FINAL PROGRAM REPORT: SRKW Sighting Compilation 14th Edition

Project Title: Southern Resident Killer Whale Sighting Compilation 1948-2017

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Abstract:

The primary goal of the Southern Resident Killer Whale (SRKW) Sighting Compilation 14th Edition is to update and re-integrate available sighting data from the inland marine waters of Washington State and Southern British Columbia on the Southern Resident population of killer whales from 1948 through 2017. This 14th edition includes the addition of 2,468 new sightings. Of these sightings, 2,113 are new entries from the 2017 calendar year. An additional 355 SRKW sightings from the B. C. Cetaceans Sightings Network (BCCSN) that occurred during 2016 but were not added to their database until the 2017 season. Information processed for this database comes from identified killer whale sighting sources that have been systematically evaluated for accuracy, entered and integrated into a single uniform dataset in MS Access with normalized spatial locations that have been translated into latitude and longitude, UTM coordinates, and WDFW/DFO Fisheries reporting areas. The six primary data sources for this database are: 1) The Whale Museum's sighting archives (which includes sightings from Museum affiliated researchers, naturalists, and whale watch companies; Orca Network sightings posted on the internet; and sightings via the Museum's Whale Hotline); 2) Commercial whale watch pager system reports; 3) Soundwatch Boater Education program data; 4) a longitudinal dataset from Lime Kiln Point State Park; 5) SPOT recorder data; and 6) BCCSN data. This database is updated on an annual basis by staff and affiliated researchers. Included with this report are compact discs (CDs) of the entire 105,344 records in the sightings database in both MS Access and MS Excel. This project was funded with resources from NOAA Contract #**RA133F-12-CQ-0057** and The Whale Museum.

Executive Summary:

The primary goal of the present report is to update the SRKW Sighting Compilations (Osborne *et al.*, 2004; 2006; 2007; Traxler *et al.*, 2008-2011; Charapata *et al.*, 2012; Olson *et al.*, 2014-2017) with the 14th edition covering sightings from 1948 through December 2017. The goal of this report is to provide a data update to the **RA133F-12-CQ-0057** contract report.

The primary data source in the SRKW Sighting Compilation is The Whale Museum's (TWM) sighting archives of year-round public sightings reported to the Whale Hotline or directly provided to Museum staff through several different channels (Balcomb *et al.*, 1980; Heimlich-Boran, 1988; Felleman *et al.*, 1991; Osborne, 1991; 1999; Olson, 1998; Osborne *et al.*, 2007). These channels include sighting compilations from affiliated naturalists, scientists, and commercial whale-watch vessels; reports from Orca Network e-mail postings (www.orcanetwork.org); hydrophone detections from listeners to the Salish Sea Hydrophone Network (http://seasound.org and http://www.orcasound.org; and reliable reports from independent investigators and whale watchers. Other more systematic data sources collected during the summer season include: Robert Otis' longitudinal dataset from Lime Kiln Point State Park (Osborne, 1999, Osborne *et al.*, 2004; 2006; 2007; Traxler *et al.*, 2008-2011; Charapata *et al.*, 2012; Olson *et al.*, 2014-2017); Soundwatch Boater Education and Monitoring Program's 30-minute samples during vessel patrols (Koski *et al.*, 2004; 2006-2011; Eisenhardt *et al.*, 2012-2013; Eisenhardt and Koski, 2014; Seely, 2015-2016; Seely *et al.* 2017); and information from SPOT (satellite personal tracker) systems used by various whale watch and research boats from 2008-2017. Through collaboration with the Coastal Ocean Research Institute, a final source includes SRKW sightings from the B.C. Cetaceans Sightings Network's (BCCSN) primarily opportunistic sightings database from 1975-2017.

