community, and environmental groups expressing the view that some types of interactions with wild marine mammals have the potential to harass and/or disturb the animals by causing injury or disruption of normal behavior patterns. Data from the Soundwatch Boater Education Program out of The Whale Museum in Friday Harbor, Washington also indicated a high level of noncompliance with the BWW guidelines. Soundwatch performs regular patrols in Washington's inland waters around Haro Strait every summer to document vessel behavior and educate boaters on the regulations and guidelines pertaining to boating near killer whales. Soundwatch's Canadian partner, Straitwatch, mirrors these efforts in transboundary waters. Soundwatch and Straitwatch have collected information on incidents where the guidelines to avoid harassment were not being followed. Violations of current ESA and MMPA prohibitions were routinely reported to NOAA's Office for Law Enforcement; however, the prohibitions were difficult to enforce.

The 2008 recovery plan includes a variety of management actions to recover Southern Resident killer whales. One goal of the plan is to minimize disturbance of Southern Residents from vessels. To achieve this goal, the recovery plan recommends the following actions:

1. Continue to evaluate and improve voluntary whale-watching guidelines.
2. Evaluate the need to establish regulations regarding vessel activity in the vicinity of killer whales.
3. Evaluate the need to establish areas with restrictions on vessel traffic.

In 2007, NMFS published an Advance Notice of Proposed Rulemaking to obtain public input on whether regulations were needed and what type of regulations might be appropriate to protect the whales from vessel impacts. Around the same time, San Juan County and Washington State efforts were also underway to implement mandatory regulations to protect the whales. In September 2007, the San Juan County Council enacted a local ordinance (No. 35-2007) designed to prevent boaters from harassing Southern Resident killer whales that frequent county waters. The ordinance made it unlawful to feed killer whales or "knowingly" approach a killer whale

within 100 yards in San Juan County. In addition, a state law with similar language to the BWW guidelines was approved on March 28, 2008 to protect killer whales in Washington State waters and became effective in June of 2008 (RCW 77.15.740).

Based on research and vessel monitoring results, an Environmental Assessment (EA) under the National Environmental Policy Act (NEPA), and public input, NMFS determined that the existing prohibitions, regulations, and guidelines did not provide sufficient protection of killer whales from vessel impacts. The NEPA review (NMFS 2010) analyzed a variety of alternative protective regulations; benefits and impacts to resources including the whales, whale watch industry, and recreation; and included the latest scientific information regarding vessel impacts and data on economics.

NMFS concluded it was necessary and advisable to adopt regulations to protect killer whales from disturbance and sound associated with vessels, to support recovery of Southern Resident killer whales. NMFS proposed vessel regulations in 2009 (74 FR 37674, July 29, 2009), gathered public comments, and in 2011 adopted final regulations pursuant to rulemaking authority under MMPA section 112(a) (16 U.S.C.1382(a)) and ESA section 11(f) (16 U.S.C.1540(f)). These regulations are also consistent with the purpose of the ESA "to provide a program for the conservation of [...] endangered species" and "the policy of Congress that all Federal departments and agencies shall seek to conserve endangered species [...] and shall utilize their authorities in furtherance of the purposes of [the ESA]" (16 24 U.S.C. 1531(b), (c)). The federal vessel regulations were established in 2011 to prohibit vessels from approaching killer whales within 200 yards (182.9 m) and from parking in the path of the whales within 400 yards (365.8 m). These regulations apply to all vessels in inland waters of Washington State with exemptions to maintain safe navigation and for government vessels in the course of official duties, ships in the shipping lanes, research vessels under permit, and vessels lawfully engaged in commercial or treaty Indian fishing that are actively setting, retrieving, or closely tending fishing gear (76 FR 20870, April, 14, 2011). The conclusion of the final NEPA analysis (NMFS 2010) was that the preferred alternative (200 yard approach rule and prohibition on parking in the path) would provide a high benefit to the whales and minimal impact to the commercial whale watch industry or to recreational opportunities.

Assessing the Effectiveness of Vessel Regulations

Several commenters who supported the vessel regulations suggested that monitoring the effectiveness of the regulations would be an important step to assess compliance, the benefit to the whales, and identify any needed changes in the future. Several commenters expressed concern about the regulations, but were more supportive if there was a periodic review in place to evaluate the regulations. NMFS agreed that monitoring effectiveness of the regulations is an important part of an adaptive management process to ensure the regulations are effective in protecting the whales and to identify any unforeseen impacts to local communities. The success of a regulatory program to address vessel impacts is vital to recovery of the Southern Residents. Therefore, in the final rule (76 FR 20870, April 14, 2011), NMFS committed to reviewing the vessel regulations to evaluate effectiveness, and also to study the impact of the regulations on the viability of the local whale watch industry.

In March 2013, NMFS held a killer whale protection workshop to review the current vessel regulations, guidelines, and associated analyses; review monitoring, boater education, and enforcement efforts; review available industry and economic information and identify data gaps; and provide a forum for stakeholder input to explore next steps for addressing vessel effects on killer whales. The presentations and supporting documents (including workshop notes) can be found at http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/killer_whale/vessel_regulations.html.

This review of effectiveness is similar to reviews of other rules related to vessel restrictions. For example, in 2008, NMFS published a final rule to implement speed restrictions to reduce the threat of vessel collisions with North Atlantic right whales (73 FR 60173). The rule was set to expire 5 years following the publication, and within the 5 years NMFS was to develop ways to monitor and assess the effectiveness of reducing ship strikes (Silber and Bettridge 2012; Laist et al. 2014; Silber et al. 2014). In this technical memorandum, we describe our assessment of the effectiveness of the 2011 vessel regulations using similar measures analyzed in these previous assessments: education and outreach efforts, enforcement, vessel compliance, biological effectiveness, and economic impacts. For each measure, we focus on the 5 years leading up to the regulations (2006-2010) and compare trends and observations to the 5 years following the regulations (2011-2015). We conclude with recommendations for future management and policies.

2. EDUCATION AND OUTREACH

Educating the public and the whale watching industry is essential to promoting compliance with any new regulations and achieving a reduction in vessel impacts to the whales. Both voluntary and mandatory programs can create a sense of duty, particularly when education emphasizes the importance of the rules as part of the program (May 2005; National Marine Protected Areas Center 2005; Keane et al. 2008). Since the 1990s, NMFS has worked with partners to promote voluntary viewing guidelines through the BWW campaign, providing guidance to boaters about how to operate their vessels and responsibly view whales and other marine wildlife while minimizing any impact. One long-term partner, the Soundwatch Boater Education Program, was launched by The Whale Museum in Friday Harbor, Washington in 1993. The mission of this program is to prevent and record vessel disturbance to marine wildlife in the Salish Sea, especially with regard to Southern Resident killer whales and other marine mammals. Soundwatch staff and volunteers spend between 4 and 7 days per week every summer educating boaters on the water and on land about the mandatory federal and state regulations as well as the voluntary BWW guidelines. They also use this time to record incidents of noncompliance with these regulations and guidelines (https://whalemuseum.org/pages/soundwatch-boater-education-program).

In 2010, NMFS concluded that compliance with the voluntary guidelines was not sufficient to protect the endangered Southern Resident killer whales and that mandatory regulations would help improve compliance and protect the whales (NMFS 2010). The first element of compliance—ability to comply—depends on knowledge of the regulations and how easy it is to follow them. NMFS is confident that commercial operators, particularly members of the PWWA,

are aware of the existence of vessel regulations and their details. NMFS managers and enforcement officers have met regularly with the industry association to get input and provide updates on the development of regulations and updates to viewing guidelines for over a decade. Washington Department of Fish and Wildlife (WDFW) enforcement officers have also met with the industry, including participation in meetings with whale watch boat drivers to discuss compliance with the U.S. federal and Washington State regulations to protect the whales (see Section 4).

Like commercial operators, recreational boaters are subject to the mandatory ESA and MMPA rules and penalties, and are the target audience of the BWW education campaign. Since the implementation of the 2011 federal regulations, Soundwatch has recorded higher rates of noncompliance committed by recreational vessels compared to Canadian and U.S. commercial whale watch operators. This is similar to vessel incident patterns prior to the regulations and is discussed in detail in Section 4. One reason for this pattern may be that recreational boaters are less likely to know about the current general mandatory prohibitions or the specific voluntary guidelines. Recreational boaters do not belong to associations whose members all make a business of watching whales, are likely to be on the water less frequently than commercial operators, and are likely to have less contact with boater education programs and government regulators. Recreational boaters may also not be aware that whales are nearby and/or may be less able to judge distance from the whales than the more experienced whale watch operators. The commercial whale watch vessel operators are knowledgeable and experienced at maintaining the proper distance from the whales and serve as a model for recreational boaters to follow. Based on the monitoring data, Soundwatch has focused on educating the recreational boating community.

NMFS has partnered with education and outreach organizations, whale advocacy groups, and other United States and Canadian government agencies and enforcement divisions over many years to promote safe and responsible wildlife viewing practices through the development and distribution of outreach materials, training workshops, on-the-water education, and public service announcements. The Whale Museum/Soundwatch Boater Education Program, Straitwatch, and WDFW have been the leading partners in advancing the educational goals set by NMFS when the regulations were adopted, and work closely in tandem to achieve them. The following sections discuss their efforts leading up to and following the implementation of the federal vessel regulations.

Soundwatch Boater Education Program

Based out of The Whale Museum in Friday Harbor, Washington, the Soundwatch Boater Education Program has spent thousands of hours educating boaters on and off the water on the impacts that vessels have on killer whales and how to view the whales responsibly. During the summer months when Southern Residents return to their summer foraging grounds in the inland waters of Washington, Soundwatch conducts regular patrols on the water to monitor vessel activity around the whales (see Section 4). Soundwatch contacts boaters to educate them about the regulations and distribute BWW brochures (Appendix A) in addition to recording incidents of boaters not following the federal regulations and guidelines. For example, between the months of May and September of 2015, Soundwatch contacted almost 2,000 boaters. In addition to these

on-the-water education efforts, Soundwatch also distributed over 2,000 BWW brochures, 50 posters, and 2,000 Federal Rules rack cards (Appendix B) to regional federal, state, county, and private parks (Seely 2016).

Soundwatch also plays an integral role in reducing disturbance from commercial and recreational kayakers through education and training. In 2010, the San Juan County Park contracted Soundwatch to develop an education and monitoring program to enforce a Kayak Vessel Code of Conduct aimed at reducing wildlife disturbance caused by kayakers. Soundwatch has continued to administer the Kayak Education and Leadership Program (KELP) to teach kayakers how to comply with guidelines and the federal vessel regulations to reduce their impact on Southern Residents (Appendix C). These efforts have become especially important in the reduction of vessel disturbance around San Juan Island since the adoption of the regulations, as commercial kayaking companies have seen a 30% increase in their customer base in that time (Seely 2016).

When Soundwatch contacts a boat on the water to inform them of the federal regulations, they perform a brief survey to determine how awareness of the regulations has changed in the years following their implementation. This information was collected consistently starting in 2009 with the BWW guidelines that later became the federal regulations. The number of people who responded that they were aware of the new regulations was highest in 2011, shortly after they were announced. Since then, awareness has hovered at around 47% of boaters, with only 42% of the boaters contacted in 2015 responding that they had a previous understanding of the regulations (Figure 2.1) (Seely 2016). Figure 2.1 also illustrates a significant reduction in the number of boaters contacted by Soundwatch before and after the regulations were put in place. This reflects a change in Soundwatch's on-the-water monitoring and outreach protocols, which is discussed further in Section 4.

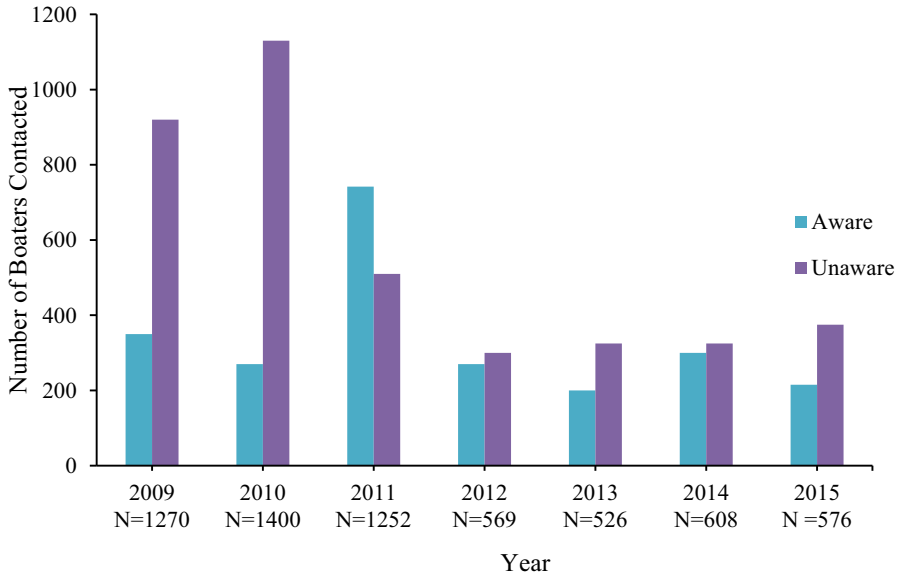

Figure 2.1. The number of boaters contacted by Soundwatch every year from 2009 to 2015 who responded that they were aware or unaware of the guidelines (2009-2010) that later became the federal regulations (2011-2015). Although awareness increased significantly in 2011, overall it has fluctuated around 47% of boaters (Seely 2017).

Department of Fisheries and Oceans Canada (DFO) and Straitwatch

The Canadian counterpart to Soundwatch is Straitwatch, which is operated by Cetus Research & Conservation Society, a non-profit based in British Columbia that works to reduce human impacts on marine mammals in the Salish Sea and along the coast. Straitwatch's goals include decreasing vessel disturbance on whales and educating boaters about the BWW guidelines. Straitwatch's efforts are supported by the DFO, which has been a core partner for the BWW campaign for over a decade. They have been integral in developing and updating the guidelines—before and after the U.S. regulations went into place—to educate boaters in the transboundary area near the San Juan Islands. Although the U.S. federal regulations do not apply in Canadian waters, the BWW guidelines still help promote responsible whale watching and encourage practices that are in line with the regulations. In addition to operating in the transboundary area of the Salish Sea, Cetus also operates a program in Canadian waters to protect Northern Resident killer whales that are listed as threatened under the Species at Risk Act in Canada. Although Canada has not adopted the same vessel regulations as the U.S., Straitwatch's efforts promote BWW goals and create some continuity in vessel conduct across the border and have contributed to our knowledge about compliance with the guidelines and impacts of vessels (http://cetussociety.org/marine-stewardship-programs/straitwatch/).

WDFW Outreach

Under the ESA Section 6 grant program, WDFW has received two awards since 2013, each covering 3 years. In partial fulfillment of the terms of these grants, WDFW has conducted at least 50 10-hour patrols in northern Puget Sound each summer from 2013 to 2015 and will continue through 2018. The primary objective of these patrols is to educate vessel operators about regulations and proper boating procedures around Southern Residents while on the water. For the first funding term (2013 to 2015), WDFW officers contacted over 8,000 boaters. This work has been completed with the help of Soundwatch, whose operators coordinate with WDFW officers to ensure coverage of the widest area possible between the two groups when both are on the water. When interacting with boaters on the water during patrols, officers distribute BWW educational materials and engage boaters to explain the vessel regulations. They have also used funding to include BWW educational graphics in the WDFW Recreational Fishing Pamphlet and distribute this pamphlet to approximately 750,000 sport fishermen each year.

WDFW's increased presence has facilitated a relationship with whale watch industry groups based on collaborative communication and trust, which has also furthered educational and compliance goals. The PWWA invites WDFW officers to attend their annual meetings where members gather to discuss any changes in laws and practices. WDFW has been able to answer questions and engage in collaborations with PWWA members at these meetings. Officers have also been invited to assist many whale watching companies with their in-house vessel operator training sessions each spring. Their support of WDFW efforts and the regulations has shown that whale watching industry groups take seriously their role as examples of responsible viewing on the water.

WDFW's presence on the water has also enabled them to reach a greater audience beyond north Puget Sound boaters. They have conducted outreach through local news channels, bringing reporters and film crews on several patrols in recent years. These media outlets provide a greater platform for education, allowing enforcement officers to reach a much broader geographical range. As a result, officers have received reports of possible violations from private citizens in central and south Puget Sound.

NOAA Outreach

NOAA has been a key partner in the BWW campaign, developing guidelines, printing and distributing BWW materials, and advertising responsible wildlife viewing messages (Figure 2.2). Upon the implementation of the new regulations in 2011, NOAA launched an extensive outreach campaign to ensure that all boaters were aware of the changes. As a part of this campaign, NOAA worked closely with DFO, Soundwatch, and Straitwatch to update the BWW materials (Appendix A) and develop new brochure inserts and posters specific to the federal regulations (Appendix B). NOAA also worked with these and other partners to distribute those materials widely, including to all commercial whale watching companies. In addition to Soundwatch, Straitwatch, WDFW, and DFO, other partners that help in distributing BWW materials include the Center for Whale Research, the Seattle Aquarium, Killer Whale Tales, the Orca Network, the Georgia Strait Alliance, the Vancouver Aquarium, the B.C. Cetacean Sightings Network, B.C. Parks, the Cetus Research & Conservation Society, the PWWA, the Recreational Boating Association of Washington, and The Whale Museum. These partners distribute materials to their members and at their events, help post them at local marinas, and incorporate them into their websites, programs, and classroom education materials. Much like WDFW enforcement, the NOAA Office of Law Enforcement also distributes BWW brochures when interacting with boaters on the water.

Figure 2.2. Billboard advertisement purchased to advertise the Be Whale Wise (BWW) guidelines prior to the implementation of the federal regulations.

Along with updating and distributing the new BWW materials in 2011, NMFS also developed a web page and promoted the new regulations in TV, radio, and magazine advertisements. The www.bewhalewise.org web page includes information about the federal and state regulations and the BWW guidelines, and provides a mechanism for people to report potential violations. The

TV and radio ads were targeted around Sea Fair to reach large numbers of recreational boaters. NMFS has also purchased advertising space in Northwest Sportsman magazine and has given presentations to recreational boating groups and the Passenger Vessel Association to ensure that recreational boaters, in addition to commercial whale watch and fishing vessel operators, are aware of the regulations and can comply with them. Representatives from NMFS have also spoken to the media to reach a wider audience across the Puget Sound region.

In 2016, the BWW materials and website were updated to integrate voluntary guidelines and mandatory regulations into one brochure for further clarification of the federal regulations and recommended best practices. This new brochure was presented to the PWWA at their 2016 symposium and was printed and distributed in time for the 2016 boating season (Appendix D).

Another important partnership to reduce vessel impacts to whales is through land-based viewing. The Recovery Plan for Southern Resident Killer Whales (NMFS 2008) includes education and outreach activities and specifically identifies promoting land-based viewing of killer whales as an action to minimize impacts from vessels (Recovery Action 3.2.3). The Whale Trail promotes land-based viewing and also supports education and outreach recovery actions to raise awareness and promote stewardship through identifying land-based viewing sites around the range of the whales. The Whale Trail brings together several of our important BWW partners, including The Whale Museum, Seattle Aquarium, WDFW, and others. This project continues to grow as we identify new sites along the West Coast and create new signs, which include responsible viewing messages, to reach a broad public audience. Lime Kiln State Park on the west side of San Juan Island is a Whale Trail site and provides education to large audiences (340,000 visitors in 2015). The Whale Trail also includes Washington State Ferries and each ferry and terminal posts Whale Trail and BWW information, reaching another large audience.

Conclusions

Education and outreach about the regulations and BWW guidelines has been an integral part of implementation of the 2011 regulations. Education is essential to promote compliance and support protection for the whales. NMFS has worked with many partners to ensure that both commercial whale watch operators and recreational boaters are aware of the regulations and guidelines through a number of on- and off-the-water efforts. Together with our partners we have reached hundreds of thousands of people through distributing materials, advertising, and web pages. While many boaters acknowledge that they have prior knowledge of the rules when contacted by Soundwatch, there are new recreational boaters visiting the San Juan Islands for the first time each year, and these boaters present one of the biggest challenges for ensuring awareness of the regulations and guidelines before encountering the whales. NMFS will continue to work with partners and the boating community to increase education and outreach programs.

3. ENFORCEMENT

Prior to adopting the vessel regulations in 2011, NMFS estimated how the number of vessel incidents might change compared to under the previous voluntary program (NMFS 2010). The analysis described in the EA considered those elements that might influence the level of compliance, such as the ability and willingness of individuals to comply with mandatory rules.

An individual's compliance with the rules depends on awareness of the rules' existence, and whether the rules are clear and easy to follow. Once aware of rules, individuals may be willing to comply with them out of a sense of civic duty or obligation, social influences, fear of sanctions, or economic consequences associated with non-compliance (May 2005; National Marine Protected Areas Center 2005; Keane et al. 2008, Silber et al. 2014). An essential component of achieving compliance with mandatory regulations is the enforcement of those regulations.

There are many ways in which vessel operators may be motivated to comply with both voluntary and mandatory regulations. Both commercial and recreational operators are motivated by a sense of obligation to protect the whales, as stated explicitly by the PWWA. For commercial operators, certain social influences can also serve as strong motivation. One example of social influences that can positively impact a commercial operator's compliance is through maintaining their reputation among peers and customers. In contrast to incidents of not following voluntary guidelines, violations of a mandatory regulation would likely be publicized and therefore cause more severe harm to their reputation and therefore business success (National Marine Protected Areas Center 2005). Fear of sanctions and their monetary consequences, however, is a stronger motivation for compliance with mandatory rules rather than voluntary guidelines, which generally do not have sanctions associated with non-compliance. In this sense, stronger compliance may be garnered with mandatory regulations versus voluntary guidelines. Recreational boaters are also more likely to comply with mandatory regulations, although they may be less likely to know the details of mandatory regulations than commercial operators.

Based on the best available information, NMFS concluded that vessel operators would generally be more likely to adhere to mandatory specific regulations than to the voluntary guidelines. NMFS also concluded that promulgation of specific mandatory regulations was likely to result in fewer incidents between vessels and whales than occurred under the previous regime as a result of the enforceability of mandatory regulations (NMFS 2010). The likelihood of compliance with any particular rule would be affected by the clarity of the rules, motivations to comply, and the level of monitoring and enforcement. To achieve the enforcement goals established during the rulemaking process, NMFS, including the Office of Law Enforcement (OLE), has partnered with WDFW and other enforcement groups.