The Whale Museum's sighting archive data was collected in a fashion that is not subject to a uniform test of reliability due to the large variety of sighting platforms, observers, and the variation in their qualifications (Heimlich-Boran, 1988; Osborne, 1991; 1999; Olson, 1998). However, the systematic summer datasets from Lime Kiln Point State Park, The Whale Museum's Soundwatch Program, and the commercial pager records are systematic enough to use as homogeneous samples on their own for some statistical considerations (Hauser, 2006; Hauser, *et al.*, 2006). Outside of the summer season there are extreme sampling biases in terms of 1) number of observers, 2) number of observers actively searching for whales, 3) period of daylight, and 4) visibility in terms of sea surface and atmospheric conditions. It is also important to note that TWM has increased its efforts to collect sightings data over the years by recruiting new sources, many of which overlap in coverage area. Though all the data has been given with a point source, killer whale movements cover large areas and the original location sources are often approximate. However the data can be considered to be accurate to +/- 1 kilometer when using them in a standard GIS application.

Included with this report is a compact disc (CD) of the entire Sighting Compilation database in MS Access (Appendix I) and MS Excel (Appendix II).

Project Goal and Objectives:

The primary goal of this contract report is to update the historical SRKW Sighting Compilation and spatial database for the inland marine waters of Washington State and Southern British Columbia

(Osborne *et al.*, 2004; 2006; 2007; Traxler *et al.*, 2008-2011; 2013; Charapata *et al.*, 2012; Olson *et al.*, 2014-2017) so that scientists and managers have a reliable, up-to-date spatial dataset on the movement patterns of SRKW that is uniform between studies. The specific objectives of this contract were to continue to compile SRKW sighting information through 2017, process it for accuracy and completeness, and integrate it with the existing dataset.

Changes to the 2017 Orca Master Dataset:

The following changes were made to the historical Orca Master dataset related to reports in Hood Canal:

A J pod sighting on 11/8/2007 from the BCCSN dataset was discovered to contain an error. The lat/long coordinates place them just north of the Hood Canal Bridge; however, the qualitative description indicated that the whales were near Point No Point on the Kitsap Peninsula. This was corrected in the Orca Master database by eliminating the Actlat and ActLong values and changing the quadrant to 397.

A sighting in Hood Canal on 4/16/2016 was also discovered to be an error. The initial report indicated that the whales were at the "mouth of Hood Canal" as they headed out Admiralty Inlet. Though this report was initially added to one of the Hood Canal default quadrants (i.e., 434), this sighting was corrected to quadrant 393.

On 7/4/2005, a sighting from BCCSN was listed as J pod; however, according to multiple other records in TWM's database, these whales were most likely transients. Thus, "Ts" was added to the likely pod column for this sighting.

For two 2006 sightings in quadrants 438 and 439, "Ts" was added to the likely pod column based on discussions with NOAA scientists.

Project Results:

Data Sources

The source information for each of the five datasets comprising the 14th edition of the Southern Resident Sighting Compilation are identified in Table 1 including a basic description of the dataset, periods of coverage, locations, and numbers of records. In Table 2, each field in the database is described and classified in terms of the data type, its format and its rules for entry.

The first data source is The Whale Museum's (TWM) sighting archives. The Whale Museum has long maintained an archive of marine mammal sightings (Boran, 1980; Osborne 1991; 1999). These sightings are reported to the Museum by several channels, including the Whale Hotline (a phone reporting system for public sightings), TWM's online reporting system (http://hotline.whalemuseum.org), e-mail through TWM's website (hotline@whalemuseum.org), datasheets provided to whale watch operators by TWM, Orca Network (a non-profit based on Whidbey Island that provides email sightings updates), eyewitness sighting compilations from affiliated

naturalists, scientists, and commercial whale-watch vessels; reports from Museum staff, interns and visitors; and hydrophone detections from listeners to the Salish Sea Hydrophone Network (http://seasound.org and http://www.orcasound.org). Sightings are recorded on a datasheet and then entered into a Microsoft Access database. Sighting Archive records are identified as from a **public** source if the observer is not known to Museum staff or as **reliable** if the observer is known to be experienced or professional. The marine mammal sightings archives provide the only year-round source for the Orca Master dataset and are primarily composed of opportunistic reports. All other dedicated sighting datasets which are incorporated in this master database are primarily focused on the six months of summer (April-September).

We again were generously provided with a variety of reports on the SRKWs by whale watch companies in 2017. These data were collected by boat captains and/or naturalists and provide reliable information on location, pod(s), and direction of travel. Although considered to be "reliable," the source code "TWM-SA-WW" was assigned to these records in order to better track the number of sightings received by this method. We had two Vancouver whale watch companies participate during the 2017 season, giving us several unique sighting reports from the northern part of the whales' range during the summer.

The second data source is the pager data previously operated by Sea Coast Expeditions and later acquired by Orca Spirit Adventures Group of Victoria, B.C. Observations of whale movements were systematically collected by members who were searching from both land and water for the whales; sometimes this also included a paid shore observer on Mt. Douglas on Vancouver Island. As the pages were sent out, information on whale locations and pod identity were recorded by Lime Kiln Lighthouse interns or TWM staff/volunteers in a notebook. In some years, Sea Coast Expeditions personnel kept records of the pages and sent copies of them to TWM at the end of the year, but this practice was discontinued in 2003. After 2003, The Whale Museum shifted to recording the pages separately in our own set of notebooks as sightings occurred throughout the summer. The notebooks and photocopies were then entered into an Excel spreadsheet. The pager data were available during the whale watch season, May through October. As noted, this data source was suspended after the 2007 season.

The third data source is provided by Soundwatch. The Whale Museum runs the Soundwatch Boater Education and Monitoring program to distribute educational literature to private whale watch boats and collect data on the vessel traffic around the whales (Koski, 2004; Koski and Osborne, 2005; Koski, 2006-2011; Eisenhardt, 2012-2013; Eisenhardt and Koski, 2014; Seely, 2015-2016; Seely *et al.* 2017). Every half hour Soundwatch personnel count boats around the SRKW noting the time, GPS location, pod and direction of the orcas. These data were collected on field data sheets or Android data loggers and were then entered into a Microsoft Access database. Soundwatch data are only available during the regular whale watch season (May-September). Any similar sighting information obtained from the Cetus Society's Straitwatch Boater Education program was also included with the Soundwatch data.

The fourth source of data is a longitudinal dataset collected by Dr. Robert Otis from Lime Kiln Point State Park. From 1990 to 2014, from late May until early August, Dr. Robert Otis has recorded data about the whales as they pass by the park in the hours between 9:00 a.m. and 5:00 p.m. This represents a very important summertime control dataset that establishes a uniform observer effort and helps identify detailed pod movements in a portion of Haro Strait (Osborne *et al.*, 2004; Koski and

Osborne, 2005).

A fifth data source was the Satellite Personal Tracker or SPOT recorders from May-October. The SPOT data recorders have been used for seven consecutive years. Two SPOT devices were utilized in the 2017 season: one by the Orca Behavior Institute (a non-profit research organization) and one by Ron Bates (Five Star Whale Watching Company in Victoria, Canada). The SPOT devices record a position every 10 minutes when the appropriate button is pushed. Location data were sent via satellite link to the SPOT website (http://www.findmespot.com/en/) from which it was downloaded. Boat logs from the reporting party were reviewed to ensure that any coordinates incorporated into the Orca Master dataset occurred when whales were present. The SPOT recorders generate accurate lat/long coordinates and have proven to be a useful source for tracking movement patterns of boats following the whales.

A sixth source of data comes from a continued collaboration with the B. C. Cetaceans Sightings Network. These data were acquired through collaboration with the Coastal Ocean Research Institute, and annual data exchanges are expected to continue. This report incorporates BCCSN's sighting records of SRKWs from the 2017 season. Because BCCSN frequently receives archival data, we have also included additional sightings from 2016 that were not submitted until the 2017 season. Because of this delay, it is also important to note that BCCSN records for 2017 are likely incomplete and will be expanded in future reports. Like much of The Whale Museum's sighting archives, data obtained from BCCSN were collected opportunistically with limited knowledge of the temporal or spatial distribution of observer effort. As a result, absence of any sightings at any location does not demonstrate absence of SRKWs.