Enforcement Effort over Time

Beginning in 2004, WDFW conducted enforcement patrols directed at protecting Southern Residents from harassment of vessels. However, prior to 2008, there were only voluntary wildlife viewing guidelines and enforcement efforts were primarily focused on education and outreach and investigating potential violations under the ESA and MMPA. By June 12, 2008, the Washington legislature passed a law that restricted vessel activities near killer whales (this state law was updated in 2012, RCW 77.15.740, to correspond to the 2011 federal vessel regulations). This new legislation provided law enforcement new tools to shift efforts from primarily education and outreach to include law enforcement. Between 2004 and 2009, WDFW law enforcement officers received funding from NOAA to conduct 25 to 35 summer patrols specifically focused on protecting Southern Residents from vessel harassment. Although funding was reduced in 2010, WDFW law enforcement officers still conducted 18 patrols. NOAA also provided funding to the San Juan County Sheriff for a small number of patrols in 2004-2005. By

2012, the number of patrols had increased with WDFW having up to 12 dedicated whale days and NOAA OLE with 16 dedicated whale days (Eisenhardt 2013).

In 2013, there was a substantial increase in on-the-water patrols. WDFW was awarded an ESA section 6 grant that year to last through June 2015. This grant was renewed in 2016 to last through June 2018. The primary objective of the awarded project was to educate as many boaters as possible, both private and commercial, on how to be in compliance with state and federal laws. A second objective included tracking and monitoring progress and results by supporting Soundwatch. The ESA section 6 funding provided a new WDFW vessel and one additional full-time officer. In addition, a portion of the funding supported the Soundwatch program with vessel upgrades, additional days on the water, and data analysis (specifically for 2013, Soundwatch had 40 additional days on the water). In the first year of the dedicated patrols (beginning in the summer of 2013), 74 patrols were conducted, more than tripling previous efforts. WDFW conducted 40 patrols in 2014 and 68 patrols in 2015 (Table 3.1). NOAA's Office of Law Enforcement conducted a total of 81 patrols following the 2011 regulations (Table 3.2). Law enforcement also reached out to commercial boats and kayak rental stores regarding outreach- and enforcement-related issues.

Violations, Citations, and Warnings over Time

While vessel incidents are recorded and reflect vessel behavior that has the potential to constitute harassment and take under the ESA and MMPA, translating this information into enforcement cases and successful prosecutions can be difficult. NOAA's Office of Law Enforcement receives numerous reports from the public regarding potential violations. The public and the whale watch industry refer a large number of additional observed violations to WDFW Enforcement. However, there is often insufficient evidence for WDFW or NOAA to investigate the majority of these complaints. The BWW web page provides a portal for submitting potential violations (including photos) and includes the information required to support further investigation.

Dozens of verbal and written warnings have been issued in the summer of each year that WDFW has been on the water. For example, in 2010 (with an effort consisting of 18 patrols and 160 vessel hours), 575 citizens were contacted resulting in approximately 35 verbal warnings (Table 3.1). More enforcement patrols from increased funding following the federal vessel regulations resulted in more boaters contacted and more warnings given. In fact, a total of 106 warnings were issued in 2013, and 9 citations were issued (three of them to commercial boats and six of them to private boats). In the summer of 2014, WDFW officers contacted over 1,900 boaters (these contacts included both enforcement and education reasons), gave 90 warnings and 9 citations in 40 patrols. In 2015, whales began frequenting inland waters by late April. That year, WDFW conducted 68 patrols and issued 120 warnings and 20 citations. Early in the season, WDFW officers were receiving reports of possible violations in central and southern Puget Sound locations, suggesting more awareness of vessel laws outside the primary northern Puget Sound locations.

Table 3.1. Number of boaters contacted, warnings issued, and citations issued by WDFW from 2006 to 2015.

Year	# Patrols	Boaters Contacted	Warnings Issued	Citations Issued
2006	33	88		
2007	10	33	9	
2008	20	598	20	3
2009	22	372	7	3
2010	18	575	35	6
2011	—*	—	—	—
2012	—	—	—	—
2013	74	2200	106	9
2014	40	1900	90	9
2015	68	2200	120	20

*— Indicates no data

Table 3.2 Number of boaters contacted, warnings issued, and citations issued by NOAA OLE from 2012 to 2015.

Year	# Patrols	Boaters Contacted	Warnings Issued	Citations Issued
2012	11	5	1	—*
2013	23	38	5	2
2014	23	25	6	1
2015	24	40	11	2

*— Indicates no data

Prior to the federal regulations, a small number of cases where negligent operation of a vessel resulted in harassment have been successfully pursued. In 2005, one case of harassment of killer whales under the MMPA through the negligent operation of a vessel resulted in a $1,000 fine. Following the ESA listing in 2005, NMFS assessed an additional violation in 2006, which resulted in settlement and imposition of a higher fine based on the endangered status of the whales and was settled for $2,000. Both cases were settled in 2007. Three state citations were issued in 2008, three were issued in 2009, and six were issued in 2010. Of the six citations issued in 2010, four were committed by Canadian whale watch companies, one by a private boater, and one by a private pilot. These incidents included repeatedly and intentionally positioning the vessel close to passing whales or repeatedly maneuvering the vessel in the path of the whales.

Impact of Enforcement on Incident Rates

Unfortunately, having mandatory regulations and an active education and outreach campaign does not always ensure compliance. In fact, data suggests that boater behavior in the vicinity of Southern Residents and compliance to vessel regulations are strongly influenced by the presence or absence of a marked patrol vessel. For example, from 2013 through 2015, Soundwatch recorded a substantial drop in the number of observed incidents that occurred when WDFW was on the scene compared to when they were not present (Figure 3.1) (Seely 2015).

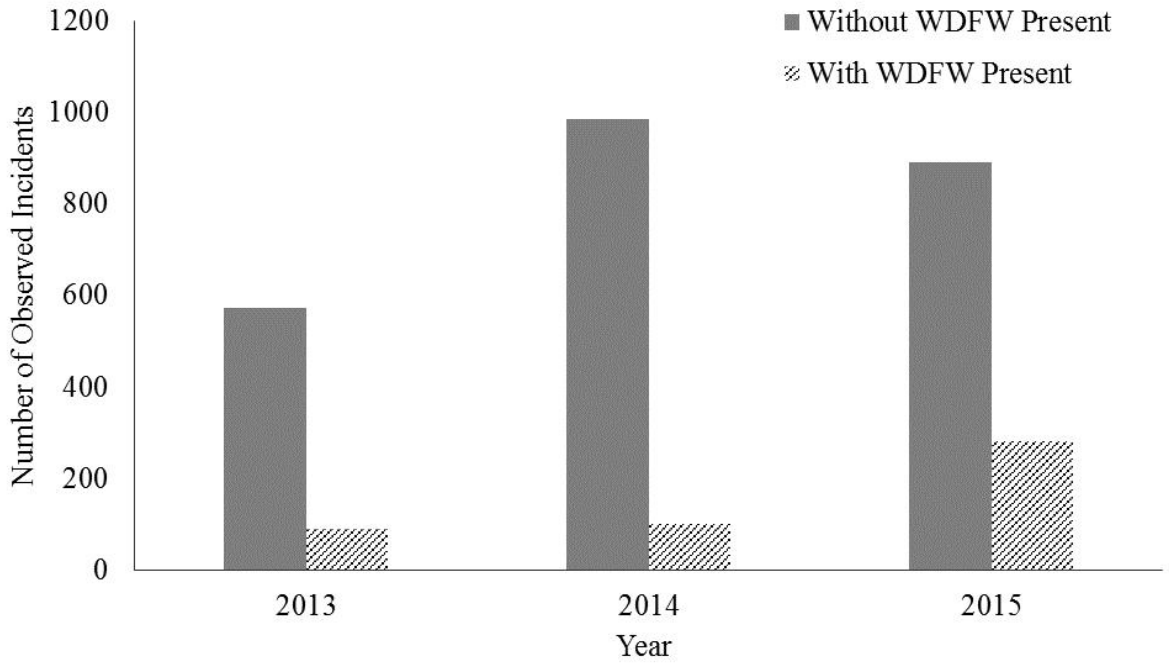

Figure 3.1. Observed number of incidents by Soundwatch between 2013 and 2015 with and without WDFW on the scene (Seely 2015).

A decrease in the number of observed incidents was not just observed in one vessel type. In fact, Soundwatch data has shown better adherence to the laws from both recreational and commercial vessels. For example, in 2013, Soundwatch documented a significant decrease in the rate of regulatory incidents (per 30 minute sampling period) for both U.S. and Canadian whale watch vessels, guided ecotour kayaks, and private boaters in the presence of WDFW enforcement, suggesting a continued need to increase enforcement presence (Figure 3.2) (Eisenhardt 2014).

Because compliance with the vessel regulations substantially increases when WDFW enforcement vessels are in the area, this suggests that many commercial and some recreational boaters may be aware of the regulations, but are more likely to comply only when enforcement action may be taken. In fact, Soundwatch documented that approximately 60% of boaters who were contacted in 2011 were aware of the rules, 13% of them had one or more incidents recorded before contact, and approximately 5% had incidents after contact (Koski 2012). This same trend was found in several years (see Section 4.0). The benefits from enforcement and outreach patrols likely include that the egregious and repeat offenders will be dealt with through the legal process, potential violators will be stopped from intentionally violating the laws, and uninformed boaters will be educated on responsible whale watch viewing in the proximity of the whales.

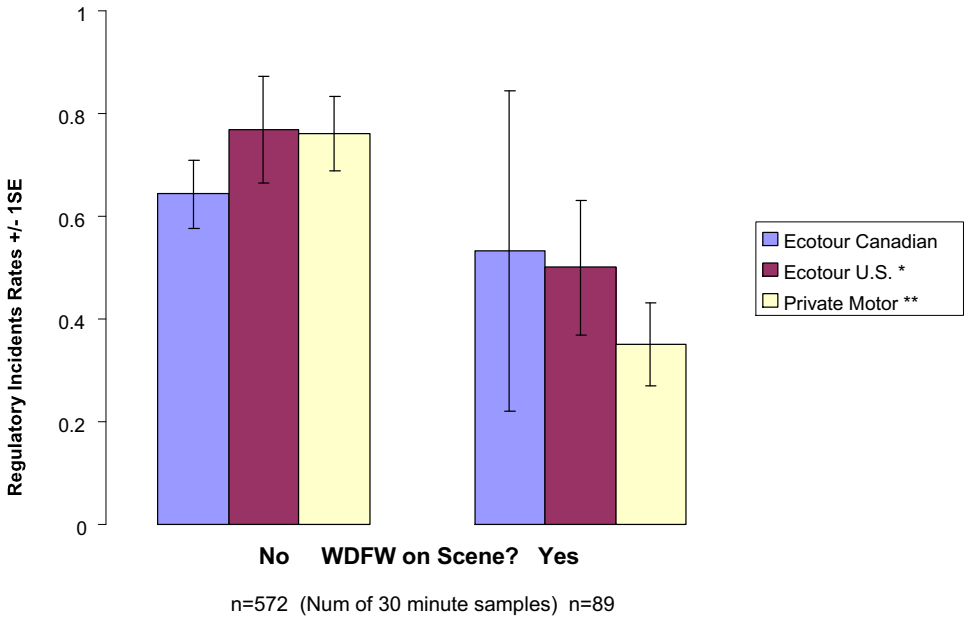

Figure 3.2. Effect of WDFW enforcement presence on 2013 regulatory incident rates (per 30 minutes per vessel). Figure from Eisenhardt (2014).

Enforcement Challenges

One challenge to measuring the effectiveness of the vessel regulations is the inconsistent regulations, enforcement, and monitoring presence in Canada compared to the U.S. Although DFO's Resident Killer Whale Action Plan lists developing and implementing "regulations, guidelines, sanctuaries, and other measures to reduce or eliminate physical and acoustic disturbance of Resident Killer Whales" as an approach to recovery, implementing mandatory regulations like those in the U.S has not occurred yet (Fisheries and Oceans Canada 2017). In addition, the long-term trends in the Soundwatch data demonstrate a need for the continued increase of enforcement patrols and action on the water (Seely 2016). Soundwatch and other groups have highlighted that sustainable funding for enforcement is critical. Increased enforcement effort was also supported during the Recovery Plan and vessel regulations public input process.

NMFS has previously acknowledged that enforcement of the prohibition on parking in the path of the whales would be challenging and recognized that whales can be unpredictable and can approach vessels unexpectedly. However, the prohibition on parking in the path was intended to address specific situations observed by monitoring groups where operators repeatedly position themselves to intercept the whales and do not get out of the way, rather than situations where whales are moving erratically and boaters find themselves in the path unexpectedly. In discussions between enforcement officers and vessel operators, awareness about the whales'

behavior, the specifics of a situation, and the discretion involved in selecting which cases to pursue are all key factors.

Conclusions

Although education and outreach efforts can improve compliance, the strongest motivations to improve behavior are having a sense of civic duty or obligation, social influences, fear of sanctions, or economic consequences associated with non-compliance. Enforcement is essential to promoting compliance with the vessel regulations and achieving a reduction in vessel impacts to Southern Residents. In fact, data suggest that boater behavior and compliance with vessel regulations are strongly influenced by the presence or absence of a marked patrol vessel to a measurable degree (a 2 to 3 times reduction in incidents when patrol boats were present). Vessel operators are more likely to adhere to mandatory specific regulations than to the previous voluntary guidelines. It is reasonable to assume that commercial operators know about the mandatory regulations for the same reasons that they were familiar with the previous voluntary guidelines, and have strong incentives to comply to protect their business reputation. Similarly, recreational boaters are more likely to comply with mandatory regulations, although they may be less likely to know the details of mandatory regulations than commercial operators. In general, promulgation of specific mandatory regulations is likely to increase enforcement capability and compliance, which NMFS predicted would result in fewer incidents between vessels and whales than occurs under the previous regime.

4. VESSEL COMPLIANCE

Before the federal vessel regulations were adopted in 2011, monitoring data revealed that vessel compliance with voluntary guidelines was low and that the number of violations of these guidelines was steadily increasing. Since the 1970s, whale watching has gained popularity, becoming an integral part of the tourism industry in the Northwest. It has grown to a near $58 million industry, with a total of 96 active commercial whale watching vessels in 2015, the highest number ever recorded (IEc 2015; Seely 2016).

Soundwatch has partnered with NMFS for over 15 years to monitor vessel compliance with federal regulations and compile their data in annual reports, which can be found at https://whalemuseum.org/pages/soundwatch-boater-education-program. These reports depict trends in compliance and enforcement both before and after the 2011 implementation of the federal vessel regulations. Soundwatch monitors vessels operating near killer whales and records activities that are inconsistent with the federal regulations and BWW guidelines as "vessel incidents" (Seely 2016). Giles et al. (2010) also reports compliance with the voluntary BWW guidelines prior to the installment of the federal regulations. After the regulations were implemented, WDFW received federal funding to support both monitoring and enforcement activities (see Section 3). Their biannual grant reports have provided insight into changes in vessel operator behavior over time since the implementation of the regulations. Together with the Soundwatch reports, these data provide the basis to compare vessel compliance trends before and after 2011. The following sections discuss the complexities of the compliance dataset, its limitations, and the trends that can be extrapolated from it.

Challenges with Comparing Data Before and After 2011

The primary confounding issue with comparing vessel compliance before and after 2011 is that the minimum allowed distance from the whales increased with the federal regulations. The voluntary BWW guidelines in place before 2011 recommended vessels remain 100 yards away from the whales, whereas federal regulations implemented in 2011 dictate that vessels must stay at least 200 yards away. New incident categories were added to measure compliance with the new 200-yard approach rule. Because the no-approach distance in the pre-2011 guidelines was not as expansive as the one later codified in the federal regulations, Soundwatch did not record an incident when vessels were 100 to 200 yards from the whales before 2011. By adding new incident categories, the overall number of incidents increased and some incidents are likely counted more than once based on the data collection protocol. For example, if a vessel was observed within 200 yards and then proceeded to move to within 100 yards, this was counted as two incidents, again increasing the number of total incidents in the years following the regulations (2011-2015). Furthermore, comparing the number of total incidents recorded each year by Soundwatch before and after 2011 is not an accurate depiction of noncompliance associated with the federal regulations and rulemaking because there are multiple incident categories specific to voluntary guidelines not codified in the regulations (Table 4.1 and Table 4.2).

Table 4.1. Incidents by category observed by Soundwatch from 1998 to 2015. Table from Seely (2016).

Behavior Category	Yearly Incident Percentages																	
•Notes Categories Not Used During All Years	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
•Leapfrogging	37%	31%	23%	1%														
Under power within 0-100 yards of whales	6%	4%	5%	4%	5%	12%	9%	10%	12%	15%	12%	13%	12%	8%	4%	10%	9%	7%
•Stopped within 0-100 yards of whales														17%	8%	7%	13%	11%
•Under power within 100-200yards of whales														12%	10%	15%	12%	8%
•Stopped within 100-200yards of whales														18%	15%	6%	14%	13%
Within 440 yards of SJI No-Boat Zone	39%	26%	17%	17%	7%	13%	4%	8%	4%	5%	6%	8%	10%	6%	6%	2%	0%	2%
Within 880 yards of Lime Kiln	2%	2%	2%	1%	2%	5%	1%	2%	1%	3%	1%	3%	4%	1%	2%	1%	1%	2%
Crossing path of whales	4%	3%	5%	2%	4%	7%	6%	4%	5%	8%	4%	5%	5%	2%	7%	10%	8%	3%
Chasing/pursuing whales	3%	1%	3%	2%	<1%	4%	3%	1%	2%	3%	3%	3%	3%	1%	<1%	<1%	0%	0%
Inshore of whales	5%	29%	24%	25%	19%	16%	22%	18%	17%	16%	21%	24%	17%	13%	10%	10%	9%	9%
Airplane within 1000 feet	4%	2%	4%	7%	14%	6%	6%	4%	6%	8%	8%	6%	4%	3%	<1%	8%	2%	2%
Within 200 yards of National Wildlife Refuge	0%	1%	3%	1%	2%	2%	1%	0%	<1%	1%	1%	<1%	1%	<1%	1%	<1%	0%	0%
•Other		1%	3%	3%	14%	5%	15%	11%	10%	3%	2%	1%	1%	0%	1%	1%	0%	0%
•Within 220 yards of shore; whales present			4%	4%	2%	<1%	4%	1%	2%	2%	<1%	<1%	1%	1%	2%	1%	0%	0%
•Repositioning within 100 yards			7%	7%														
•In the Path (formerly Parked in the path of whales)				26%	24%	17%	19%	27%	26%	17%	25%	19%	23%	11%	16%	18%	17%	26%
•Fast within 1/4 mile					3%	4%	9%	10%	11%	16%	11%	13%	13%	6%	8%	9%	8%	11%
•1st Approach head on, behind, or on shore					4%	2%	1%	<1%	1%	2%	3%	2%	3%	1%	4%	1%	3%	2%
•Kayaks spread out					<1%	3%	0%	<1%	1%	1%	1%	1%	1%	<1%	2%	1%	1%	2%
•Kayaks with whales outside 1/4 SJI Zone					<1%	1%	0%	<1%	1%	<1%	1%	1%	1%	<1%	1%	<1%	0%	0%
•Kayaks paddling w/in 0-100 yds						3%	0%	<1%	1%	<1%	1%	<1%	1%	<1%	1%	<1%	0%	<1%
•Kayaks paddling w/in 100-200 yds														1%	1%	1%	1%	1%
•Kayaks parked on headland															<1%	<1%	0%	0%
Total %	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Total Observed Incidents	398	791	653	533	259	373	761	957	1,281	1,085	1,419	2,572	1,067	2,500	2,621	2,234	2,509	1,635
Estimated Annual Observation Hours	426hr	510hr	462hr	486hr	378hr	312hr	486hr	564hr	516hr	420hr	540hr	420hr	442hr	573hr	306hr	331hr	425hr	393hr

Table 4.2. Number of incidents of noncompliance with BWW guidelines (2006-2010) and federal regulations (2011-2015) per year.

	# of Incidents per Year									
	Before Federal Regulations					**After Federal Regulations**				
Incident Description	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Motoring w/in 100 yards	**159**	**94**	**164**	**242**	**126**	**210**	**93**	**215**	**219**	**148**
Parked w/in 100 yards	**-***	**58**	**125**	**105**	**110**	**418**	**221**	**150**	**323**	**173**
Motoring w/in 100-200 yards	**-**	**-**	**-**	**-**	**-**	**301**	**269**	**333**	**298**	**150**
Parked w/in 100-200 yards	**-**	**-**	**-**	**-**	**-**	**460**	**400**	**128**	**351**	**209**
Kayak w/in 100 yards	**10**	**8**	**11**	**9**	**5**	**10**	**16**	**3**	**11**	**9**
Kayak w/in 100-200 yards	**-**	**-**	**-**	**-**	**-**	**15**	**34**	**12**	**21**	**16**
TOTAL	169	160	300	356	242	1414	1033	841	1223	705
Park in path	330	271	284	491	191	263	605	623	642	356
TOTAL distance and path	**499**	**431**	**584**	**847**	**433**	**1677**	**1638**	**1464**	**1865**	**1061**
Annual Observation Hours	**516**	**420**	**540**	**420**	**442**	**573**	**306**	**331**	**425**	**393**

*-No Data

In addition to the difficulties associated with comparing data before and after 2011, there are also challenges associated with comparing data from year to year. As county and state regulations went into effect in 2007 and 2008, some of the BWW guidelines became legally binding, including a 100-yard approach limit. The federal regulations completed in 2011 pushed this approach limit out to 200 yards, causing a discontinuity between federal and local laws. The state regulations were amended in 2012 to match the federal regulations; however, the changes from year to year make comparing trends in compliance over time challenging. Furthermore, although the regulations have remained consistent in the U.S. since 2011, there are no equitable regulations in Canadian waters.

The next challenge in assessing compliance trends is linked to how Soundwatch operates on the water, combining outreach activities and monitoring for vessel incidents. Although they record how much time is spent on the water overall, they do not estimate how much of that time was spent with whales present, and how much was dedicated specifically to monitoring vessel activity as opposed to outreach and education activities. As such, the total number of observation hours each year with the whales reflects multiple activities, not just collecting vessel incident data (Seely 2016). Soundwatch has devised a more accurate estimation of the amount of time spent observing vessel behavior when whales are present. They record the number of vessels present twice an hour, once on the hour mark and once on the half-hour mark. These observations represent 30-minute periods spent actively monitoring the whales and the vessels around them. When outreach efforts prevent them from stopping to record the number of vessels present at the hour and half-hour mark, the lack of a vessel count represents a 30-minute period dedicated to outreach and not monitoring vessel activity. Therefore, the data can be standardized to account for variations in effort from year to year by dividing the total number of incidents by the number of vessel counts performed that year, and then multiplying by two to get a rate of incidents per hour (Seely 2016). Although this method introduces some uncertainty into the

calculation, there is far less uncertainty than would be associated with using the total number hours on the water, which represents time split between outreach and monitoring.