Table 1: Description of data sources with number of existing records.

DATA Source	Years	Description	Location Record	Record Source Code	No. of Records
TWM Sighting Archive	1948-2017 Year-round	Sighting records reported by public and reliable observers to TWM	Locations given in descriptive terms and matched to TWM Quadrants.	TWM-SA-Pub TWM-SA-Rel TWM-SA-WW TWM-HYD-Pub TWM-HYD-Rel	16,372 18,858 9,708 1,279 3,274 49,491
Pager	1997-2007 Summers	Whale watch pager system	Pager coordinates matched to TWM Quadrants	TWM-Pager	18,893
Soundwatch	1998-2017 Summers	Sightings observed by Soundwatch personnel recorded	TWM Quadrant	TWM-SW	14,485

		every half-hour on the water.			
Lime Kiln Station	1991 1994-2017 Summers	Sightings by Dr. Robert Otis, Ripon College May-Aug every day from 9-5.	Lime Kiln study area is TWM Quadrant 181	TWM-Otis	2,018
SPOT data	2008-2017 Summers	Satellite GPS tracking units used by various researchers	Actual Lat/Long tracks of boats following whales	SPOT	8,876
BCCSN data	1975-2017	Sightings reported by public to BCCSN	Locations provided in descriptive terms and coordinates and matched to TWM Quadrants	BCCSN	11,581

Field Descriptions

Table 2 provides an outlined description of the fields included in the Orca Master dataset. The following is a detailed description of each field.

Date information is included in a short date field and split out to month/day/year for ease of sorting the data.

Time is included both as a short time field and as an integer to accommodate different types of software that might be used in the analysis of this data.

Pod identity is included where known. When pod identity was not known "Orcas" is listed as the pod. Unknown or questionable pods may not be Southern Residents, but known sightings of transients, offshores, and northern resident orcas have not been included in this dataset. In spite of this effort to exclude other ecotypes, there are likely some records in the dataset that are not Southern Residents.

LikelyPod is a field that was added in 2009 in an effort to more accurately designate ecotypes in this dataset. It has always been customary to report sightings "as is" when they come in. However, many times TWM staff member recording the data is aware of what pod(s) is (are) in the area at that time (or has some other access to this information). This column allows this information to be added, thereby making the final dataset more accurate without altering the original data.

Direction is the heading of the whales at the time of observation and is indicated as a text field

with N for north, E for east, etc. Whale turnarounds are indicated by the word "then" as in "N then S". Non-directional behavior is listed as "mill". Whale groups that have split and are going in different directions are listed as "N and S" or other appropriate directions.

Location is described in 4 distinct ways: TWM Quadrants, WDFW/DFO Fishery Areas, UTM coordinates, and latitude/longitude. All of the location data from each of the data sources was matched from their original description to the Museum's quadrant system (Figure 1: Heimlich-Boran 1988, Olson 1998; Osborne, 1999). It is important to note that the quadrants only extend about 2/3 of the way out the Strait of Juan de Fuca and as far north as Burrard Inlet so the whale sightings outside of these areas will have a fish area but not a quadrant assigned to them. As the UTM coordinates and lats/longs are derived from the quadrant system (they are the centroid for those quadrants), those sightings without a quadrant will also not have UTM coordinates and lats/longs. As the spatial aspects of our data sources have started to improve we felt it important to include any GPS lats/longs that were reported to us. These are included in the "ActLat" and "ActLong" columns.

The location data for the Sighting Archive data originally consisted of descriptions of the area where the animals were seen, usually referring to a point on land. Locations from the Pager data were reported on a grid system used by the whale watch operators. All anecdotal location data were matched from the original description, often referring to a point on land, to the TWM quadrant that was adjacent to the land-based sighting. Hydrophone detections were ascribed to the quadrant containing the hydrophone. SPOT data generates actual latitudes and longitudes that are converted to Quads/Fish areas and then to Lats/Longs/UTMs representing the centroid for that quadrant. BCCSN data were also reported in latitudes and longitudes that were converted to Quads/Fish areas and then to Lats/Longs/UTMs representing the centroid for that quadrant. Pager data were transformed into quadrants as well as latitude and longitude and UTM coordinates by digitizing the quadrant map and developing a computer program to perform the needed interpolations and transformations (V. Veirs, pers. comm.). The quadrant results were checked against the earlier work of Jean Olson to ensure accuracy (Olson *et al.*, 2001). Additionally, all observations were assigned to fishery management areas to facilitate larger groupings of data. All U.S. sightings are assigned to Washington Department of Fish and Wildlife (WDFW) fish areas (Figure 2). All B.C. sightings are assigned to Department of Fishery and Oceans Canada (DFO) fish areas (Figure 3). The letter "C" is appended to the DFO fish areas to indicate that the sighting is in Canadian waters.

Source is the original data source for the record as identified in Table 1. TWM-SA for Museum sighting archive; TWM-HYD for all reports of acoustic detections via the various hydrophone arrays; TWM-Pager for pager data; TWM-SW for Soundwatch data; TWM-Otis for Dr. Otis' Lime Kiln data; SPOT for SPOT data; and BCCSN for BCCSN data.

Table 2: Descriptions of the data fields in the Orca Master Dataset.

FIELD	Data Type	Format	Description	Format Example /Rules of Entry
Date	Date	11/16/2017	Date of observation	11/16/2017
Time1	Time	13:00	Time of observation	13:00

Time2	Long Integer	1300	Time of observation	1300
Month	Long Integer	11	Month of observation	11
Day	Long Integer	16	Calendar day of observation	16
Year	Long Integer	2017	Year of observation	2017
Pod	Text		Pod identity	J *J-Pod members (including L-87 as of mid-summer 2010)* K *K-Pod members (including L-87 from 2007-mid-summer 2010)* L *L-Pod members* JKL *J,K, and L-pod members traveling together* Jp, Kp, or Lp *Part of J, K, and/or L pod in the area* L12s *L12 subpod* L11s *Specifically L-25, L-41, L-77, and L-94* Lm *Main part of L-pod without the L12 subpod* SRs *Known Southern Residents but unknown pod* Orcas *Pod identification not known* J? *Uncertain pod identification*
Likely Pod	Text		Likely Pod or Ecotype identity	Same as "Pod" but includes possible transient ecotype sightings designated as "Ts"
Dir	Text		Direction whales seen heading	N *North* N then S *Whale turnaround* mill *Non-directional/ milling* N and S *Whales split – going different directions*
FishArea	Text		WDFW Fish Areas -US DFO Fish Areas-BC	WDFW Fish areas 1-13 *Figure 2* DFO Fish Areas 12C-29C *Figure 3*
Quadrant	Long Integer		TWM Quadrants 1-445	TWM Quadrants 1-445 *Figure 1*
Lat	Double		Latitude of quadrant centroid	In decimal degrees
Long	Double		Longitude of quadrant centroid	In decimal degrees
UTMx	Double		WGS84 UTM Zone 10 N coordinate	
UTMy	Double		WGS84 UTM Zone 10 N coordinate	
Source	Text		Source data for record	TWM-SA-Pub *Public info from TWM Sighting Archive* TWM-SA-Rel *Reliable info from TWM Sighting Archive* TWM-SA-WW *Info obtained directly from WW vessels and from Five Star Charters* TWM-HYD-Pub *Public info from hydrophone arrays* TWM-HYD-Rel *Reliable info from hydrophone arrays* TWM-Pager *Whale watch pager data* TWM-SW *Soundwatch observation* TWM-Otis *Otis data from Lime Kiln State Park* SPOT *Combined SPOT data from various vessels* BCCSN *BCCSN data*
ActLat	Double		GPS latitude reported	In decimal degrees
ActLong	Double		GPS longitude reported	In decimal degrees

Recent Temporal Trends in SRKW Habitat Use

Annually there are three primary habitat-use patterns that SRKWs exhibit: 1) summer (June - August) primarily centered in the straits around the San Juan Islands; 2) fall/winter (September - January) a variation on summer with extended excursions into Puget Sound and short trips to the outer coast; and 3) winter/spring (Feb-May) extended excursions outside the Salish Sea along the outer coast, particularly for K and L pods (Heimlich-Boran, 1988; Osborne, 1999; Hauser 2006; Hauser *et al.* 2006).