It is also difficult to account for changes in the number of vessels present with the whales when incidents are recorded. The average number of vessels near the whales has varied from year to year, with a decreasing trend prior to the regulations and an increasing trend since 2011 (Figure 4.1). This may have been due to a variety of factors, such as access to fisheries or economic dynamics that affect participation in recreational boating. For example, the increase in the number of boats in 2014 and 2015 was likely due, in part, to the healthy salmon fisheries in those years. However, the number of vessels with the whales is not recorded every time an incident is observed, so standardizing a rate by the number of vessels present for each incident is not possible. For the purposes of this analysis, the best available standardization methods for both time and number of vessels were used to compare the results and determine if any trends can be discerned despite the difficulties associated with standardizing the data using these methods.

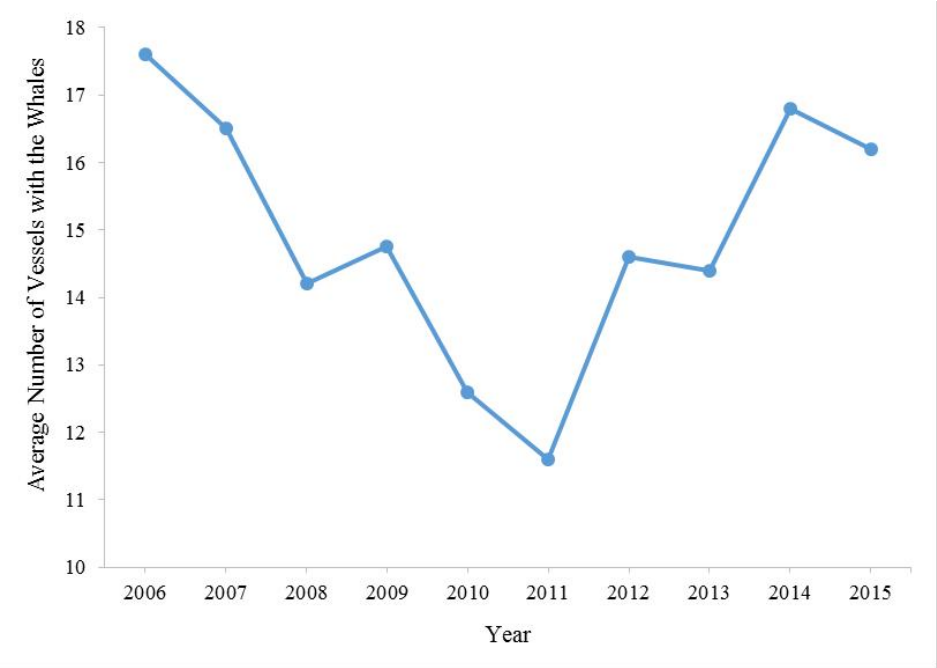

Figure 4.1. The average number of vessels with the whales from 2006 to 2015. Before the regulations were implemented in 2011, Soundwatch observed a decrease in the average number of vessels with the whales from year-to-year. This number increased annually from 2011 to 2015.

Biological factors such as prey availability can influence the behavior of the whales in ways that make monitoring and enforcement difficult. Social cohesion has been observed to fluctuate from year to year, resulting in a more spread out population in some years (Parsons et al. 2009). Foster et al. (2012) found a link between social cohesion of the whales and salmon abundance. In years of low salmon abundance, the whales were observed to be more spread out. During these periods, Southern Resident killer whale total space use was greater and movement patterns were

more convoluted compared to periods of greater salmon abundance (McCluskey 2006). Other environmental factors may also result in this behavior, though further study is required to identify those factors (Parsons et al. 2009). Lack of social cohesion makes it difficult to monitor vessel behavior because as the whales spread out, so do the whale watch vessels. Thus, one Soundwatch vessel and/or one WDFW enforcement vessel are left to monitor several groupings of vessels over a greater geographic area instead of just one group in a concentrated area. This may influence the data in a variety of ways, which can make it difficult to analyze for trends in a greater context.

Compliance by Vessel Type over Time

Prior to 2011, data from Soundwatch indicated a high level of noncompliance with the voluntary BWW guidelines with over 1,000 incidents each year. These data supported the need for regulations rather than relying on voluntary measures and were used to develop the vessel regulations. The high level of noncompliance included recreational vessel operators viewing killer whales, commercial whale watch vessels, and other types of vessels in the Pacific Northwest. In other regions, reviews of the effectiveness of voluntary conservation agreements have also indicated that voluntary guidelines may be insufficient to protect marine mammals. In the Northeast, Wiley et al. (2008) found that, despite conditions that seemed supportive of the use of voluntary measures, the high level of noncompliance to voluntary speed-zone buffers for endangered whales likely failed to achieve the desired conservation goals.

In the 5 years leading up to the installment of the current federal regulations, Soundwatch recorded an average annual incident total of 1,480 for the BWW guidelines. The most frequent violators tended to be recreational boaters, making up about 55 to 70% of the total annual incidents. The high level of noncompliance of recreational vessels relative to commercial whale watching vessels was likely due to the inexperience of recreational vessel operators with boating near killer whales or their lack of knowledge of the BWW guidelines. Commercial whale watching operators also have the advantage of the use of a common radio frequency to alert each other of the location of the whales, making them less likely to be “surprised” by the whales than private boaters are (Koski 2011). Canadian commercial whale watching operators were responsible for about 15 to 30% of all incidents, followed by U.S. commercial operators with roughly 10 to 20%.

Data collected in 2009 by Giles et al. (2010) are consistent with this pattern (Figure 4.2 and Figure 4.3).

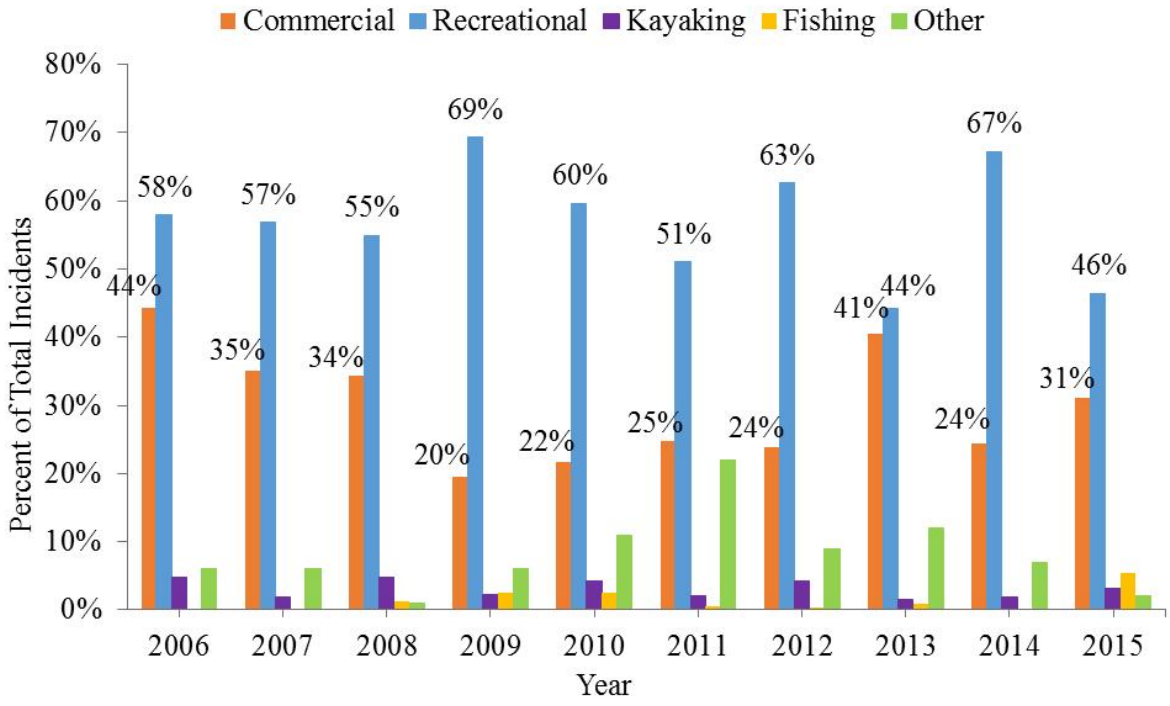

Figure 4.2. Percentage of the total number of incidents committed by vessel type from 2006 to 2015. Vessel types include commercial and recreational whale watchers, kayakers, fishing vessels, and others, including research and monitoring vessels. The incidents of noncompliance represented consist of parking in the path of the whales and coming within 100 yards before 2011 and within 200 yards after 2011. Note that researchers operate under federal scientific permits that specifically allow close approaches to the whales.

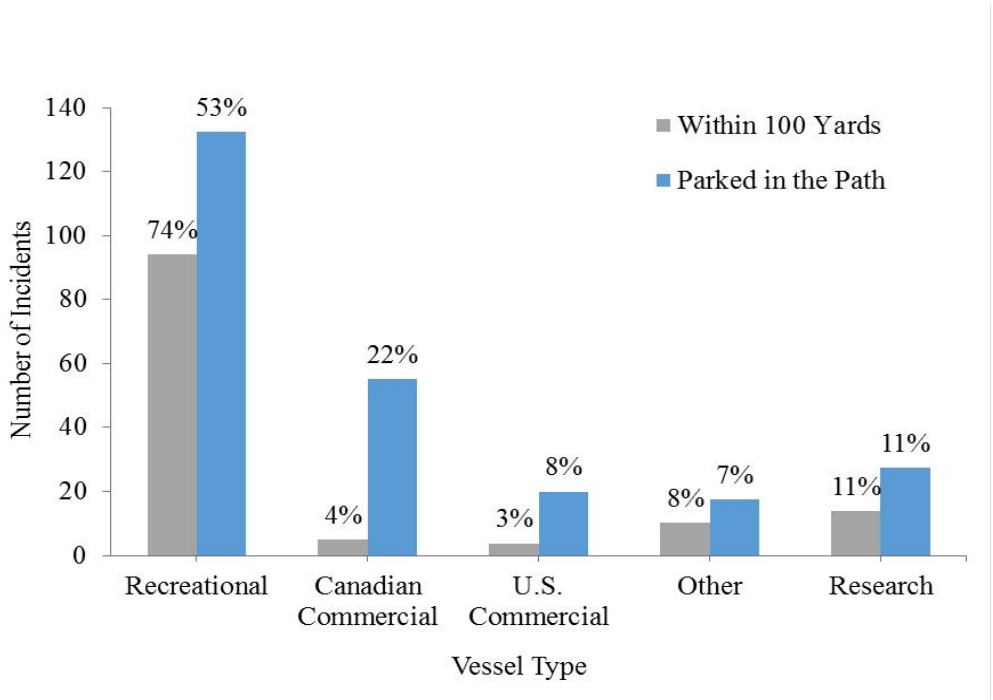

Figure 4.3. Number and percent of incidents of not complying with federal regulations for each vessel type observed in the summer of 2009 by Giles et al. (2010). Private recreational vessels, Canadian and U.S. commercial whale watching vessels, research vessels, and others (including aircraft, kayaks, etc.) were observed out of compliance with what would later become federal regulations. Before the regulations were created, however, proximity incidents were only recorded for vessels within 100 yards of the whales instead of the more stringent 200 yards specified in the later regulations.

Another explanation for the higher level of compliance exhibited by the commercial whale watch industry is their history of involvement in developing best practices and the BWW guidelines long before the federal regulations existed. This process began in 1994 when the industry experienced a surge of growth that continued into the early 2000s. A code of conduct developed by the Whale Watch Operators Association Northwest—what is now the PWWA—established a set of best practices for whale watch operators which served as an example for developing the BWW guidelines. Today, PWWA members still abide by specific industry guidelines which, in some ways, are even more restrictive than the BWW guidelines. They also hold each other accountable for obeying the guidelines and during certain time periods had an industry advisory council where noncompliance was addressed (Giles and Koski 2012).

The 2015 Soundwatch Report summarizes the trends in vessel incident rates in the 5 years following the creation of the current regulations (Seely 2016). The percentage of incidents where the federal regulations were not followed by vessel type mirrors that of the previous years, with recreational boaters committing the majority of the incidents observed, followed by commercial whale watching operators. In 2015, private recreational boaters made up about 46% of the incidents, with commercial operators at about 31% (Figure 4.2) (Seely 2016). The continued

higher compliance with the new regulations by commercial operators is likely the product of their direct engagement in the rulemaking process to develop regulations, clear communication with enforcement, and their commitment to conservation (see Section 2.0).

Compliance Trends over Time

To analyze the effects of the federal regulations on vessel operator behavior, we compared compliance with the regulations 5 years before and 5 years after they were codified. Using these data, no dramatic changes have been observed since the 2011 regulations were put in place. Rather, the compliance data varies greatly from year to year, both before and after 2011 and depending on the source of the data. Some reasons for this variation are discussed in the Comparing Data Before and After 2011 section above. For all of these reasons and more, it is difficult to say whether or not a single consistent trend exists for vessel compliance, and it may be several more years before one emerges.

For this analysis, the Soundwatch data were standardized as described above. The standardized annual rate of incidents per hour was then averaged over 5 years before and 5 years after the federal regulations were implemented. However, before 2011 no data were collected for the number of vessels between 100 and 200 yards from the whales. Therefore, incidents involving the 100-yard guideline were analyzed for patterns in compliance instead. An increase in incident rates involving both parking in the path and coming within 100 yards of the whales was observed (Figure 4.4). When the data are plotted annually instead of as an average, however, high variability from year to year is evident. Figure 4.5 presents the annual number of incidents per hour. It shows an initial increase in the rate of parking in the path incidents in 2012. This rate has decreased steadily since then. Although the rate of incidents of boating within 200 yards of the whales has fluctuated since 2011, the data show an overall decreasing trend.

A preliminary analysis of the Soundwatch data suggests that vessel compliance has actually decreased since the implementation of federal regulations, as opposed to the increase in compliance that was predicted when the regulations were put in place (Figure 4.4, Table 4.3). It is possible that changes in the prioritization of on-the-water activities have influenced the data. For example, Seely et al. (in review) report fewer contacts with well-behaved boaters and recreational fishing vessels, which may have resulted in an increase in time spent monitoring vessel behavior and recording incidents. Further investigation reveals that while the annual number of incidents increased after 2011, so did the average number of vessels with the whales (Figure 4.1). Seely et al. (in review) report that the total number of incidents is not correlated to the number of vessels with the whales, however their analysis does not account for monitoring effort. Higher numbers of overall incidents could also be related to a higher number of incident categories as described above (Table 4.1) and potential double counting of vessels within 100 and 200 yards of the whales.

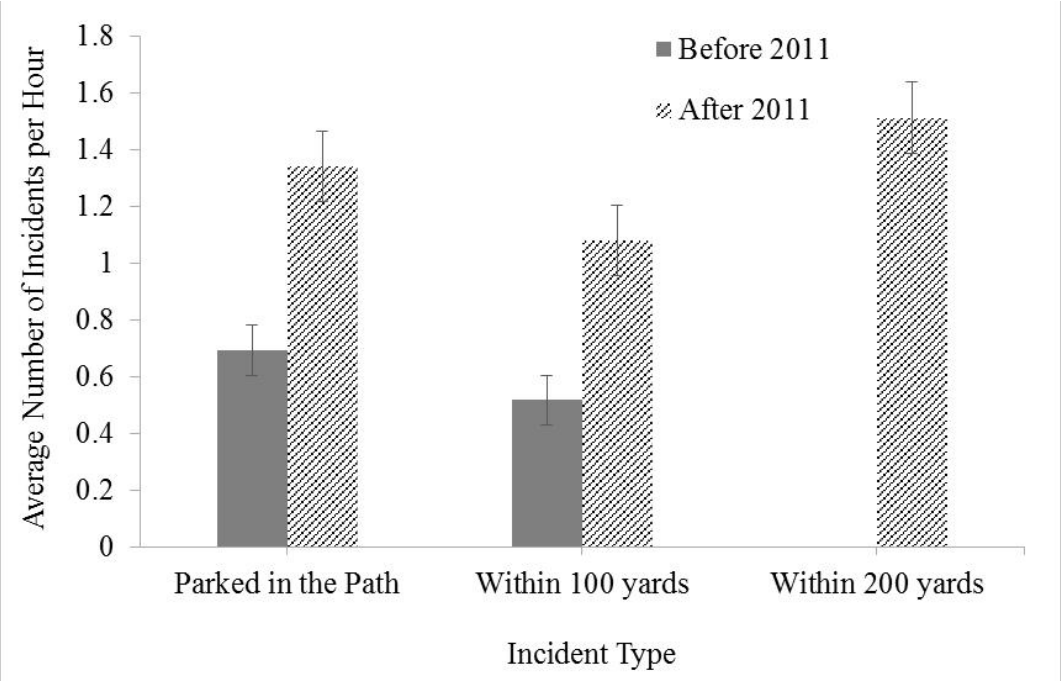

Figure 4.4. Rate of incidents of noncompliance before and after implementation of regulations in 2011. These averages were found by dividing the number of incidents each year by the number of vessel counts and multiplying by 2 to get a rate of incidents per hour for each year. These rates were then used to find the average for the 5 years prior to and the 5 years after 2011. Vessels between 100 and 200 yards of the whales were not recorded as out of compliance with any regulation or guideline before 2011, so no data are available for the number of vessels within 200 yards before 2011.

Table 4.3 Average number of annual incidents pre and post-regulation.

Avg. annual incidents	**2006-2010**	**2011-2015**
Parked in path	313.4	497.8
Within 100 yards	267.4	467.2
Within 100-200 yards	*data not collected	601

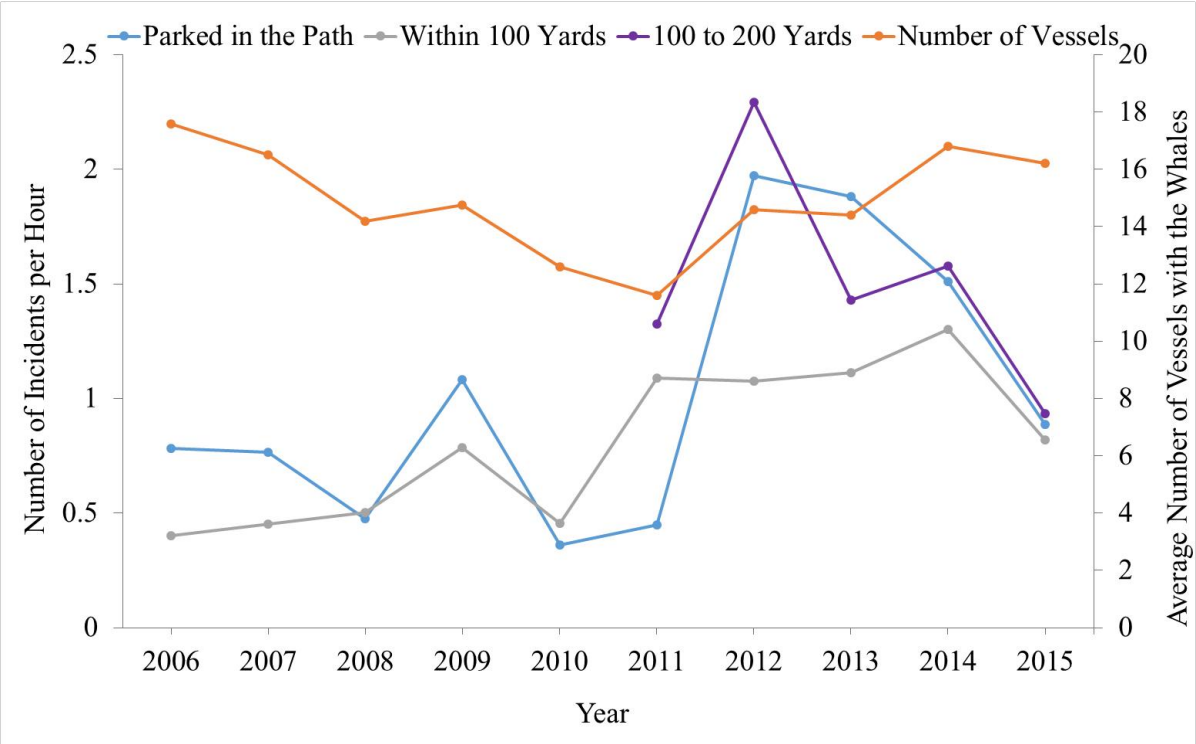

Figure 4.5. Rate of vessel incidents before and after 2011 plotted with the number of vessels with the whales each year. Incident rates were found by dividing the number of incidents each year by the number of vessel counts performed in the presence of whales. This value was then multiplied by 2 to get a rate of incidents per hour.

The changes in trends of compliance with the BWW guidelines after the regulations were codified are also worth noting. Although the guidelines are largely voluntary and include many categories not covered by the mandatory federal regulations, trends in compliance with these guidelines appear to mirror those of compliance with the regulations. The total number of incidents of noncompliance with the guidelines initially increased in 2011 and 2012 before steadily decreasing again in the years after (Figure 4.6). This could be due to a number of reasons, some linked to the codification of the regulations and some independent of them. For example, it is possible that the increase is due to an increased number of vessels with the whales, or that the subsequent decrease was due to increased awareness of the threats vessels pose to the whales as a result of re-energized education and outreach campaigns when the regulations were codified (see Section 2.0). Whatever the reason, the decreasing trend in the rate of some incidents after 2012 demonstrates some benefit to the whales.

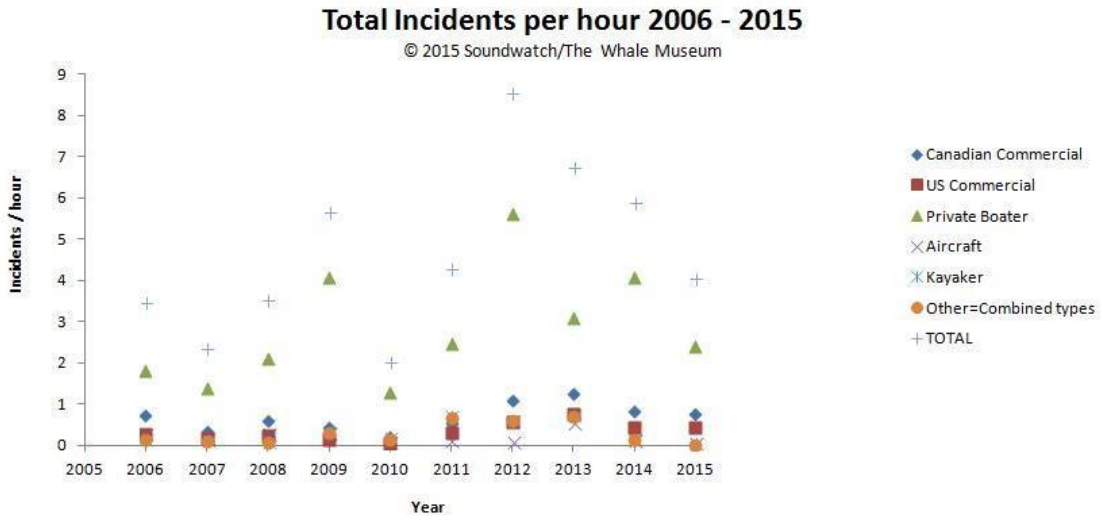

Figure 4.6. The rate of incidents of noncompliance with all BWW guidelines by vessel type from 2006 to 2015. Although the number of incidents initially increased in 2011 and 2012 for almost all vessel types, the data show a decreasing trend in incidents over time after the regulations were implemented (Figure from Seely 2016).

Since enforcement presence on the water increased in 2013, Soundwatch has observed an overall decrease in the number of incidents while enforcement is present (see Section 3.0). However, enforcement data extends back to 2006 and indicates that the number of citations given out over time before and after the federal regulations were codified has actually increased, which could suggest a decrease in compliance (Table 3.1). One goal of the regulations was to provide objective measurable metrics to support enforcement and this could be a reason for the increase in citations over time. Like the Soundwatch data, the state regulations only targeted boaters within 100 yards until they were changed in 2011 to 200 yards to match the federal regulations. Furthermore, prior to receiving federal funding for enforcement in 2013, WDFW was constrained by funding limitations to contact fewer boaters on the water. These reasons might explain why the number of citations increased after the regulations were codified. It is worth noting that there was an unusually high number of citations issued in 2015, which was likely because of the eight Southern Resident calves born that season. These births were widely publicized, and as reported in WDFW grant reports, the attention resulted in a higher number of recreational whale watchers on the water. Because recreational boaters accrue the most incidents of any group, it is logical that their increased presence would lead to a significant increase in the number of incidents. WDFW also increased their presence on the water in 2015 in response to this trend, resulting in the issuance of more citations than in previous years when enforcement effort may have been lower.

Incidents of Risky Behaviors

A subset of the total number of vessel incidents, including (1) parking in the path, (2) head-on approaches, (3) crosses the path of whales, and (4) chasing/pursuing whales, are considered the most risky vessel behaviors that have the highest likelihood of resulting in vessel strikes. The

average rate of each of these incident categories prior to and following the vessel regulations are shown in Figure 4.7. To calculate the average rate of incidents for each time period (2006-2010 and 2011-2015), we standardized the data to account for variations in effort from year to year, as described above, to get a rate of incidents per hour. Lastly, we averaged the rates in each time period to compare pre- and post-incident rates for each of the four categories. The results show that there were higher rates of incidents for all categories following the regulations except 'chasing the whales' (Figure 4.7). However, when we examine these rates over time for each year, we find that rates fluctuated from 2006 to 2010, then increased in most categories, peaking in 2013, and then declined through 2015 (Figure 4.8). The total number of incidents for each year also reflects a substantial increase in these behaviors following the regulations (Table 4.4).

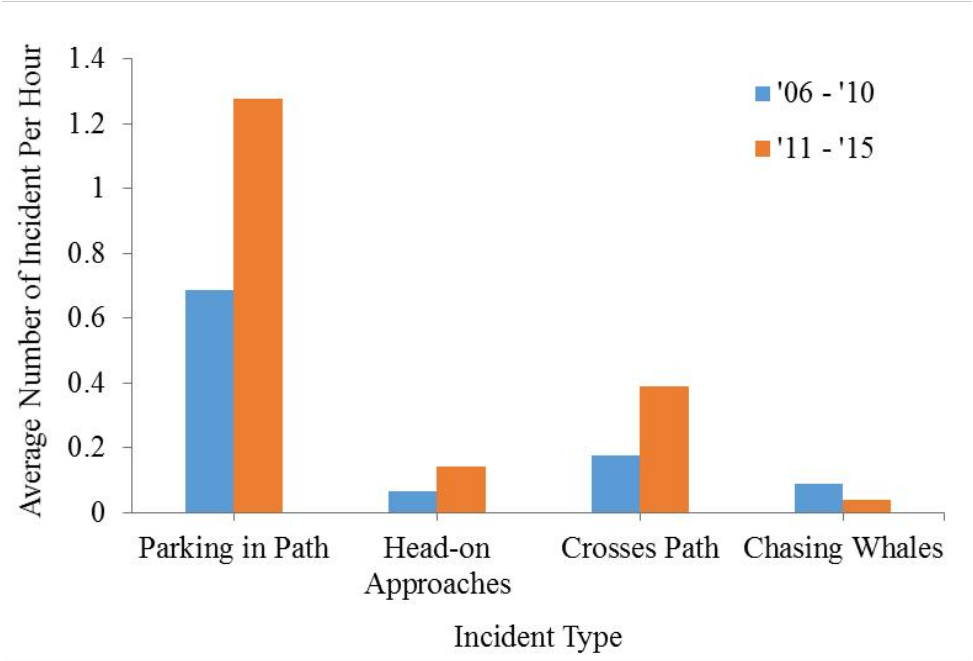

Figure 4.7. Average rates of vessel incidents from 2006 through 2010, and 2011 through 2015. The four incidence categories, (1) parking in path, (2) head on approaches, (3) crosses path, and (4) chasing whales, are considered categories that increase the likelihood of vessel strikes (Seely 2016). The average number of incidents per hour was estimated by averaging the rate of incidents for each time period (2006-2010 and 2011-2015).

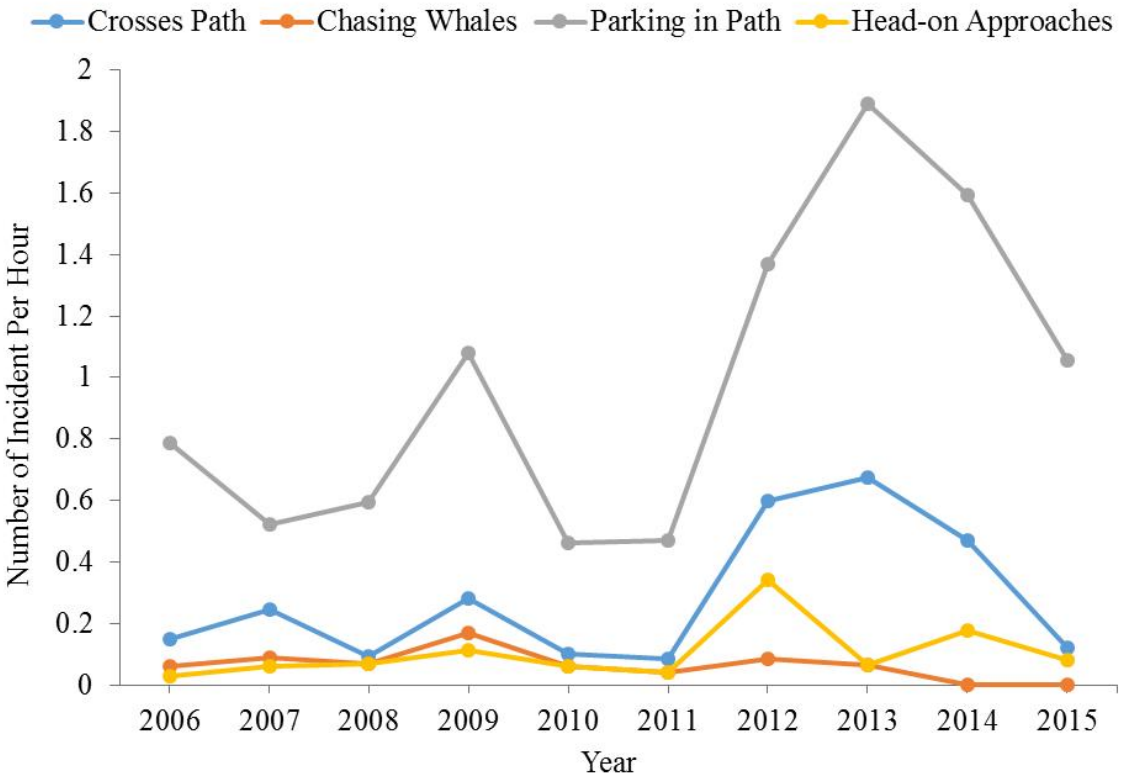

Figure 4.8. Annual incident rates from 2006 to 2015 for four incident categories that may increase the likelihood of vessel strike: (1) parking in path, (2) head on approaches, (3) crosses path, and (4) chasing whales (Seely 2016).

Compliance with a Voluntary Whalewatch Exclusion Zone

The San Juan County Marine Stewardship Area includes a voluntary Whalewatch exclusion zone along the west side of San Juan Island, an important foraging area for the whales. It consists of a 1/4 mile area off the coast of the island, plus an additional 1/2 mile area off of Lime Kiln Point State Park (Figure 4.9a). This zone also encompasses a national wildlife refuge and a biological reserve (Figure 4.9b). Although the expansion and formalization of a mandatory "no-go" zone was considered under Alternative 4 and Alternative 5 of the EA evaluating our vessel regulations (NMFS 2010), a no-go zone was not included in the final rule (76 FR 20870, April 14, 2011). Strong opposition to the no-go zone alternatives was expressed during the public comment period, and several alternatives to the proposed zone were suggested. NMFS ultimately chose not to include the no-go zone in the final rule so as to allow for more time to consider the suggestions made in the public comments.

(a)

(b)

Figure 4.9a and b. Maps of the voluntary no-go zone on the west side of San Juan Island. Figure 4.9a (*left*) shows the 1/4-mile no-go zone on along the coast and the 1/2-mile no-go zone around Lime Kiln Point State Park (Soundwatch 2005). Figure 4.9b (*right*) shows the Whalewatch Exclusion Zone, the Marine Biological Reserve, and the National Wildlife Refuge (Evans and Kennedy 2007).

As a part of their monitoring program, Soundwatch has collected data on compliance with the voluntary zone to determine if it is effective in influencing vessel operator behavior as a voluntary measure. As with the federal regulations, the majority of incidents of noncompliance with the zone were committed by recreational boaters (Figure 4.10). In 2009, recreational boaters committed these incidents at a rate that was 22 times higher than commercial whale watch operators. The rate of noncompliance fluctuates greatly from year to year (Figure 4.10). It is clear from the data that recreational boaters have a harder time complying with the voluntary zone, potentially because they are less aware of its existence compared to the commercial operators. However, the rate of noncompliance with the zone is relatively low compared to the rate of noncompliance with the regulations. Even in the worst years, the rate of noncompliance with the voluntary zone remained below one incident per hour. This suggests a high level of compliance overall with the voluntary whalewatch exclusion zone.

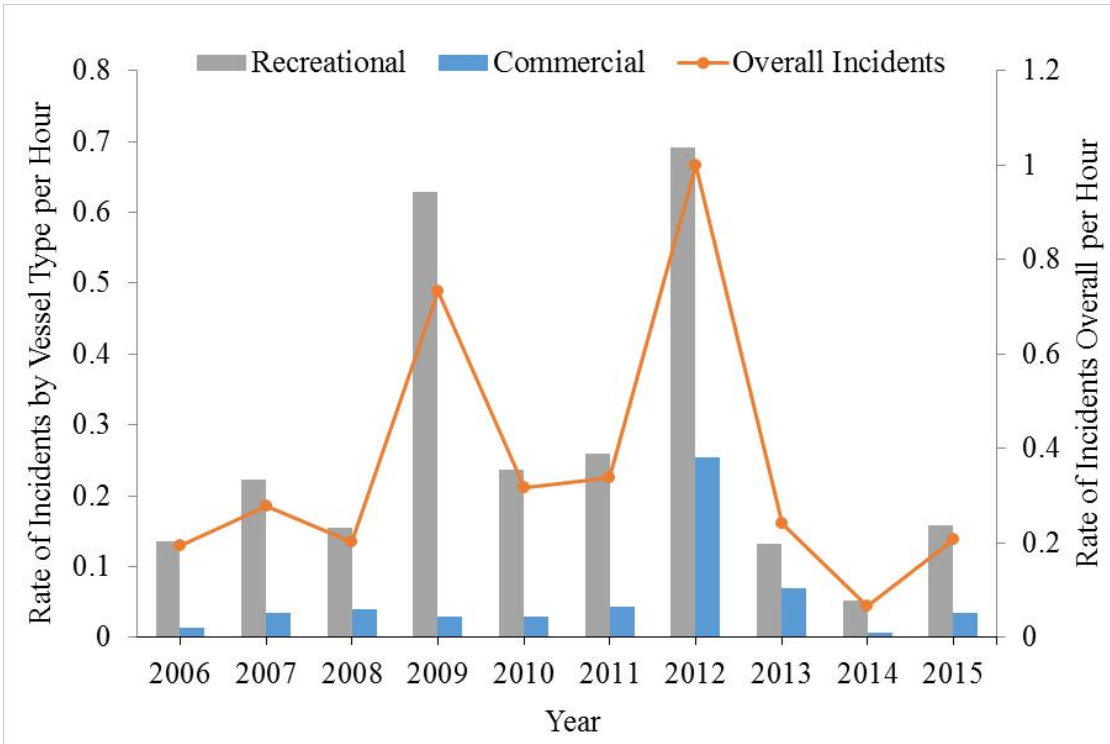

Figure 4.10. Rate of noncompliance with the voluntary whalewatch exclusion zone. The rate of incidents per hour fluctuates from year to year, but it is clear that recreational boaters are responsible for significantly more incidents than commercial whale watch operators (Seely 2016).

Compliance with Voluntary Speed Limits

The BWW guidelines recommend a speed limit near the whales and a mandatory speed limit was considered in the EA but not adopted in the final regulations (NMFS 2010). According to the guidelines, boaters should reduce their speed below 7 knots any time they are within 400 meters of the whales. Although the EA concluded that a speed limit near the whales would reduce the risks of vessel strikes and acoustic masking, NMFS concluded that it would ultimately be too difficult to enforce. However, NMFS remains committed to working with BWW partners to monitor compliance with the voluntary speed restrictions, evaluate new technologies for determining speed over water, and reduce impacts from fast moving vessels in close proximity to the whales.

Soundwatch monitors compliance with the voluntary speed limit. Again, recreational boaters commit the majority of the incidents of going over the speed recommendation (Figure 4.11). In 2011, they committed these incidents at a rate 20 times higher, and in 2012 at a rate 30 times higher, than commercial whale watch operators. Before 2011, the rate of incidents fluctuated greatly from year to year, but appears to follow a decreasing trend beginning in 2012. From these data, it is apparent that recreational boaters are most likely to not follow the voluntary speed limit in the BWW guidelines, although their compliance seems to be improving over the last 4 years. The overall rate of noncompliance is relatively low, at less than one incident per hour.

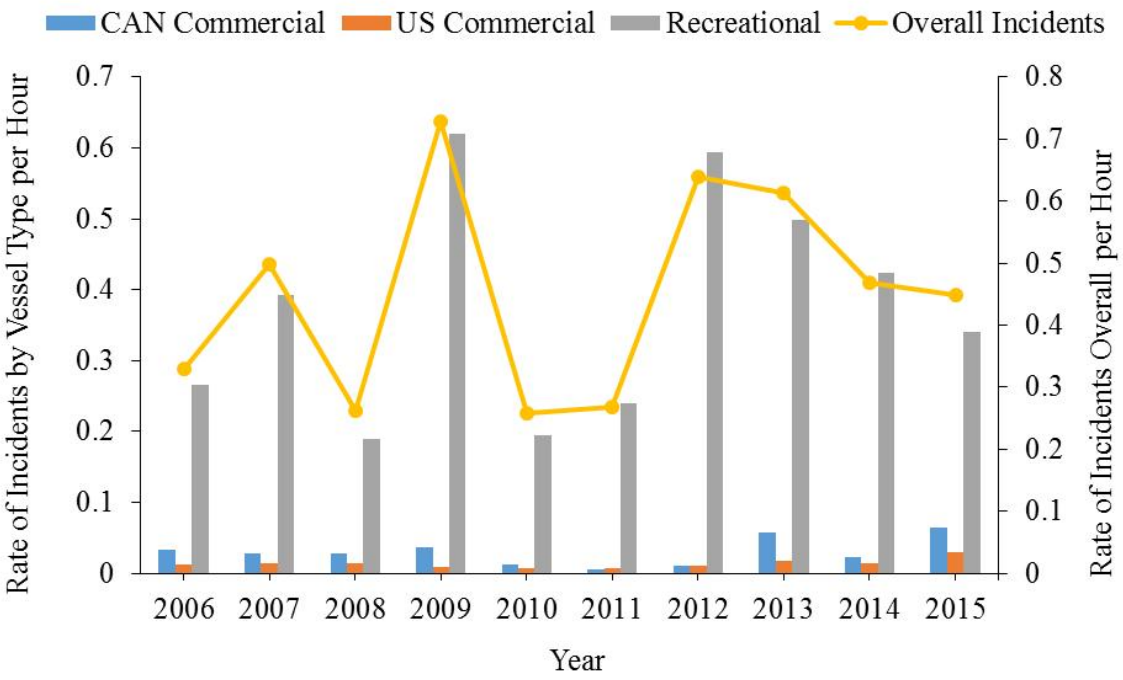

Figure 4.11. Rate of noncompliance with the voluntary BWW speed limit. Again, recreational boaters are responsible for the most incidents in this category. However, their noncompliance appears to be on a downward trajectory (Seely 2016).

Compliance by Kayakers

In 2010, 2011, and 2012, Soundwatch collected specific data from shore on kayaker activities when whales were present within a half mile of shore along the west side of San Juan Island (Koski 2011; Koski 2012; Eisenhardt 2013). In 2012, the effort was the greatest and the data from all 3 years provide information on compliance with the BWW and KELP guidelines before and after the regulations were put into place in 2011. Observers conducted 10-minute scans recording incidents of kayakers not following guidelines (and regulations starting in 2011) (Table 4.5).

Table 4.5. Kayaker compliance with BWW and KELP guidelines from 2010 to 2012.

	2010	**2011**	**2012**
Percent of incidents commercial	66	73	57
Percent of incidents recreational	34	27	43
Average # of incidents per 10-minute scans	5.06	1.46	1.04
Average # incidents per individual kayaker per 10-minute scans	1.01	0.46	0.28

Two trends are apparent in these data. First, the commercial kayakers commit a higher percentage of incidents compared to recreational kayakers. This is likely due to the larger

number of commercial kayakers present in the area and some companies advertising kayaking with the whales may tend to seek out the whales. Second, kayakers significantly improved their compliance following implementation of the regulations with declining rates of incidents per scan. In addition, taking into account the number of kayakers present for each scan, the rate of incidents per individual kayaker also declined over time. The education program at the San Juan County boat launch and training for kayak guides likely played a major role in educating kayakers about the guidelines and regulations and improving compliance. Those education programs have continued beyond the data collection and remain in place.

Conclusions

Although there is an overall decreasing trend in the rate of noncompliance with all of the BWW guidelines combined as observed in Figure 4.6, there does appear to be a higher rate of noncompliance with some of the federal regulations after they were codified in 2011. Following the initial increases in rates of regulation incidents starting in 2011 there has been a decreasing trend, which suggests compliance may be improving as boaters become more familiar with the regulations over time. As discussed in Section 3, the presence of the WDFW enforcement team on the water has increased since 2013 and has a positive effect on compliance with the regulations. It is possible that if enforcement presence were to increase, compliance could continue to increase, providing further benefits to the whales. Canadian regulations similar to those in the U.S. might also improve compliance and have been recommended (Giles and Koski 2012). Unfortunately, there has been an increase in incidents of some particularly risky behaviors. These trends in the rates of noncompliance indicate that vessels still pose a threat to Southern Resident recovery. Continued monitoring of vessel activity around the whales will be important to follow trends over a longer period and evaluate effectiveness of the regulations into the future.

5. BIOLOGICAL IMPACT

Several marine mammal species have demonstrated behavioral responses to vessel activities. However, the behavioral responses may not be consistent across species or within a species, and the degree of the response can vary as well. Furthermore, changes in behavior may not be observable and a lack of an observed response may not indicate a lack of impact (New et al. 2015). This creates a challenge when assessing if Southern Resident killer whales are less affected by vessels than they were prior to the federal vessel regulations. However, in this section we review previously known behavioral responses to vessel activities (as described in detail in NMFS 2010) as well as new studies that have emerged since 2011. In order to put behavioral responses into a biologically meaningful context, we analyze the link between observed behavioral responses and the whales' energy requirements. We follow this by discussing what we currently know about population-level consequences (such as vital rates) from short-term behavioral and physiological changes and highlight where the data gaps are. We then focus our assessment on whether Southern Residents are more likely to display surface active behaviors and/or modify vocal behaviors following implementation of the vessel regulations by analyzing vessel compliance and boater behavior. We also describe the acoustic environment of the inland waters and the received underwater noise levels the killer whales have likely experienced pre- and post-regulations.

Review of Short-Term Behavioral Responses to Vessels

Although the long-term effects of behavioral responses from vessel interactions are not well known, it is well documented that resident killer whales respond to vessels engaged in close proximity (often engaged in whale watching) with short-term behavioral changes (Kruse 1991; Kriete 2002; Williams et al. 2002a, 2002b, 2006, 2009; Foote et al. 2004; Bain et al. 2006; Noren et al. 2007, 2009; Lusseau et al. 2009; Wieland et al. 2010; Senigaglia et al. 2016). These observed behavioral changes have included faster swimming speeds (Williams et al. 2002a), less directed swimming paths (Williams et al. 2002a; Bain et al. 2006; Williams et al. 2009), and less time foraging (Bain et al. 2006; Williams et al. 2006; Lusseau et al. 2009; Giles and Cendak 2010; Senigaglia et al. 2016). Vessels in the path of the whales can also interfere with important social behaviors such as prey sharing (Ford and Ellis 2006) or nursing (Kriete 2007).

Behavior changes have also been observed in the presence of different types of vessels. For example, changes in behavior of dolphins and killer whales have been documented in the presence of both motorized and non-motorized vessels (Nichols et al. 2001; Lusseau 2003; Trites et al. 2007; Noren et al. 2007, 2009; Williams et al. 2010). In addition, researchers have also looked at the behavioral responses of killer whales in relation to boat density (Williams and Ashe 2007; Giles and Cendak 2010). Giles and Cendak (2010) found that whales spent significantly less time foraging in high boat density conditions and were also more likely to remain foraging in low boat density conditions. In more recent work, Giles (2014) found that when whales are grouped together, there are high boat densities around the whales. Previous research results also indicate that these short-term behavioral changes observed in killer whales can occur at varying distances of the vessels, from vessel approaches within 100 meters (109.4 yards) to vessels at 400 meters (437.4 yards) and greater (Williams et al. 2002a; Bain et al. 2006; Noren et al. 2007, 2009; Lusseau et al. 2009; Williams et al. 2009).