The most basic underlying pattern is SRKW presence or absence from the inland waters of the Salish Sea. This is illustrated in Figure 4, where pod detection is color-coded in a matrix of months-by-years. Figure 4 shows the nearly year-round occurrence of J Pod, and the continuous monthly presence of the entire population (J, K, and L pods) in the inland waters during the summer and fall months. The trend in this pattern since the winter of 1999-2000 is for K and L Pods to increase the number of months they are detected in the inland waters by staying in the Salish Sea through the fall and into the early winter, before completely exiting the inland waters for months at a time in late winter. In recent years (e.g., 2009 and 2013-2014), however, there have been some noted anomalies with the absence of J pod from the Salish Sea in April for the first time since the onset of TWM's database in 1976. This year, 2017, included several notable deviations from the long-term trends. It was the first time since the start of this database that J pod was not sighted in the inland waters during the month of August. It was also a summer with relatively limited occurrence of K pod: it was the first time that K pod was not sighted in the month of August; it was the second year in a row that K pod was essentially absent in July (note: the only report of K pod in July involved a single hydrophone detection of the K14s at 01:30 on July 1st as they exited the inland waters); and it was the first time since 1997 that K pod was not present in October. It is also worth noting that when K pod was present in June, it was only part of K pod (the K14s).

In Figures 5 and 6, the seasonal occurrence of SRKW in the Central Salish Sea vs. Puget Sound is illustrated (after Osborne, 1999). In these figures, the number of days per month SRKW were detected from 1978 to 2017 were plotted relative to their respective decadal (10-year) means of occurrence for each month. All sightings that were designated as "Ts" under likely pod were not included in these figures. For the Central Salish Sea, SRKW show an overall pattern of increased occurrence during the summer months that is fairly consistent across the decades. In recent years (e.g., 2010, 2013-2014, 2016), a trend of reduced occurrence in the spring months may be emerging with some years (e.g., 2013) showing reduced occurrence throughout the summer months as well. This year, 2017, the number of orca days per month was notably lower than the decadal mean throughout the spring and summer months (April – August) with the most prominent difference occurring in August. SRKW were only documented on 2 days in August compared to decadal a mean of 21.8 days (Figure 5). Whale days were at or above the decadal mean during the remainder of the year (September – March).

SRKW occurrence in Puget Sound proper follows a pattern of reduced presence in the spring and summer and an increasing occurrence in the late fall and early winter. This fall/winter pattern seems to have become established after a sub-group of L-Pod was trapped in Dyes Inlet in 1997. In 2010 and 2011, the numbers of days with SRKW in Puget Sound were essentially absent except for the fall/winter pattern (Figure 6). In 2017, SRKW sightings in Puget Sound followed the decadal mean

fairly closely with deviations from the decadal mean most prominent in January, where the number of days detected was well below the decadal mean, and April, where the number of days detected was higher than the decadal mean (Figure 6).

Figure 7 depicts the number of SRKW sightings reported in 2017. Reports were tallied for each quadrant and then depicted on the map at the centroid of each quadrant. As indicated in the legend, the larger the size of the symbol, the larger the number of sightings in that quadrant. All 2017 sightings were included in this map, so it does not just indicate where the whales were found most often, but also indicates where people are more likely to view and report the whales. All sightings that were designated as "Ts" under likely pod were not included in the map. The figure emphasizes the importance of Haro Strait as well as the use of the corridor south of Admiralty Inlet and north of Vashon Island in Puget Sound proper. This is likely driven by late fall/early winter excursions by the SRKW into the Puget Sound to feed on chum salmon run.