Vessel sounds may mask or partially or completely prevent the perception of clicks, calls, and whistles made by killer whales, including echolocation used to locate prey and other signals the whales rely on for communication and navigation. Masking of echolocation would reduce foraging efficiency (Holt 2008), which may be particularly problematic if prey resources are limited. Masking sound from vessels could affect the ability of whales to coordinate their feeding activities, including searching for prey and prey sharing. Foote et al. (2004) found that Southern Resident killer whales increased the duration of their primary communication call when vessels were present. Wieland et al. (2010) also reported increased call durations, but for a larger number of call types (16 out of 21 calls) in a similar comparison. Holt et al. (2009) found that killer whales increase their call amplitude (i.e., loudness) in response to increased vessel noise levels.

Energetic Costs from Short-Term Behavioral Disturbance

Increased energetic costs from behavioral disturbance and/or reduced foraging/energy intake can decrease the fitness of individuals (Lusseau and Bejder 2007) and can result in poor nutrition. Interference with foraging that results in poor nutrition can affect immune function, growth, and development. For example, it can affect the age at which animals reach reproductive maturity, fecundity, and annual or lifetime reproductive success, and if severe enough, can lead to

mortality (Dierauf and Gulland 2001; Trites and Donnelly 2003). Interference with behaviors including prey sharing and communication could also change social cohesion and foraging efficiency and therefore the growth, reproduction, and fitness of individuals.

Several researchers have estimated the physiological consequences of behavioral responses and the potential energetic costs of the behaviors observed when vessels are present. A recent study was designed to determine the energetic costs of surface active behaviors that have been observed in response to vessel presence. Noren et al. (2012) estimated the energetic costs in two trained adult male Atlantic bottlenose dolphins and found that the more energetically costly surface behaviors, such as breaching, can increase metabolic rates in cetaceans and may impact an individual's daily energy requirements depending on the frequency of the vessel interactions and the energetic cost of the surface active behaviors performed. Williams et al. (2006) previously estimated that Northern Resident killer whales expended slightly more energy in the presence of vessels. They estimated that changes in activity budgets in the presence of vessels result in an approximate 3% increase in energy expenditure compared to when vessels are not present.

Changes in sound production may also affect energetic requirements. When producing sounds, including whistles and clicks, captive dolphins were found to have a measurable, although relatively small, metabolic cost (Noren et al. 2013; Noren et al. In Press). More recently, Holt et al. (2015) measured the oxygen consumption in captive bottlenose dolphins during vocalizations that varied in levels of sound production. They found that increased vocal effort (i.e., the total acoustic energy of the sounds produced), increased the metabolic rate relative to the resting rate, demonstrating that modifications in vocal effort can have an energetic impact on an individual. There is a potential for significant impact on an individual when the energetic costs from increased sound production, or vocal modification, and the costs from increased surface active behaviors are combined over an extended period of time.

Although there is a higher energetic cost of increased performance of surface active behaviors and modifications of vocal effort, the corresponding increase in energy expenditure may be less important than the reduced time spent feeding and the probable reduction in prey consumption. From their observations, Williams et al. (2006) calculated that Northern Resident killer whales spent 18% less time foraging in the presence of vessels for 12 hours compared to when vessels are absent. Similarly, Southern Resident killer whales spent 17 to 21% less time foraging in the presence of vessels for 12 hours, depending on vessel distance (D. Noren unpublished data, calculated from data in Lusseau et al. 2009).

Spending less time foraging in the presence of vessels is not an anomaly observed in killer whales alone; a similar behavioral response has been found in several cetacean species worldwide (Senigaglia et al. 2016). For example, Pirotta et al. (2015) found that changes in dolphin echolocation signals in the presence of vessels likely results in a reduction in foraging activity, highlighting the impact that repeated disruptions can have on total energy intake. Reductions in bottlenose dolphin foraging/feeding behavior, based on surface-based observations of activity states may be as high as 46 to 87% when dolphins are exposed to vessels for 12 hours (D. Noren unpublished data). The large variation in level of impact is attributed to vessel distance, how specific populations' activity budgets change with vessel disturbance, and

geographic location (D. Noren unpublished data). Currently, the degree of impact of repeated disruptions from vessels on Southern Residents is unclear. However, reducing repeated disruptions from vessels will likely reduce the impact on foraging and, in turn, reduce the potential for nutritional stress. Therefore, in order to adequately measure the effectiveness of the federal vessel regulations, we need to better understand how vessel disturbance relates to foraging and if this impact has been reduced over time.

Link between Short-Term Behavioral Disturbances and Population-Level Impacts

The previous studies described briefly thus far (and in more detail in NMFS 2010) have found short-term behavioral changes in response to vessels, and that these changes may affect energy requirements. An important component in assessing whether impacts of vessels on Southern Residents have been reduced after regulations came into effect, however, is understanding if these short-term behavioral changes result in long-term impacts to the population. This component still remains unknown. One approach that may help address this knowledge gap is using the population consequences of disturbance (PCoD) framework (New et al. 2015). This framework has been used for different species to assess acoustic disturbance to individuals and link disturbance to population-level effects (National Research Council 2005). Essentially, the PCoD framework links a disturbance directly to physiological and/or behavioral changes in an individual. These physiological and/or behavioral changes are linked to the health of the individual, which in turn might make it possible to link the effects of disturbance from whale watch boats to vital rates and population dynamics (Figure 5.1).

This method (using the PCoD framework) to assess whale watching impacts on population dynamics has been recently attempted. Christiansen and Lusseau (2015) developed a model to measure the effects of whale watching activities on fetal growth for minke whales (*Balaenoptera acutorostrata*). They estimated the relative decrease in feeding activity during interactions with whale watch vessels (i.e., the proportions of time spent feeding with and without whale watch vessels) was approximately 42% and the corresponding non-feeding activities were increased by 7.6%, leading to a 63.5% decrease in energy intake. However, when they examined the cumulative bioenergetic costs over the feeding season, they found that the boat interactions experienced at the individual level were low and therefore the estimated effect on fetal growth was negligible. The authors emphasize that if individual whales were exposed the majority of their day (12 hours) in the presence of whale watch boats, a 60% energy loss would be enough to have a biologically relevant effect on fetal growth (Christiansen and Lusseau 2015). Southern Resident killer whales spend the majority of daylight hours in inland waters in the presence of whale watch vessels. Whale watching tours have now also extended their time on the water to include sunset trips in July through September, increasing the time boats spend with the whales. Some have even begun offering year-round trips, increasing the duration of the whale watch season (Giles and Koski 2012). Although the degree of foraging interruption at the individual level is unknown, it likely varies each day and by location. For example, if a whale spends the majority of its time feeding off the west side of San Juan Island, it will likely be exposed to boats throughout the day because of the relatively high boat traffic that occurs there compared to other areas.

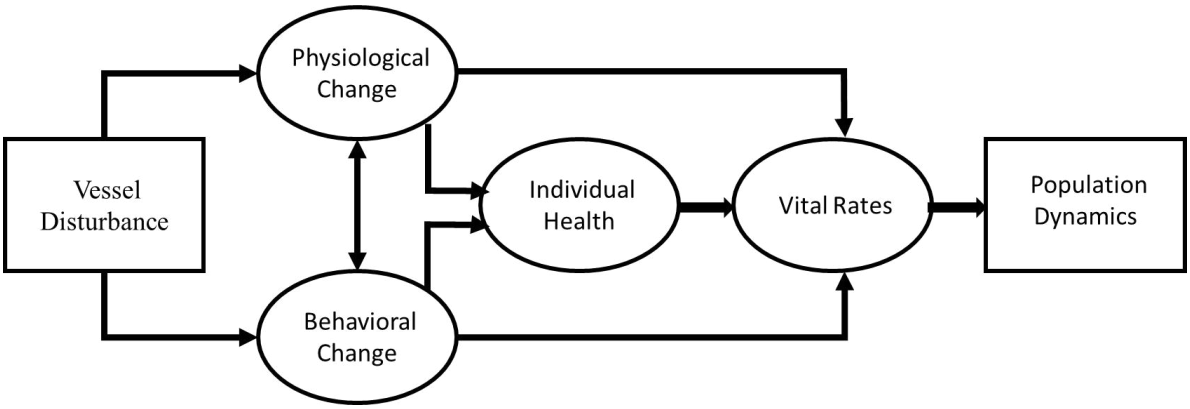

Figure 5.1. Conceptual framework of the PCoD model that links vessel disturbance at the individual level to physiological and/or behavioral changes, the individual health, and vital rates, which link to population level dynamics. Adapted from New et al. 2014 and 2015.

As discussed above, previous studies have provided the links between vessel disturbances and behavioral changes and the corresponding estimated physiological change (or change in energetic requirements). There are also several studies that link vital rates to population dynamics (e.g., Brault and Caswell 1993; Olesiuk et al. 1990, 2005). Therefore, there may be enough data to fill in components of the PCoD model. However, the missing links include how the changes in physiology and behavior affect the health of the whales, as well as how an individual's health affects the vital rates of the population. New and ongoing health studies that will help fill these data gaps include photo-identification for the annual census, recording observations of physical condition, continuing photogrammetric monitoring (Fearnbach et al. 2011), collecting contaminant and health biomarkers, conducting stranding investigations and disease testing, and developing a database for individual health profiles (NMFS 2016b). These efforts can help link vessel disturbances the whales experience subsequent to the vessel regulations to help managers understand the population-level consequences following short-term behavioral responses. Although we don't have enough information to fully understand these relationships, we acknowledge that the amount of time Southern Residents are likely exposed to vessels is enough to affect foraging at the individual level, similar to that seen in other species. Moreover, we highlight that if the whales are spending the majority of their day in the presence of whale watch boats when they are attempting to forage, there may be a biologically relevant effect on the vital rates and therefore may still have an impact at the population-level.

Comparing Short-Term Behavioral Responses Pre- and Post-Regulations

Although there are no studies that specifically analyze if Southern Residents are displaying greater or fewer behavioral changes from vessel interactions following the vessel regulations, we know that killer whales display certain behaviors (physiological and acoustical) under certain vessel conditions. In order to deduce if the vessel regulations are effective at reducing biological impacts, here we evaluate the specific vessel incidents before and after the regulations that are thought to impact the whales to an extent that would either increase energetic requirements and/or reduce foraging success and opportunities.

Average distance from vessels to whales: The 2011 federal vessel regulations changed the whale watch viewing distance from 100 yards to 200 yards. As described above, previous studies have documented that behavioral responses can occur at varying distances from vessels, including out to 400 meters (437.4 yards) but to a lesser extent than that observed at 100 meters (109.4 yards) (Williams et al. 2002a; Bain et al. 2006; Noren et al. 2007, 2009; Lusseau et al. 2009; Williams et al. 2009). With all else being equal, and under the assumption that the farther away vessels are from the whales the less impact those vessels will have, we assessed the average distance of vessels to the whales before and after the regulations.

Specifically, Houghton (2014) evaluated compliance with the vessel regulations by using spatial distributional data for vessels within 1,000 meters of whales that were tagged with DTAGs (suction-cup multi-sensored archival tags that include hydrophones for audio recordings, an accelerometer, sensors for temperature and pressure, and sensors used to derive depth, pitch, roll, and heading of the whale) to document any changes in whale watch behavior. She found that occurrence of vessels within 100 m, 200 m, and 400 m of the tagged whales changed over time. In fact, her study suggests that the average distance between the vessels (both commercial and recreational whale watch vessels) and the whales has significantly increased since the regulations were codified (Figure 5.2). Although the average distance increased over time, close approaches by both commercial and recreational boats occurred each year. For example, the minimum distance whale watch boats were observed from the whales in 2010, 2011, and 2012 was 17, 42, and 4 m, respectively; private vessels were observed to be 32, 23, and 55 m, respectively. These observations of close approaches indicate that the whales may still be negatively impacted by close approaches of vessels, and that short-term behavioral responses from these close approaches are likely to still occur, similar to before the regulations.

The proportions of vessels by type within these same distance groupings have changed over time (Table 5.1) (Houghton 2014). For example, in 2010, 5% of private boaters were within 100 m of the whales, 39% were within 200 m, and approximately half of them were within 400 m (Table 5.1). By 2012, there were lower proportions of private boaters at each distance than compared to the proportions in 2010. The proportion of commercial whale watchers in each distance category was slightly different than that found for private vessels. Similar to private vessels, the proportion of commercial vessels at 100 m decreased over time (Table 5.2), whereas the proportions of commercial vessels at 200 m and 400 m appeared to fluctuate.

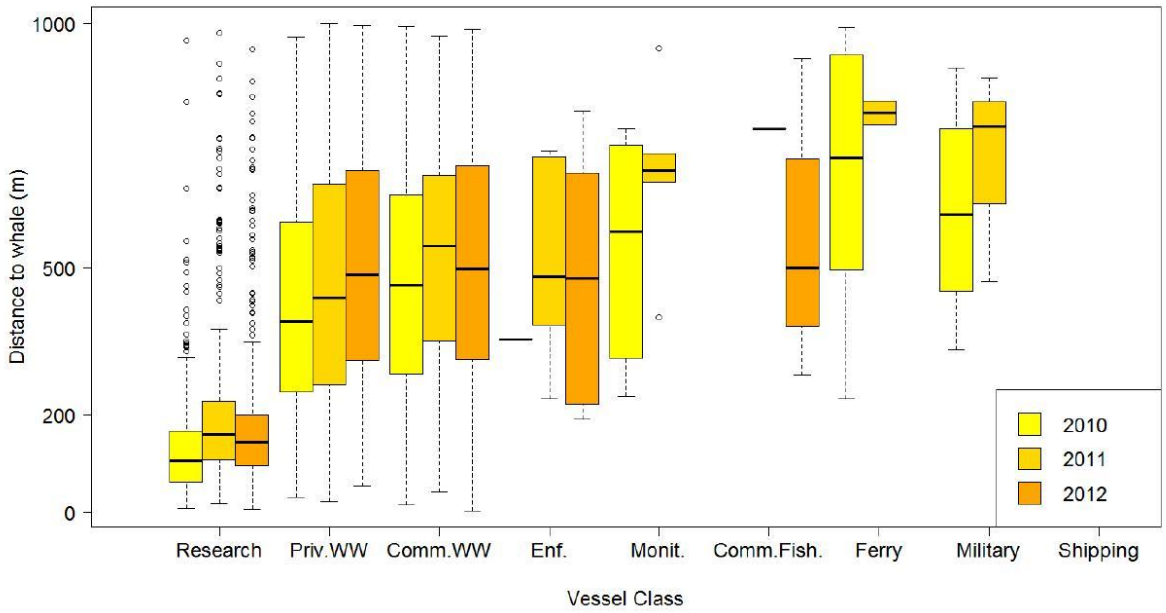

Figure 5.2. Box and whisker plot of distance of vessels from whales by vessel type for 2010, 2011, and 2012. Median distance is represented by a thick black line, the inner quartile range is represented by boxes, and the minimum and maximum distances observed are represented as the ends of the whiskers. "Research"–research vessels were permitted to conduct research and exempted from the vessel regulations; "Priv. WW"–Private whale watch vessels; Comm. WW"–Commercial whale watch vessels; "Enf."–Enforcement; "Monit."–Monitoring Vessels; "Comm. Fish."–Commercial fishing vessels. Figure from Houghton (2014).

Table 5.1. Count and proportion of private (recreational) vessels within 100 m, 200 m, and 400 m by year (data from Houghton 2014).

Year	100 m		200 m		400 m	
	Count	Proportion	Count	Proportion	Count	Proportion
2010	13	5.4%	39	16.2%	122	50.6%
2011	4	5.6%	11	15.3%	33	45.8%
2012	8	3.0%	37	14.0%	101	38.3%

Table 5.2. Count and proportion of commercial whale watch vessels within 100 m, 200 m, and 400 m by year (data from Houghton 2014).

Year	100 m		200 m		400 m	
	Count	Proportion	Count	Proportion	Count	Proportion
2010	25	5.1%	74	15.1%	209	42.7%
2011	3	2.3%	9	6.9%	40	30.5%
2012	9	2.1%	51	11.6%	167	38.0%

When analyzing these data, it is worth noting that the sample size was relatively small (22 individuals were tagged over the course of the study), and that the inner quartile range was quite large, indicating a broad spread of the data (Houghton 2014). Furthermore, repeated measures of certain boats have not been addressed yet. It also remains unclear if this increased average distance of vessels from the tagged whales following the federal regulations is representative of the average distance of vessels from all whales, or just a product of the study design. It is also unclear if this increased average distance reduces the impacts to such an extent to allow the whales more foraging opportunities and reduce energetic requirements. Given these general trends in average distance, and decreasing trends in the incidents within 200 yards described in Section 4, the impacts from vessel distance may be less than before the federal regulations.

Vessel behaviors that increase the likelihood of vessel strikes: Vessel strikes can result in direct injury or mortality, and even small injuries can be a path for infections (Dierauf and Gulland 2001). Killer whales have been injured or killed by collisions with vessels, primarily from being struck by propeller blades (Visser 1999; Ford et al. 2000; Visser and Fertl 2000; Baird 2001; Carretta et al. 2001, 2004; Van Waerebeek et al. 2007). Some killer whales that have sustained severe injuries from collision with vessels eventually made full recoveries. For example, a female killer whale observed by Ford et al. (2000) healed from wounds extending almost to her backbone. Leapfrogging also increases the risk of direct contact with killer whales, which although rare, resulted in a collision between a Southern Resident and a whale watch vessel off the San Juan Islands in July 1, 2005. Only one killer whale mortality was caused by a vessel strike from the 1960s through the 1990s in the region (Baird 2002). However, several additional mortalities since then have been reported. In March of 2006, a lone Southern Resident killer whale (L98) residing in Nootka Sound, British Columbia for several years, was killed by a tug boat strike. Although L98 exhibited unusual behavior and often interacted with vessels, his death demonstrates the risk of vessel accidents. In July 2006, the death of a stranded Northern Resident female was attributed to blunt trauma, likely caused by a vessel strike (Gaydos and Raverty 2007). Stranding data indicate several other more recent killer whale strandings from vessel interactions. For example, an adult female transient killer whale stranded off Westport, Washington from trauma, likely from a large propeller strike. In December 2016, an 18 year-old male Southern Resident died in British Columbia from blunt force trauma and the cause is still under investigation (http://www.pac.dfo-mpo.gc.ca/fm-gp/species-especes/mammals-mammiferes/srkw-eprs-j34-eng.html). In 2016, a Northern Resident killer whale was observed by aerial photogrammetry to have a superficial propeller wound (SWFSC unpubl. data).

As described in Section 4 and NMFS (2010), the risky vessel behaviors that have the highest likelihood of resulting in vessel strikes include parking in the path, head on approaches, crossing the path of whales, and chasing/pursuing whales. It is likely that the number of vessels surrounding the whales largely influences these incident rates, which incorporate the best available measure of effort. As noted in Section 4, there are challenges in evaluating trends using the Soundwatch dataset. It is difficult to tease out how these trends in rates are directly influenced by a change in the number of vessels surrounding the whales. Regardless of the influence of vessel count on incident rates, the rates themselves have increased following the vessel regulations (see Figures 4.7 and 4.8), and the total number of incidents in each of these behavior categories is higher than prior to the regulations. There is variability in the annual numbers of the risky incidents, with parking in the path being the most common. For example,

the highest number of observed incidents of parking in the path occurred in 2014 (with 677 observations), whereas the lowest number of observed parking in the path incidents was 184 and occurred in 2007 (see Table 4.4). Because both the rates of incidents and total number of incidents in these risky behavior categories has increased following the vessel regulations, there is an increased likelihood of vessel strike. However, the annual rate of parking in the path incidents has shown a declining trend in the most recent years after peaking in 2012 and 2013 (Figures 4.5, 4.7, and 4.9). If that trend continues, the risk of vessel strikes may also go down.

Underwater Noise Levels Prior to and Following the Regulations: Vessel sound has the potential to interfere with important biological functions for killer whales. For example, vessels likely create sound levels that interfere with the whales' communication and foraging behavior by masking their acoustic signals. Killer whales generally have a range of hearing from 0.6 to 115 kHz (Szymanski et al. 1999; Branstetter et al. 2017) and this wide frequency range of hearing makes killer whales susceptible to effects from a wide range of sounds, including sound produced by vessels. Killer whales change their behavior in response to changes in their acoustic environment. For example, they compensate for increased background noise from vessel traffic by increasing their call amplitude (Holt et al. 2009) or by increasing their call length (Foote et al. 2004).

Holt (2008) reviewed the current knowledge and data gaps at the time regarding sound exposure in Southern Resident killer whales. The review provides an overview of acoustic concepts, killer whale sound production, ambient sound levels in Haro Strait (Veirs and Veirs 2006), sound propagation in killer whale habitats, effects of sound exposure, and assessment of probable acoustic impacts on Southern Residents. The recovery plan recommended expanded monitoring of whale watch vessels, evaluating the relative importance of different types of vessels (e.g., shipping, ferries, etc.), and determining the acoustic environment of the whales. More recently, there have been several studies that have improved upon the previous studies and characterized sound from ships and vessels as well as ambient noise levels in the inland waters (Bassett et al. 2012; McKenna et al. 2013; Houghton et al. 2015; Veirs et al. 2016). There are new studies that have also characterized received noise levels by the whales before and after the vessel regulations (Holt et al. 2017) and the potential response of the whales to different noise levels (Williams et al. 2014). Here we provide a review of these new studies and the implications to the biological effectiveness of the vessel regulations.

In a recent study, Bassett et al. (2012) assessed ambient noise levels in inland waters of Washington State (northern Admiralty Inlet, which is not part of the whales' core summer habitat) for both unweighted broadband (between 20 Hz and 30 kHz) and M-weighted (or marine mammal weighted) sound pressure levels, and the contribution of different vessel types on the ambient noise. Admiralty Inlet provides shipping access to the ports of Seattle, Everett, and Tacoma as well as to U.S. Navy and Coast Guard facilities. Ferries and cruise ships also transit the Inlet regularly. Therefore, larger vessels such as cargo ships, tugs, and passenger vessels dominate this waterway. Bassett et al. (2012) found that the variability measured in the ambient noise was largely due to vessel activity. Moreover, cargo ships contributed to almost 80% of the vessel noise budget, followed by tugs and then ferries that had a combined contribution of approximately 20% of the noise budget. In a similar study, Veirs et al. (2016) estimated sound pressure levels for ships (greater than 65 feet [19.8 m]) that transited through the Haro Strait, a

core use area visited by Southern Resident killer whales (Hauser et al. 2007). They estimated the average daily ship traffic is 19.5 ships per day. Tugs, cargo ships, vehicle carriers, and tankers were the most prevalent ship classes. For both low frequencies (20 to 30 dB from 100 to 1,000 Hz) and high frequencies (5 to 13 dB from 10,000 to 40,000 Hz), the received levels were above background levels, indicating that underwater noise from ships extends up to high frequencies similar to noise from smaller boats. Considering large ships pass through Haro Strait approximately every hour throughout the year (Erbe et al. 2012), concern over ship noise interfering with Southern Resident killer whale communication, foraging, and navigation has been identified as a concern (Veirs et al. 2016). A new effort based in Canada, the Enhancing Cetacean Habitat and Observation (ECHO) Program, is a Vancouver Fraser Port Authority-led initiative aimed at better understanding and managing the impact of shipping activities on at-risk whales throughout the southern coast of British Columbia (http://www.portvancouver.com/environment/water-land-wildlife/marine-mammals/echo-program/). NOAA participates in the advisory working group and technical working groups for ECHO.

There are several vessel characteristics that influence source and received levels. McKenna et al. (2013) collected acoustic measurements from transiting container ships off the coast of southern California and compared these measurements to ship design (length, gross tonnage), operational conditions (speed), and ocean conditions (month, wave height). Broadband source levels ranged between 5 and 10 dB, depending on transit conditions. The majority of the variability in source levels was explained by ship speed. Veirs et al. (2016) also found that there was a linear relationship between received levels and ship speed. McKenna et al. (2013) suggested that because ship speed was the most important covariate in predicting source levels, reducing ship speed should result in lower sounds. In fact, speed from smaller private and commercial vessels was also found to be the best predictor in received levels by the Southern Residents (Houghton et al. 2015). They suggest measures that reduced vessel speed would likely reduce acoustic exposure to Southern Resident killer whales (Houghton et al. 2015).

Similar to Houghton et al. (2015), Holt et al. (2017) utilized DTAGs to measure received noise levels by the whales (in dB re 1µPa) and compared noise levels before and after vessel regulations came into effect. Using the cylindrical or spherical spreading loss model, they predicted that changing the vessel approach distance from 100 yards to 200 yards as described by the federal vessel regulations, would result in a reduction in noise between 3 and 6 dB. However, Holt et al. (2017) found that the received noise levels the killer whales experience were not significantly different following the implementation of the federal vessel regulations. Received noise levels in 2010 and 2012 were similar and were significantly higher than the similar levels in 2011 and 2014 (Figure 5.3). Holt et al. (2017) found that the proportion of observations in which vessel speed was categorized as stationary decreased following the implementation of the regulations. Vessel operators may spend more time underway to ensure they can maintain the required distance and increased speed may have offset noise level reductions from increased distance. Noise was best predicted by year, vessel counts, and average vessel speed category. Both vessel speed and vessel count were positive predictors of noise levels, however, changes in vessel counts had a smaller effect on noise levels than vessel speed.

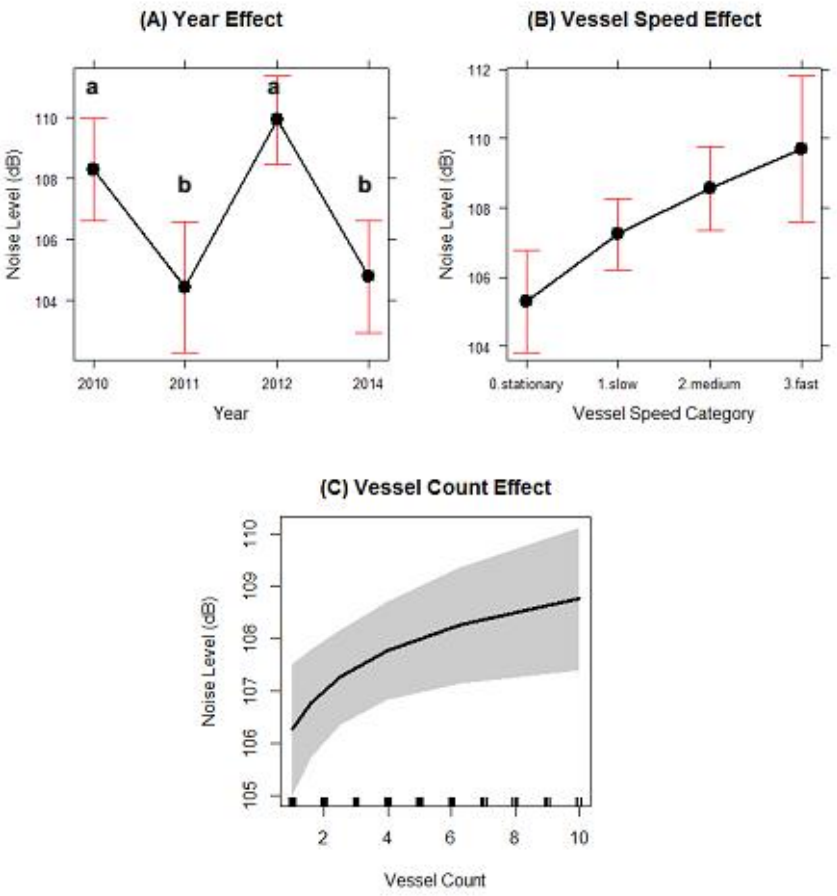

Figure 5.3. Plot of fitted explanatory variables on noise level (in dB re 1 µPa) of the top-ranking model inclusive of all data. (A) year, bars are standard errors of the estimate, pairwise comparisons that are statistically different are indicated by the lowercase letters above the plots; (B) vessel speed category; (C) vessel count with counts plotted in linear terms, gray area is the 95% confidence interval of the predictor. Reprinted from Holt et al. (2017).

The received noise levels (in the 1 to 40 kHz band) were between 96 and 127 dB re 1µPa, with an average of 108 dB ± 5.5 (Holt et al. 2017). Recent modeling efforts estimated a dose-response function relating behavioral response of killer whales to received levels from ships (Williams et al. 2014). Although they acknowledge large uncertainties around their estimates, Williams et al. (2014) found that whales would have a 50% chance of responding to ship noise when the received levels are near 130 dB rms. In a previous study, Holt (2008) concluded that vessel noise was predicted to significantly reduce the range at which echolocating killer whales could detect salmon in the water column. The detection range for a killer whale echolocating on a Chinook salmon could be reduced 88 to 100 percent by the presence of a moving vessel within 100 yards (91.4 m) of the whale. The detection range was reduced by 38 to 90 percent when different vessels were operating at different speeds 200 and 400 yards from the whales. Reduction in detection ranges decreased with greater distance from the whales and this was the case for both fast (cruise) and slower (powering up) vessels. Holt et al. (2017) cautioned that because there

was inter-annual variability, only one year of baseline data prior to the vessel regulations (i.e., a small sample size), and logistical constraints in the field, that the results should be interpreted with caution. Although it is unclear if the received levels the Southern Residents experience are loud enough to have more than a short-term behavioral response, continuous disruption from vessels and reduced foraging efficiency could have physiological effects, such as poor nutrition, and affect fitness of individuals as described above.

Over the next 2 years, the NWFSC will focus on using the DTAG data to investigate fine scale details of subsurface acoustic and movement behavior during different activities, especially those predictive of foraging, to then determine potential effects of vessels and noise on Southern Resident killer whale behaviors. They will analyze acoustic cues (such as echolocation and prey handling sounds) that are validated with prey samples, to identify foraging events. They also plan to quantify foraging behavior based on kinematics. Acoustic and movement sensor variables that reliably identify foraging behavior will then be determined, which will allow them to make estimates of foraging effort and success on an individual level. The results will help to determine which vessel variables and associated noise have an effect on foraging effort/energy acquisition in Southern Resident killer whales. Comparing DTAG results with studies of Northern Residents in Canada will also expand our ability to interpret behavioral results.

Conclusions

Southern Resident killer whales respond to vessels in close proximity with short-term behavioral changes. There is a higher energetic cost of surface active behaviors and vocal effort resulting from vessel disturbance; however, this increased energy expenditure may be less important than the reduced time spent feeding and the resulting potential reduction in prey consumption. Although it is unknown if these short-term behavioral changes affect the population dynamics, it is likely that because Southern Residents are exposed to vessels the majority of daylight hours they are in inland waters, there may be biologically relevant effects at the population-level.

In summary, the vessel regulations were designed to reduce behavioral impacts, acoustic masking, and risk of vessel strike and this review provides mixed results about benefits to the whales following implementation of the regulations. Since the regulations were codified, there is evidence that the average distance between vessels and the whales has increased, and the proportions of vessels by vessel type that are within 400 yards has also changed over time. This increased average distance likely reduces some of the impacts to the whales. However, there is a higher rate of incidence of some of the riskiest vessel behaviors that have the highest likelihood of resulting in vessel strikes. These behaviors include parking in the path, head on approaches, and crossing the path of whales. Because the overall rates have increased for these vessel behaviors, it is likely that Southern Residents are more at risk of a vessel strike. Certain vessel incidents, however, such as parking in the path, have declined in the last 2 years. Lastly, from the DTAG dataset received noise levels in tagged whales was best predicted by year, vessel counts, and average vessel speed category. Sound levels, however, are highly variable and have not shown a decline following implementation of the regulations. The majority of the variability in source levels was explained by speed. Because speed of both large ships and smaller vessels is the most important covariate in predicting source levels, several studies have suggested that reductions in speed should result in lower sound levels and would likely reduce acoustic

exposure to Southern Resident killer whales. Ongoing analysis of the DTAG data will provide additional information on whale behavior in response to changing vessel activities and sound levels.

6. ECONOMIC IMPACT

Since the early 1980s, whale watching has developed into a popular and economically viable tourist industry in many localities around the world. The whale watching industry in the Pacific Northwest has been recognized as one of the fastest growing (Hoyt 2001, 2002). In Washington and British Columbia, killer whales are the principle target species for the commercial whale watching industry, easily surpassing other species such as gray whales, porpoises, and pinnipeds (Hoyt 2001; O'Connor et al. 2009). The popularity of and demand for whale watching activities gradually increased in the inland waters of Washington from 1976 to 1991, followed by a period of rapid growth through 1997 (Bain 2002; Seely 2016). The commercial whale watch fleet reached a peak in 1997 at 78 commercial vessels before rising again in 2001 to over 80 vessels. The size of the fleet has continued to grow since then, reaching 96 active commercial vessels in 2015 (Seely 2016) (Figure 6.1). In 2010, the year prior to implementation of the regulations, 76 active commercial whale watch vessels (23 U.S. and 53 Canadian) from 35 active companies (16 U.S. and 19 Canadian) were operating in Haro Strait (Koski 2010). Five years after the federal regulations were put in place, these numbers have grown to 96 vessels in 57 active commercial whale watch companies (Seely 2016). In 2015, the number of U.S. companies equaled the number of Canadian companies at 19 each. However, Canada still has more active vessels than the U.S., with 57 Canadian compared to 39 U.S (Seely 2016). Canada's fleet consists mostly of small, high-speed vessels that make up to four trips per day, whereas U.S. vessels tend to be much larger and slower, making only a single trip in a day. Ultimately, Canadian and U.S. vessels take approximately the same number of passengers out each day despite differences in the size of the two fleets (Giles and Koski 2012).

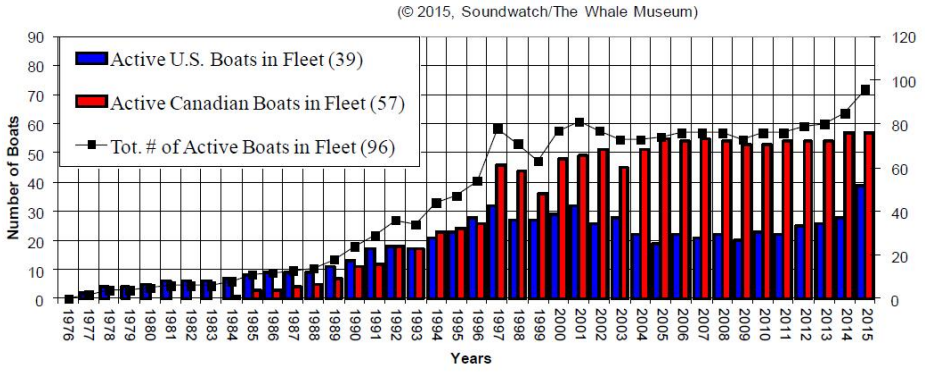

Figure 6.1. Growth of the whale watch industry in Haro Strait from 1976 to 2015. Figure from Seely (2016).

Killer whale watching became a multi-million dollar industry over a relatively short period of time. Ticket sales for vessel-based whale watching first broke the million dollar mark in 1991,

and were approaching $5.7 million by the end of 1997 (Koski 2006). Hoyt (2001) estimated that 52,000 (boat-based) participants in commercial whale watching tours in Washington State spent a total of $9.59 million in 1998; $3.31 million in tickets for whale watching, and the remainder on indirect expenditures such as food, travel, lodging, and souvenirs. Approximately 80 percent of this was estimated to be spent in Puget Sound and Georgia Basin. O'Connor et al. (2009) estimated 425,000 whale watchers in Washington State spending nearly $11 million in direct expenditures and a total of $61 million including indirect expenditures in 2008. In 2010, Industrial Economics, Incorporated (IEc) estimated that the whale watching industry contributed approximately $22 million annually and 196 jobs to the 12 counties adjacent to the whales' habitat area through direct, indirect, and induced expenditures related to the industry (IEc 2010).

When the 2011 regulations were first proposed, many members of the whale watch industry and local community expressed concern over the potential impacts that the regulations might have on the industry and local economy. While the analysis presented in the EA assembled during the rulemaking process suggests that any economic impacts of these regulations would be minor, there was uncertainty in the economic analysis, as limited data were available specific to the whale watch industry. In addition, there was potential for cumulative economic effects when considered with other variables affecting the whale watch industry. The analysis conducted in 2010 by IEc was updated with new data in 2015 to assess the economic value of the industry in the Puget Sound region 5 years after the implementation of the federal regulations. In 2016, IEc prepared an analysis of the effects of the regulations on the whale watching industry as well as on tourism in San Juan County and the greater Puget Sound region using available data on ecotourism indicators.

Assessing the Value of the Whale Watch Industry

Approach & Methods: IEc (2015) uses an IMPLAN model to measure the impact of the revenue brought to the Puget Sound region by the whale watching industry. IMPLAN is an input-output model that measures the impact that expenditures in a given industry have on the region. The measures used to evaluate this impact are employment, labor income, value added or revenue, and output. In this case, the value added measure is the best representation of the impact of the industry on the regional economy, as it does not double-count expenditures across industries linked to whale watching, such as restaurants and hotels. IMPLAN analysis is a common economic tool used by federal and state agencies to evaluate various policies. This model describes the expenditures that would be lost to the region in the absence of the whale watching industry. It is also worth noting that this is a static model that measures the effects of monetary input to the industry at one point in time, but does not reflect a change in value added over several years.

This analysis focuses on the 12 counties surrounding Puget Sound as the study area. Businesses in these 12 counties benefit directly from participants' spending on things like food, lodging, souvenirs, etc. The study included only whale watching trips that originated in the U.S., as trips from Canada were unlikely to impact the study area economy. IEc (2015) also developed a separate input-output model for San Juan County to determine the value of the industry to the San Juan County economy in particular.

The number of participants in whale watching tours each year was estimated from a 2009 analysis by the International Fund for Animal Welfare (IFAW) and from a 2014 estimate reported by the PWWA at their annual meeting. IFAW estimated that approximately 150,000 people participated in tours departing from Anacortes, Friday Harbor, Port Angeles, Port Townsend, and Bellingham each year. The PWWA estimated that 13,563 whale watching trips occurred in Puget Sound in 2014, which amounts to between 128,000 and 170,000 participants per year. IEc (2015) used this information to generate low, high, and maximum estimates of 150,000, 282,000, and 500,000 participants per year in all of Puget Sound and 48,000, 91,000, and 162,000 participants per year, respectively, on tours originating only from San Juan County (Table 6.1).

Table 6.1. Low, high, and maximum scenario participation estimates for 2014.

Participation Estimate	Puget Sound Study Area	San Juan County Study Area
Low	150,000	48,000
High	282,000	91,000
Maximum	500,000	162,000

The 2009 IFAW report estimated that each participant spent an average of $145 across the study area, which represents the amount that would be lost to the region if they did not participate in a whale watching tour. Two other sources—a NOAA Technical Memorandum on the expenditures of marine anglers and a Washington State analysis of the impact of travelers to the local economy—indicate an estimate of closer to $250 per participant. These represent the low and high estimates of spending per participant in the IEc study. The maximum estimate is provided by the USFWS survey of expenditures of wildlife-related recreational activities, which they estimate amounts to $581 per participant. Expenditures in San Juan County were estimated to be the same as the rest of the region with the addition of the cost of the ferry ride to reach the island. Although the maximum participation estimate is unlikely, it is helpful in demonstrating the sensitivity of the results of the model to the assumptions of the inputs (Table 6.2).

Table 6.2. Low, high, and maximum scenario expenditure estimates.

Expenditure Estimate	Puget Sound Study Area	San Juan County Study Area
Low	$145	$182
High	$250	$287
Maximum	$581	$618

Results and Interpretation: The analysis conducted by IEc (2015) indicates that the whale watching industry may contribute between $17 and $58 million to the local economy annually. It also provides hundreds of jobs to the Puget Sound region. This accounts for roughly 0.01 and 0.02% of the region's GDP. In San Juan County alone, the industry contributes between $4 and $13 million and tens to hundreds of jobs to the economy annually, which makes up about 1 to 3% of the local GDP (Table 6.3).

Table 6.3. Total value added estimates for the low, high, and maximum scenarios.

Value Added Estimate	Puget Sound Study Area	San Juan County Study Area
Low	$17 million	$3.96 million
High	$57.9 million	$13.1 million
Maximum	$248 million	$64.7 million

It is important to note several limitations of the IMPLAN model. As noted in the previous section, this model relies on data from 2009 to 2014. It therefore does not reflect any changes that have occurred since that time, and these estimates have significant uncertainty because of the lack of primary data. Because the annual number of participants was estimated using previous reports and the expenditures of those participants is averaged over a wide range of trip-related goods and services, the range of the impact of the industry on the regional economy cannot be narrowed down further. This analysis also doesn't account for any adjustments that the market has made, such as the re-employment of displaced personnel by any changes in expenditures that may have arisen.

A second IMPLAN analysis prepared for the PWWA in 2015 resulted in similar findings (Beyers 2015). This study also extrapolated participant expenditures in linked industries using a variety of sources and assumptions. Unlike the IEc analysis, however, this study incorporated Canadian whale watch tours in addition to U.S.-based tours. Beyers (2015) found that the industry generated an overall revenue in 2014 of $25 million and employed over 400 people. About half of that revenue was generated by Washington-based tour companies. Using an economic impact study from ArtsFund, they also estimated that participants spent roughly $35.5 million on goods and services in linked industries. Altogether, this means that the whale watching industry contributes roughly $60 million to the region annually through consumer expenditures (Beyers 2015). One other study in 2009 found similar results, estimating total expenditures at roughly $61 million (O'Connor et al. 2009). PWWA has cautioned that Beyers (2015) may not fully characterize all expenditures, such as purchase costs of new vessels, estimated by PWWA to be $15 million in 2016, as well as other services they support including welders, electricians, sign makers, and real estate. Although the expenditures in linked industries were not determined for Canadian-based and U.S.-based tours individually, it is apparent that the U.S.-based contributions estimated in this study fall within the range estimated by IEc (2015).

Assessing the Economic Impact of the 2011 Regulations on the Industry

Although IEc (2015) provides information on the value of the whale watching industry and its importance to the local economy, their results represent a single point in time and are not indicative of greater temporal trends. In 2016, IEc prepared an analysis specifically aimed at understanding the effects of the 2011 regulations on the whale watch industry as well as on tourism in San Juan Island and Washington as a whole. This retrospective analysis used several indicators for the whale watch and tourism industries and compared trends before and after 2011, as well as compared trends with other comparable industries. They found that the whale watch industry and the tourism industry in San Juan Island grew, both in comparison to trends within those industries before 2011 and as compared to other wildlife viewing industries (IEc 2016).

1. Whale Watch Industry Indicators

Several metrics serve as indicators of the health of the whale watch industry. These include the number of companies active in the industry, the number and capacity of all of their vessels, ticket prices, the number of kayak tours, and taxable retail sales in the broader economic sector. Since 2011, the industry has experienced growth in the number of active companies, the total number of vessels in the fleet, and average ticket prices. The number of companies and ticket prices have increased at roughly the same rate as in the years leading up to the implementation of the regulations; however, the number of vessels in the fleet has increased at a markedly higher rate (Figure 6.2 and Figure 6.3). Although this does not allow for conclusions to be drawn about the occupancy of each tour, it does indicate that the industry was profitable enough for companies to increase the size of their fleet. Participation in kayak tours has also experienced significant growth since 2011; however, data from before the regulations were in place is unavailable so this growth cannot be compared to the rate experienced in the years prior. The only metric in the entire study that exhibited a negative growth rate was the taxable sales in the broader economic sector. However, despite the reduced growth in this sector after 2011, this metric is not necessarily a consequence of the regulations. The breadth of the sector encompasses more than just the whale watch industry, and so the downward trend could be indicative of outside influences. Overall, IEc (2016) concludes that the regulations have not had any negative economic impacts on the whale watch industry.

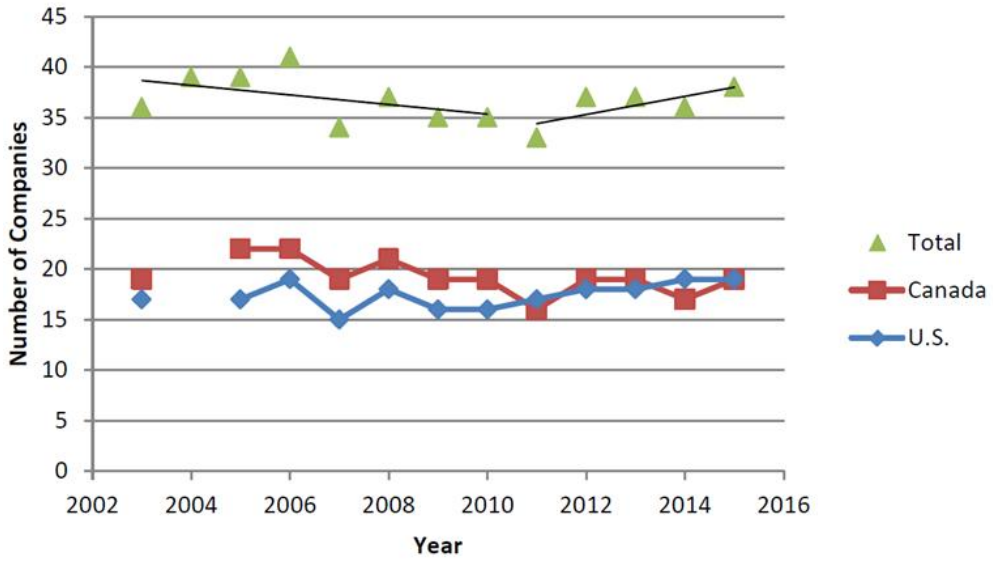

Figure 6.2. The total number of whale watch companies in operation from 2003 to 2015 Figure from IEc (2016).

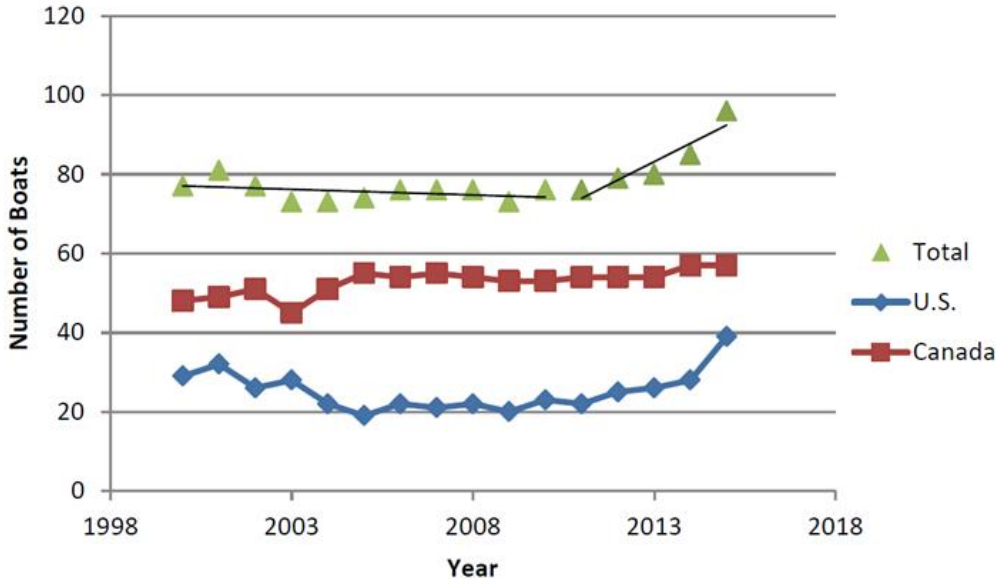

Figure 6.3. The total number of whale watching boats in the fleet from 2003 to 2015. Figure from IEc (2016).

2. San Juan County Tourism Indicators

The impact of the regulations on the San Juan County tourism industry was measured using three metrics: the number of ferry trips to the islands, lodging tax income, and tourism-related economic sectors. All three of these metrics experienced significant growth after 2011, even as compared to the rate of growth in these sectors before 2011 (IEc 2016). Data from the Washington State Ferry indicates that ridership to the San Juan Islands has increased at a rate greater than that experienced between 2006 and 2011, and that ridership to San Juan Island in particular has outpaced visitation to other islands in San Juan County (IEc 2016) (Figure 6.4). Annual revenues from lodging tax income have also increased by 40% on the island since 2011, as opposed to the 10% decline experienced between 2007 and 2010 (Figure 6.5). Finally, all of the indicators from tourism-related sectors have exhibited growth since 2011, and this growth in San Juan County specifically has outpaced that experienced statewide (IEc 2016).

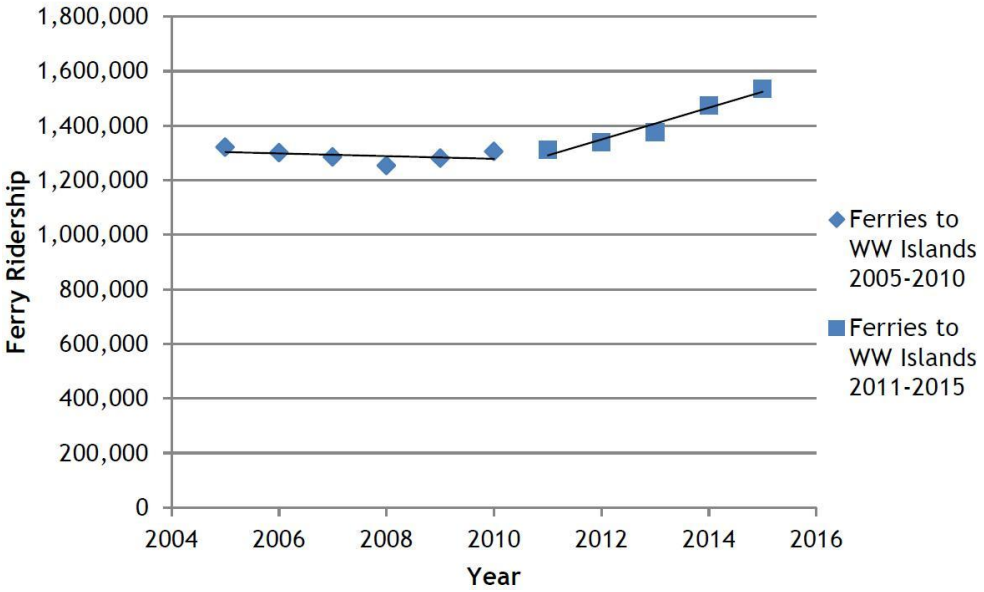

Figure 6.4. Ferry ridership to whale watch (WW) islands in San Juan County from 2004 to 2016. Figure from IEc (2016).

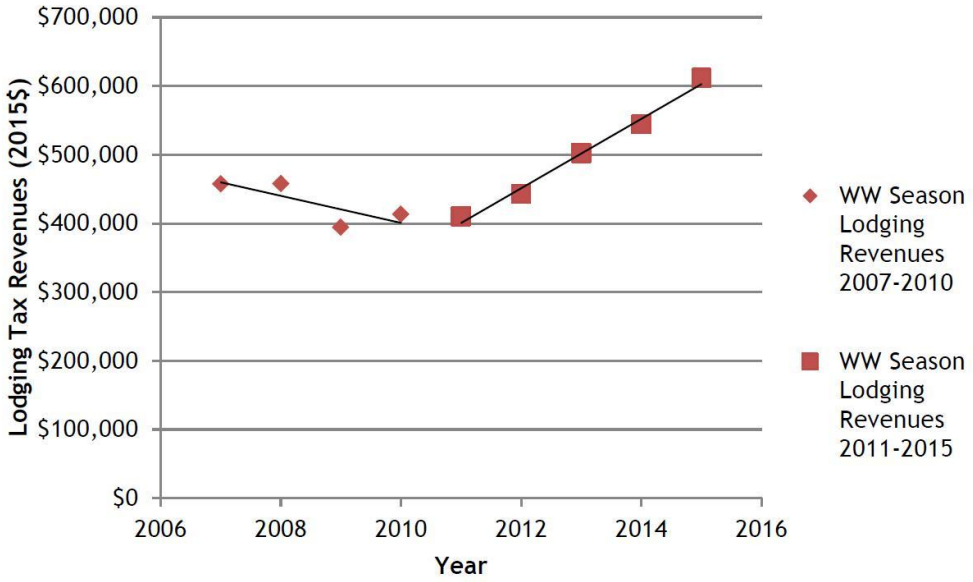

Figure 6.5. Lodging tax revenues during the whale watching season from 2006 to 2016. Figure from IEc (2016).

3. Comparison with Comparable Recreational Activities

IEc (2016) analyzed trends in recreational charter boat-based fishing, Olympic National Park visitation, and Lime Kiln Point State Park visitation to compare growth in the whale watch industry to other similar recreational activities. This comparison allows us to determine whether the whale watch and San Juan tourism industries were able to grow to their full potential under the pressures of the new regulations, or if the

growth they experienced was lessened by them. The charter boat-based fishing industry has seen a 20% growth in the total number of trips taken since 2011, as compared to the overall decrease between 2005 and 2010 (Figure 6.6). However, the total number of licenses to operate charter boats has decreased, potentially because of the recession or the increased cost of a license (Figure 6.7). Overall, the charter boat industry has experienced a different trend from the whale watch industry since 2011, and potentially a more negative one. Visitation to Olympic National Park, although fluctuating from year-to-year, seems to be growing in a similar fashion to the whale watch industry (Figure 6.8). Lime Kiln Point State Park, on the other hand, has experienced a significant growth in visitation, potentially as a result of the increase in tourism discussed above (Figure 6.9). Overall, comparing trends from the whale watch industry to those from other recreational activity sectors does not indicate a loss of growth as a result of the implementation of the regulations (IEc 2016).

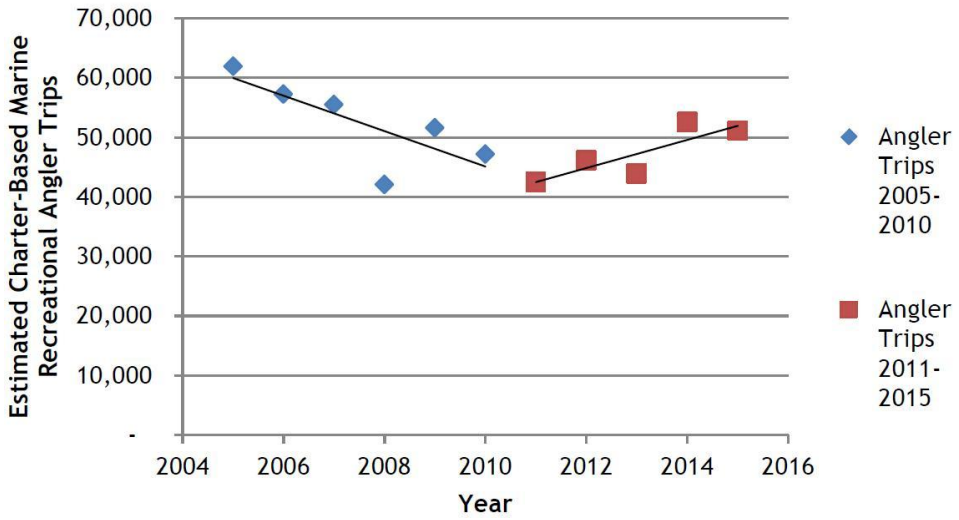

Figure 6.6. Trends in charter boat-based fishing trips from 2004 to 2016. Figure from (IEc 2016).

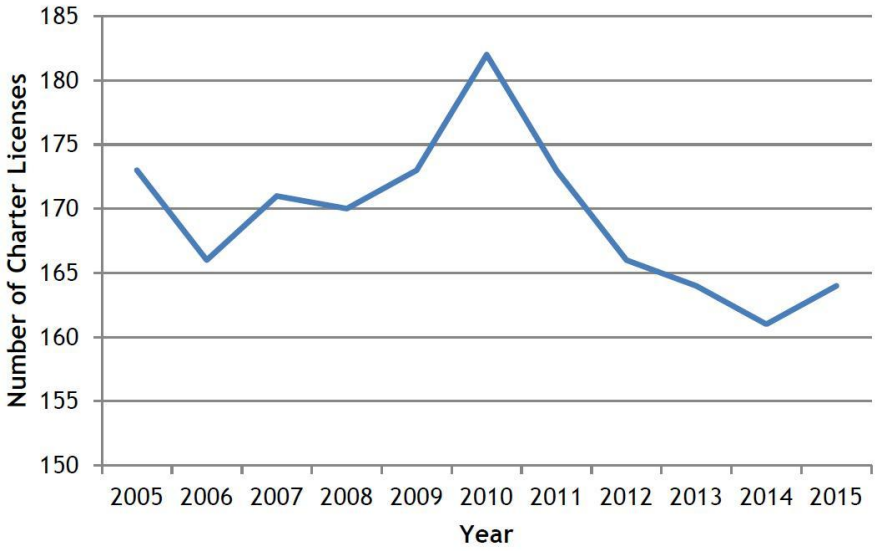

Figure 6.7. The total annual number of charter boat licenses from 2005 to 2015 (Figure from IEc 2016).

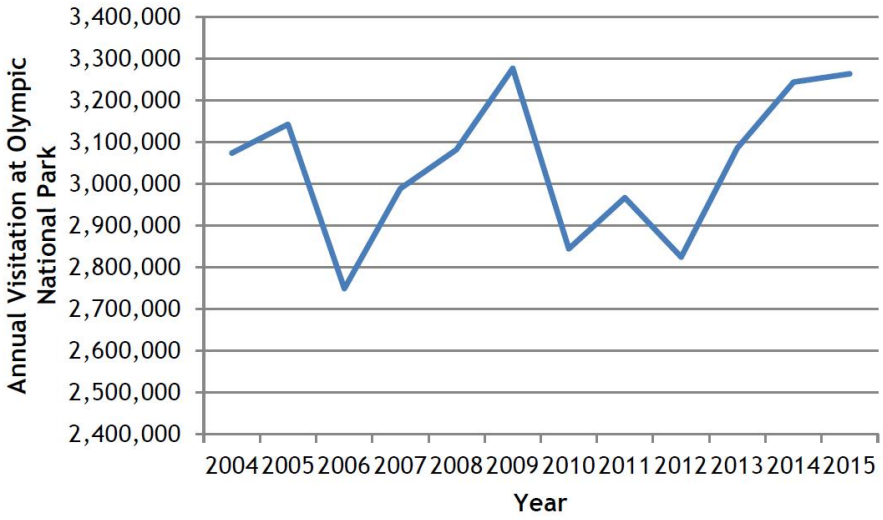

Figure 6.8. Annual visitation to Olympic National Park from 2004 to 2015. Figure from IEc (2016).

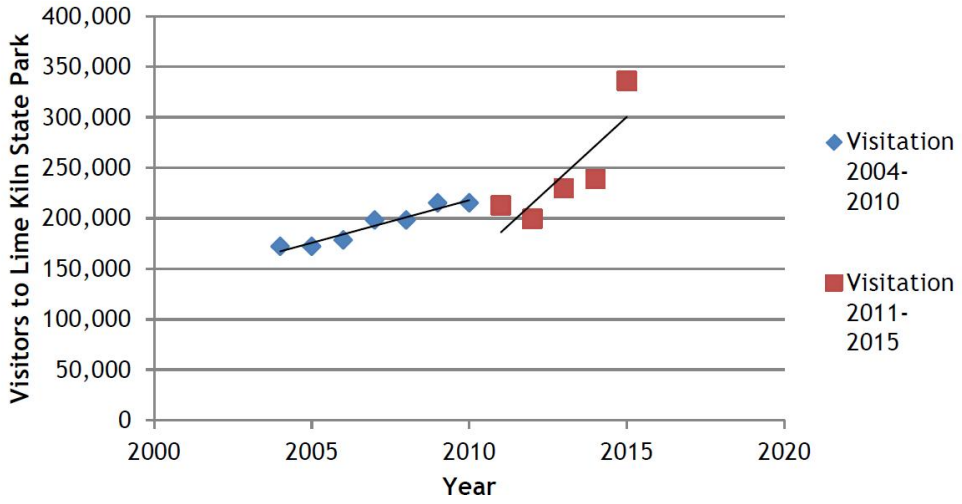

Figure 6.9. Annual visitation to Lime Kiln Point State Park from 2004 to 2015. Figure from IEc (2016).

The results of this analysis suggest that the 2011 regulations have not had a negative effect on the whale watch industry or the San Juan County tourism industry. On the contrary, both have experienced significant growth since 2011. This, however, is not an indication of a positive effect of the regulations on whale watching and tourism, but rather a lack of hindrance by them. It is worth noting that more time may be needed to discern any negative effects of the regulations on these industries, and more analysis may be needed in the coming years to continue to monitor the situation.

Willingness-to-Pay Studies

Commercial whale watch companies have identified the potential benefits of whale watching as a form of ecotourism that results in firsthand encounters with killer whales in their natural habitat. Their mission is to educate and inspire passengers by enhancing awareness about the species, the threats impeding recovery, and the actions being taken to address these threats. To achieve these goals, many whale watch companies have naturalists on board to educate passengers and answer questions. This adds to the quality of the whale watching experience for participants. When the regulations were proposed, commercial operators expressed the concern that the decreased proximity to the whales would hinder these educational opportunities and the experience of participants, and therefore result in decreased participation altogether. Several willingness-to-pay studies have explored this theory.

Some studies have focused on killer whales in the Pacific Northwest and have assessed the value that the public places on recovering endangered species. In many cases, the public is willing to pay more for the recovery of at-risk species, either in the form of increased taxes or higher prices on goods and services impacted by recovery (Anderson and Lee 2013; Wallmo and Lew 2015). Stated preference choice experiment surveys indicate that the public puts a value of approximately $86 on recovering Southern Residents, both regionally on the West Coast and across the country (Wallmo and Lew 2015, 2016). Some studies have even focused specifically on the value that whale watching participants have for wildlife viewing. They also provide data

on the factors that lead to an enjoyable or memorable whale watching trip, and how satisfied participants are with various aspects of their trip (Duffus and Deardon 1993; Andersen 2004; Malcolm 2004; Andersen and Miller 2006). Survey results of whale watch participants indicate that proximity to the whales is not the most important part of the whale watchers' experience and that seeing whales and whale behavior at all was much more important (Andersen 2004; Malcolm 2004). In addition, Malcolm (2004) found participants were most satisfied with the respect their vessels gave the whales. The number of whales, whale behavior, and learning opportunities also received higher satisfaction than the distance from which whales were observed. The participants also strongly agreed with statements related to protection of the whales.

Additional studies have been conducted on whale watching participants viewing other species (humpback whales, dolphins, seals, and sea birds) in other locations (e.g., Hawaii, Wales, Australia) (Orams 2000; Shapiro 2006; Airey 2007; Stamation 2009; Avila-Foucat et al. 2013; Kessler et al. 2014). Seeing whales up close and being close to wildlife were in the top five features important for satisfaction in some studies (Airey 2007; Stamation 2009); however, the "educational information provided" and "responsible boater behavior to not disturb the wildlife" were also important factors affecting trip satisfaction. Participants also reported that crowding of boats around the whales was likely to decrease the probability that they would participate in a trip again, and that they preferred to observe whales in such a way as to reduce their impacts on them (Avila-Foucat et al. 2013; Kessler et al. 2014).

Conclusions

The whale watch industry has been recognized as an important partner in educating the public about Southern Residents and the challenges that face their recovery. The IEc and University of Washington's IMPLAN analyses have confirmed that this industry is also important economically, not only to San Juan County but also to the greater Salish Sea region. As such, it is important to consider and evaluate any effects of regulation on the industry to determine if it has been hindered financially by that regulation. Based on studies and surveys cited above, willingness to pay for whale watching has not decreased as a result of the 2011 regulations. Furthermore, IEc (2016) has shown that the whale watch and San Juan Island tourism industries have experienced significant growth since the regulations were codified, despite the fears of many who are reliant on those industries for income. Although it may still be too early for the regulations to have had an effect on participation in those industries, it is apparent that they have not hindered the growth of whale watching and San Juan tourism since they were put in place.

7. CONCLUSIONS AND RECOMMENDATIONS

The conclusions of the different chapters in this review provide insight into the effectiveness of the regulations, and if the regulations are achieving the goal of reducing vessel impacts on the whales. While there are indicators suggesting the regulations have improved conditions for the whales, others indicate that vessel impacts continue and that some risks may have increased. Based on the above analyses, we believe that there is enough evidence to show value to the whales of the vessel regulations and we support the continued implementation of the regulations, as well as the future consideration of additional measures to protect Southern Residents from

harmful vessel effects. Below are summaries of the conclusions from each section of this report along with detailed recommendations for NMFS and its partners to pursue carrying on implementation and evaluation of the regulations in support of recovery of the Southern Resident killer whales.

Education

Boaters need to know what the rules and guidelines are for responsible boating around whales so that they can view the whales without impacting them. Working with partners and through a variety of media, NMFS has reached large numbers of boaters to make sure they are aware of the federal and state vessel regulations and BWW guidelines. Through on-water contacts with boaters, Soundwatch and enforcement patrols play a key role in educating boaters who are in the vicinity of whales. NMFS has worked closely with the commercial whale watch industry to ensure that drivers and naturalists have accurate information on regulations and guidelines. Responsible commercial whale watch operators following the regulations, BWW, and industry guidelines set a positive example for less-informed boaters. While partnerships and outreach to a variety of audiences has been successful, there are always additional approaches to expand the reach of education programs. Looking into the future, NMFS plans to continue current education and outreach efforts, and explore opportunities for expanding these efforts to reach more recreational boaters. Some of these opportunities include increasing advertising of the regulations and incorporating knowledge of the regulations into Washington's boater registration and licensing process. Boating safety courses such as the U.S. Coast Guard Auxiliary's Boating Safety Education programs may also provide a platform for reaching a wider audience. One way to reach recreational boaters that are new to the region or may be visiting and unaware of the regulations would be to target boat charter and rental companies.

Recommendations for expanding the reach of education and outreach programs include:

- Target audiences that may not be aware of the regulations and guidelines, including charter boats and rentals, visitors, float planes, and the fishing community
- Include information regarding whale behavior and travel patterns in educational materials to assist recreational boaters in predicting whale movements
- Develop materials for new boaters, pilots, etc.
- Include information on regulations and guidelines with boater registration documents and incorporate responsible viewing messages into boater safety training
- Consider expansion of Soundwatch efforts into South Sound during times of peak whale and vessel activities
- Include a question regarding how recreational boaters became aware of the regulations in the regulation awareness survey to understand how to better target that audience
- Support additional advertising

Enforcement

It is clear that enforcement presence on the water is important to achieve compliance with vessel regulations and guidelines. WDFW and NOAA enforcement officers play an important role to support education and outreach and also serve as a strong incentive for compliance through issuing warnings and citations. Enforcement officers on the water have contacted a large number

of boaters and have also issued a small number of warnings and citations each year to both commercial whale watch operators and recreational boaters. The officers on the water have communicated with the whale watch industry members about the challenges of enforcing the regulations and acknowledge that the whales can be unpredictable. Therefore, officers use discretion in issuing citations or pursuing investigations. Citations have been issued to different vessel types, including motorized boats of different sizes, kayaks, and also to drone operators (under the Washington State regulation). The Soundwatch data indicate that the enforcement program is effective and that compliance improves when enforcement agencies are on the water.

Recommendations for maintaining and improving the role of enforcement in reducing impacts to whales include:

- Continued and expanded enforcement presence on the water supported through NOAA OLE patrols
- Continued and expanded enforcement presence on the water supported through WDFW patrols funded through ESA section 6 grants and Joint Enforcement Agreements
- Continued cooperation between enforcement patrols and the whale watch fleet to share whale sightings information
- Improved coordination and communication between WDFW and NOAA enforcement and DFO
- A vessel monitoring program utilizing AIS or VMS would allow efficient use of enforcement resources through better planning and deployment of assets
- Technology improvements to document violations (e.g., radar, range finders, etc.)

Vessel Compliance

Although the available data presents several challenges in monitoring compliance trends over time, there are multiple indicators that show compliance with regulations and guidelines has improved since implementation of the regulations in 2011. The number of incident categories recorded by Soundwatch has increased with the addition of incidents related to the 200-yard (182.9-m) approach rule, and this may be the driver for increases in overall numbers of incidents recorded in recent years. New incident categories also affect the rate of incidents. Rates of incidents have increased following the regulations in 2011, but there is a decreasing trend from 2011 to 2015 for total incidents of vessels not following all regulations and guidelines. There are also decreases in the incidents of boaters not complying with regulations. Soundwatch data indicates that recreational boaters are committing more incidents than commercial operators. While there are some positive indicators of improving compliance, there are still vessels approaching the whales too closely. In addition, vessel operators also continue to engage in risky approaches that likely increase the chance of vessel strikes.

While the recommendations for education and outreach and enforcement above may help improve compliance, additional recommendations to continue monitoring and address compliance include:

- Encourage and support establishing equitable vessel regulations in Canada, which could improve education and outreach, enforcement, and compliance
- Additional years of data collection to monitor compliance trends

- Continued support for Soundwatch monitoring, and consider adjustments to data collection
- Conduct follow-up monitoring of kayak compliance
- Work to bring Soundwatch and Straitwatch data sets together and conduct additional analyses to evaluate compliance
- Use Soundwatch data and other available data to inform consideration of updates to guidelines and regulations

Biological Impact

Since the vessel regulations were implemented in 2011, additional research results have been published that provide new details on how vessels impact marine mammals worldwide and specifically Southern Resident killer whales in the Pacific Northwest. Based on the available research on different effects from vessels, the acoustic and behavioral impacts that reduce or limit foraging may be the most significant in affecting health, reproduction, and population growth. The vessel regulations were designed to reduce behavioral impacts, masking, and risk of vessel strike and this review provides mixed results about benefits to the whales following implementation of the regulations. There is some evidence that compliance with guidelines and regulations as well as average viewing distance have increased, which could result in reduced behavioral changes and reduce sound exposure. Sound levels, however, are highly variable and have not shown a consistent decline following implementation of the regulations based on the available data. Also, some of the riskiest vessel behaviors that could increase risk of strike continue or have increased. Although the overall numbers and rates of some of the riskiest boat behaviors (e.g., chasing whales, parking in the path, and head-on approaches) are relatively small in number, new reports of vessel strikes from marine mammal stranding investigations heighten concerns for these risky vessel activities. Overall, while the vessel regulations seem to have provided some benefits for the whales, additional time may be needed to ensure them sufficient protection. Improved compliance with existing regulations and guidelines and further consideration of additional protections could provide additional protection. In addition, more information on how vessels affect foraging of the whales would help inform any future adjustments or additional protections.

Several research projects are ongoing to better understand the biological impacts of vessels and sound on the Southern Residents and recommendations for continuing these efforts include:

- Continue research regarding vessel impacts on marine mammals
- Analyze baseline sound levels in Southern Resident critical habitat to better understand the current soundscape, the potential effects of increased vessel traffic, and the effectiveness of measures to reduce vessel noise
- Continue to analyze DTAG data to understand how vessel proximity, sound, and speed influences whale behavior, particularly foraging, and coordinate with Fisheries and Oceans Canada to compare differences in these factors and foraging behavior between Northern and Southern residents
- Analyze DTAG data to compare the behavioral and acoustic effects of different boat activity patterns to determine the vessel behaviors with the highest impact (paralleling at slow speed vs traveling at high speed and parking in the path)

- Coordinate with DFO and Transport Canada to implement goals for reducing vessel disturbance listed in the OPP and monitor noise from shipping
- Improve estimates of the energetic cost of reduced foraging opportunities resulting from vessel interactions
- Continue thorough necropsies of stranded whales to evaluate the risk of vessel strikes
- Continue monitoring stress hormone levels in relation to vessel activities

Economic Impact

When analyzing the economic effects of the proposed vessel regulations on different stakeholder groups, we concluded that the vessel regulations would not have a significant negative impact on the whale watching industry. Specific economic data for the industry before and after implementation of the regulations is not available to evaluate potential direct effects. Therefore, we worked with Industrial Economics, Inc. to evaluate several measures of local tourism to determine if our original conclusions were correct. All indicators, with the exception of one broad measure of taxable sales, indicate that there has been no negative impacts to local tourism following implementation of the vessel regulations. In addition, we updated our estimate of the value of the whale watching industry to the local community. Since detailed data on industry operations were not available, IEc used updated modeling and a range of inputs for variables, including ridership and expenditures, to update an estimate of the economic contribution of whale watching of up to $58 million annually. In addition, the PWWA worked with the University of Washington to collect new information to estimate the economic value of the industry, although only in years following the regulations. The University of Washington estimate is within the range of the updated IEc values. The PWWA has also noted that there may be additional contributions to the economy that have not been captured in these estimates. Overall, it is clear that the whale watching industry is a significant contributor to the local economy through jobs and expenditures in the community. Current indicators show that local tourism has not declined with the implementation of protective vessel regulations for the whales.

Additional recommendations to evaluate economic impacts include:

- Identify and evaluate additional indicators of economic impacts, including specific measures within the whale watching industry
- Refine estimates of the economic value of the industry as new information becomes available

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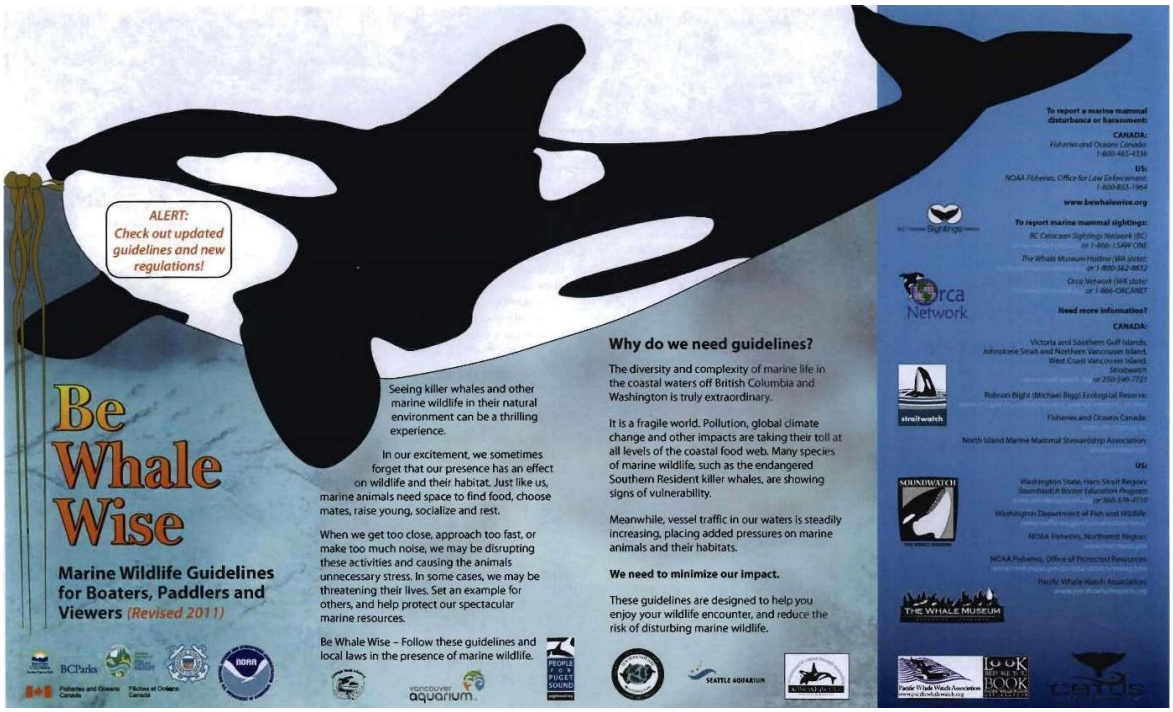
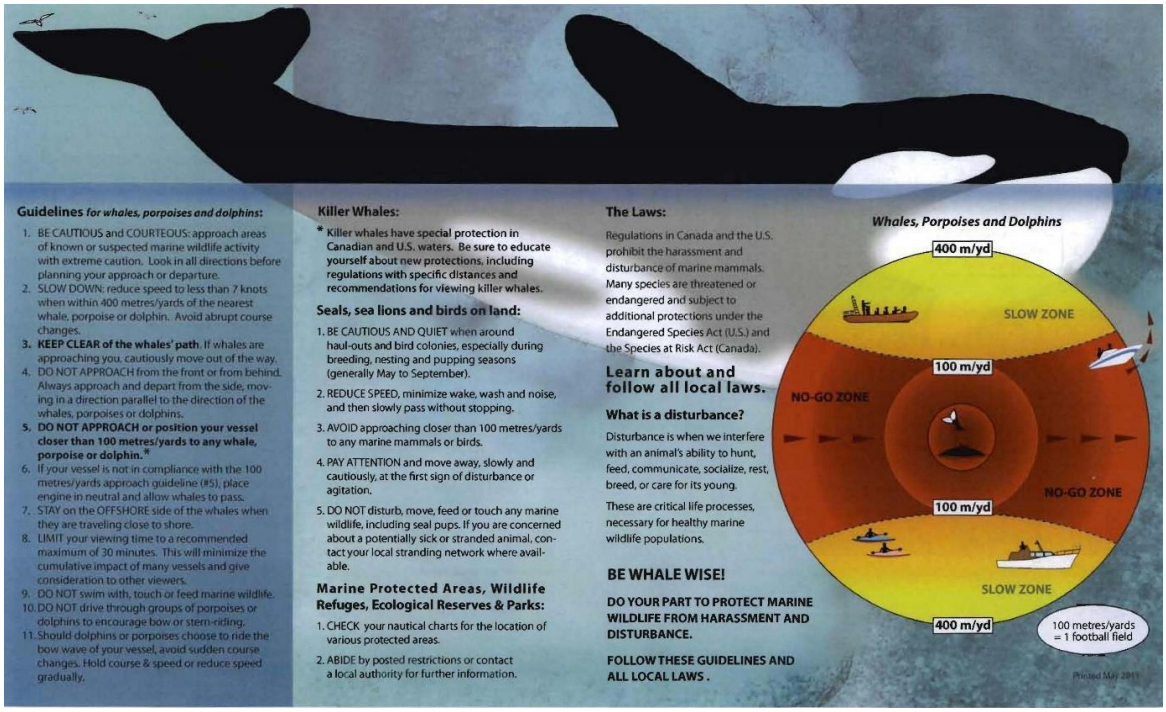
9. APPENDICES

Appendix A. 2011 Be Whale Wise Brochure



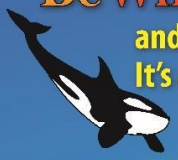


Appendix B. Rack Cards

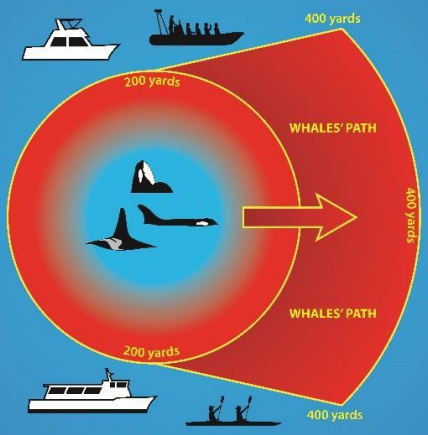
Be Whale Wise

and Follow the Law

It's as easy as 1, 2, 3...



1. The **ONE** place not to be is in the path of whales. Don't position your vessel in the path of oncoming whales within 400 yards of a whale.
2. Stay at least **TWO** hundred yards away from any killer whale (200 yards = the distance of two football fields or about 200 meters).
3. Remember these **THREE** ways to Be Whale Wise: follow the guidelines for viewing all wildlife, check for local protected areas and restrictions, and always be safe.



Visit **www.bewhalewise.org** to learn more, download the laws, regulations, and guidelines, and to report violations.

Report Violations:
NOAA Office for Law Enforcement
1-800-853-1964
or online at
www.bewhalewise.org

In 2011, NOAA Fisheries Service adopted new regulations under the Marine Mammal Protection Act and Endangered Species Act to protect **all killer whales**.

WHO do the new rules apply to? All motorized and non-motorized vessels (including kayaks), with exceptions to maintain safe navigation and for certain types of vessels- government vessels in the course of official duties, ships in the shipping lanes, research vessels under permit, and vessels lawfully engaged in commercial or treaty Indian fishing that are actively setting, retrieving, or closely tending fishing gear.

WHAT do the new rules say? Except for specific exemptions, it is unlawful for any person subject to the jurisdiction of the United States to:

I. Cause a vessel to approach, in any manner, within 200 yards (182.9 m) of any killer whale.

II. Position a vessel to be in the path of any killer whale at any point located within 400 yards (365.8 m) of the whale.

WHEN do the new rules go into effect? May 16, 2011

WHERE do the new rules apply? In inland waters of Washington State- east of the entrance to the Strait of Juan de Fuca and south of the U.S./Canada international boundary.

WHY did NOAA adopt new regulations? Southern Resident killer whales were listed as endangered in 2005. Vessel impacts were identified as one of the threats. These new regulations implement an action in the recovery plan and are designed to protect all killer whales by reducing impacts from vessels. Additional background information on the rationale and analyses to support the regulations is available at **www.nwr.noaa.gov.**

Appendix C. KELP Brochure

The Whale Museum's Soundwatch Boater Education Program promotes responsible boater behavior around marine wildlife. the **Kayak Education & Leadership Program, K.E.L.P.,** is a Soundwatch program that targets recreational and commercial kayakers on issues specific to paddlers.

K.E.L.P. informs kayakers on marine wildlife regulations and guidelines with the aim of reducing human-powered vessel disturbance. Paddlers are instructed on correct behaviors around whales, seal/sea lion haul outs and seabird rookeries, including Marine Protected Areas within the **San Juan County Marine Stewardship Area** and the National Wildlife Refuge system. Special focus is given to behaviors around endangered Southern Resident Killer Whales.

Need more information?

The Whale Museum's Soundwatch Program
www.whalemuseum.org
NOAA Fisheries, Northwest Region
www.nwr.noaa.gov
Washington Department of fish & Wildlife
www.wdfw.wa.gov/conservation/orca/

To report marine mammal strandings/sightings:
1-800-562-8832 or hotline@whalemuseum.org

To report a marine mammal disturbance or harassment:
U.S. NOAA Fisheries, Office for Law Enforcement
1-800-853-1964 or www.bewhalewise.org
Washington Dept. of Fish and Wildlife Enforcement
1-360-902-2936

Kayaker Code of Conduct Additional Guidelines crafted collaboratively by The Whale Museum's K.E.L.P. Program and the San Juan Island Kayak Association with approval from NOAA Fisheries and the Washington Department of Fish & Wildlife.

KAYAKER CODE OF CONDUCT

Paddling is a quiet and low-impact way to explore the Salish Sea. Even so, kayakers and operators of other human-powered vessels still have the potential to disturb marine wildlife. Unique challenges of limited maneuverability, limited sight distance, and a variety of safety concerns all require special consideration to remain in compliance with laws and to reduce the overall risks of disturbing marine wildlife.

The Kayakers' Code of Conduct is a set of San Juan Island, killer whale specific guidelines meant to be used along with regional Be Whale Wise Marine Wildlife guidelines and current Federal Vessel Laws for Killer Whales to assist kayakers in being lawful.

All marine mammals are protected from *harassment or disturbance* under the U.S. Marine Mammal Protection Act and the Canadian Fisheries Act. In addition, Southern Resident Killer Whales are listed as an Endangered Species under the U.S. Endangered Species Act and as a Species at Risk under the Canadian Species at Risk Act. In Washington State waters, all killer whales are listed as endangered.

Responsible Paddlers:
- Are aware of and strive to follow all local, state, and federal laws and the *Be Whale Wise* guidelines governing behavior around killer whales and other marine wildlife, as well as special Marine Protection Areas.
- Have a trip plan before leaving the shore. This includes knowing the area boating laws, accessible public landing areas, safety issues and environmental conditions.

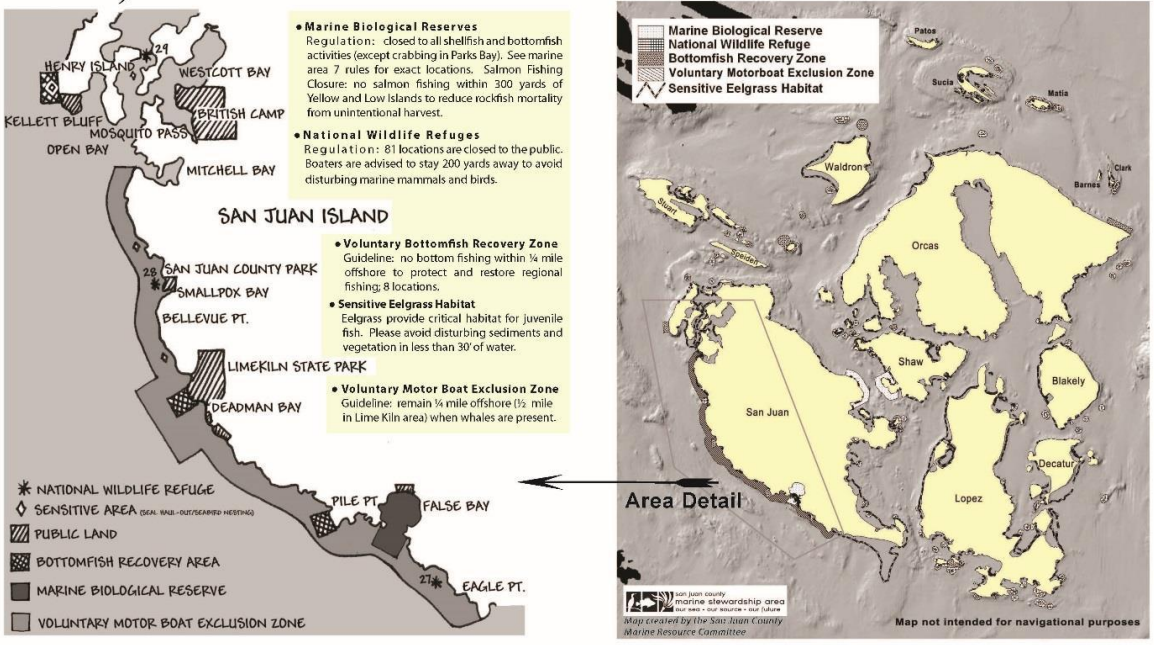
SJIKA
San Juan Island Kayak Association

NEW 2011 FEDERAL VESSEL REGULATIONS:
IN THE INLAND WATERS OF WASHINGTON STATE, IT IS UNLAWFUL* TO:
**Some exemptions (including safety, vessels actively fishing commercially, cargo vessels travelling in established shipping lanes, and government and permitted research vessels) apply.*
- Cause a vessel to approach, in any manner, any killer whale within 200 yards.
- Position a vessel to be in the path of any killer whale at any point located within 400 yards.

The new rules go into effect May 16, 2011 and apply to all types of boats, including motor boats, sail boats and kayaks.

KAYAKERS' CODE TO ASSIST IN ADHERING TO THE LAWS:
1. If whales are present when launching from shore or another vessel, kayakers will assess their position relative to the whales to determine their course of action. Kayakers can safely launch as long as they can maintain at least a 200 yard distance and avoid the 400 yard corridor in front of on-coming whales considered to be the whales' path. Preferably, kayakers should view the whales from shore and/or launch after the whales have passed.
2. When whales are approaching an area, kayakers will assess their position relative to the whales and the nearest shoreline to determine their course of action. Preferably kayakers will choose to paddle on the inshore side of whales. If paddling in a group, kayakers should stay close together.
3. To avoid being in the path of whales, kayakers will need to start moving out of the path of on-coming whales well before the whales are within 400 yards.
   - Kayakers will need to determine if by moving to shore they can maintain a 200 yard distance from whales and if it is possible to make their way to shore while avoiding the potential path of whales.
   - In some cases, kayakers may need to stay where they are, or move further offshore to avoid being within 200 yards of whales and to avoid being in the whales' path.
4. If kayakers decide to remain where they are, or to move inshore of whales, or offshore of whales, they can remain paddling, or choose to stop paddling and raft-up, as long as they can maintain at least a 200 yard distance and avoid the path of the whales. Kayakers may need to continuously alter their course and/or position to keep out of the whales' path.
5. If whales are approaching to within 200 yards of shore, inshore kayakers will move in as close to shore as possible (ideally in kelp beds), secure themselves, raft up and stop paddling until the whales have passed by. Kayakers will avoid headlands when deciding where to stop in order to avoid being in the potential path of whales.
6. **If kayakers have taken all measures to maintain a 200 yard distance and stay out of the path from whales and still unexpectedly find themselves out of compliance with the laws they shall:**
   - **Paddle out of the on-coming path of whales 400-200 yards from whales;**
   - **Immediately stop paddling within 200 yards until the whales have passed.**
7. Kayakers shall avoid disturbing haul out areas for seals/sea lions and/or sea bird nesting sites by paddling in at least a 100-yard arc, whenever possible. May through October is the most sensitive time of the year for birthing and breeding seals, sea lions and nesting sea birds. During these times, kayakers will use extra caution: avoiding noise, direct eye contact, and sporadic movements.
8. Kayakers will avoid approaching within 200 yards of a National Wildlife Refuge to avoid disturbing haul out areas for seals/sea lions and/or sea bird nesting sites whenever possible. No landings are permitted except at designated areas.
9. Do not disturb, move, feed, or touch any marine wildlife, including seal pups. If you are concerned about a potentially sick or stranded animal, contact the local stranding network hot-line number on this brochure.

SAN JUAN COUNTY MARINE STEWARDSHIP AREA



Appendix D. 2016 Be Whale Wise Brochure