Presentations of Findings and Works in Progress

Preliminary presentations of this dataset were made at the NOAA-sponsored Southern Resident Killer Whale Workshops in 2004 and 2006. The Orca Master sighting data was also used in a three part series of workshops related to Southern Resident killer whale and salmon fishery interactions sponsored by NOAA. Two of the workshops took place in Seattle, WA in September 2011 and January 2012. The third workshop took place in Vancouver, Canada in September 2012. Starting in 2016, presentations of this dataset have been made biannually at TWM's Marine Naturalist Training Program and annually at TWM's Research Symposium. In 2018, long-term trends highlighted by this dataset were presented by TWM at the 30th Salish Sea Ecosystem Conference in Seattle, WA.

Data from Orca Master have been shared with countless U.S. and Canadian management agencies, non-profit researchers, private consultants, schools, tribes, and college student projects. In 2017, we worked with eight different groups requesting access to these data. This dataset is also being increasingly used for environmental impact assessments. For example, The Whale Museum, as part of a contract with the Snohomish County Public Utility District, conducted a historical review of the usage of Admiralty Inlet by Southern Resident killer whales that was based mostly on the Orca Master dataset (Wood *et al.* 2009). In addition, as part of ten contracts with the Washington State Ferries and one contract with the U. S. Department of the Navy, The Whale Museum conducted historical reviews of SRKW usage of the Seattle, Anacortes, Bremerton, Vashon/Southworth, Coupeville, Edmonds, Mukilteo, and Port Angeles areas that were based mostly on the Orca Master dataset (Olson and Wood 2014a-c; Olson and Wood 2015; Olson 2017a-d).

To date, this dataset has been incorporated into three completed master's thesis projects (Olson 1998; Hauser 2003; McCluskey 2006), and two doctoral dissertations (Osborne, 1999; Giles, 2014). Peer reviewed publications directly utilizing this dataset have been written by Donna Hauser (Hauser *et al.* 2006, 2007), Deborah Giles (Giles and Koski, 2012) and most recently by Monika Wieland Shields (Shields *et al.* 2018). A manuscript summarizing the overall trends and importance of this dataset has been submitted by TWM to *Endangered Species Research* for peer-reviewed publication and is currently in the second stage of the review process (Olson et al., *in review*). This manuscript includes the addition of an effort corrected relative density estimate to account for some of the geographical biases in the Orca Master dataset.

Summary Copy of Data

The primary products of this contract are the 105,344 sighting records of SRKWs that have been systematically assessed and integrated into a single spatial database available in Access or Excel format (Appendices I & II). This information has been provided on CD to NOAA's Northwest Fisheries Science Center and the Northwest Regional Office, Protected Resources Division.

Individuals and/or Organizations that Collaborated and Performed the Work:

The Whale Museum staff administered grant funds, including accounting and disbursements, from award **# RA133F-12-CQ-0057**, and undertook the bulk of sighting recording, compilation and assessment. Individuals outside of The Whale Museum staff who made major contributions to the compilation and assessment of the 2017 database include: Jeanne Hyde, Alyssa Scott, Rachel Amos, Susan Berta and Howard Garrett of Orca Network and Mark and Maya Sears. Special thanks to the primary contributors of our most systematic datasets: Bob Otis of Ripon College, Sadie Youngstrom and Elizabeth Seely of Soundwatch, Orca Spirit Adventures Group, Monika Wieland of Orca Behavior Institute, and Ron Bates of Five Star Whale Watching. Thank you to Jessica Torode, Chad Nordstrom, and Lance Barrett-Lennard of BCCSN for their continued collaboration with annual data exchanges. Thank you to the commercial whale watching companies and naturalists who recorded or shared sightings data for the 2017 report including: Five Star Whale Watching, Victoria Clipper, Western Prince, Wild Whales Vancouver, Prince of Whales, and Eclipse Charters.

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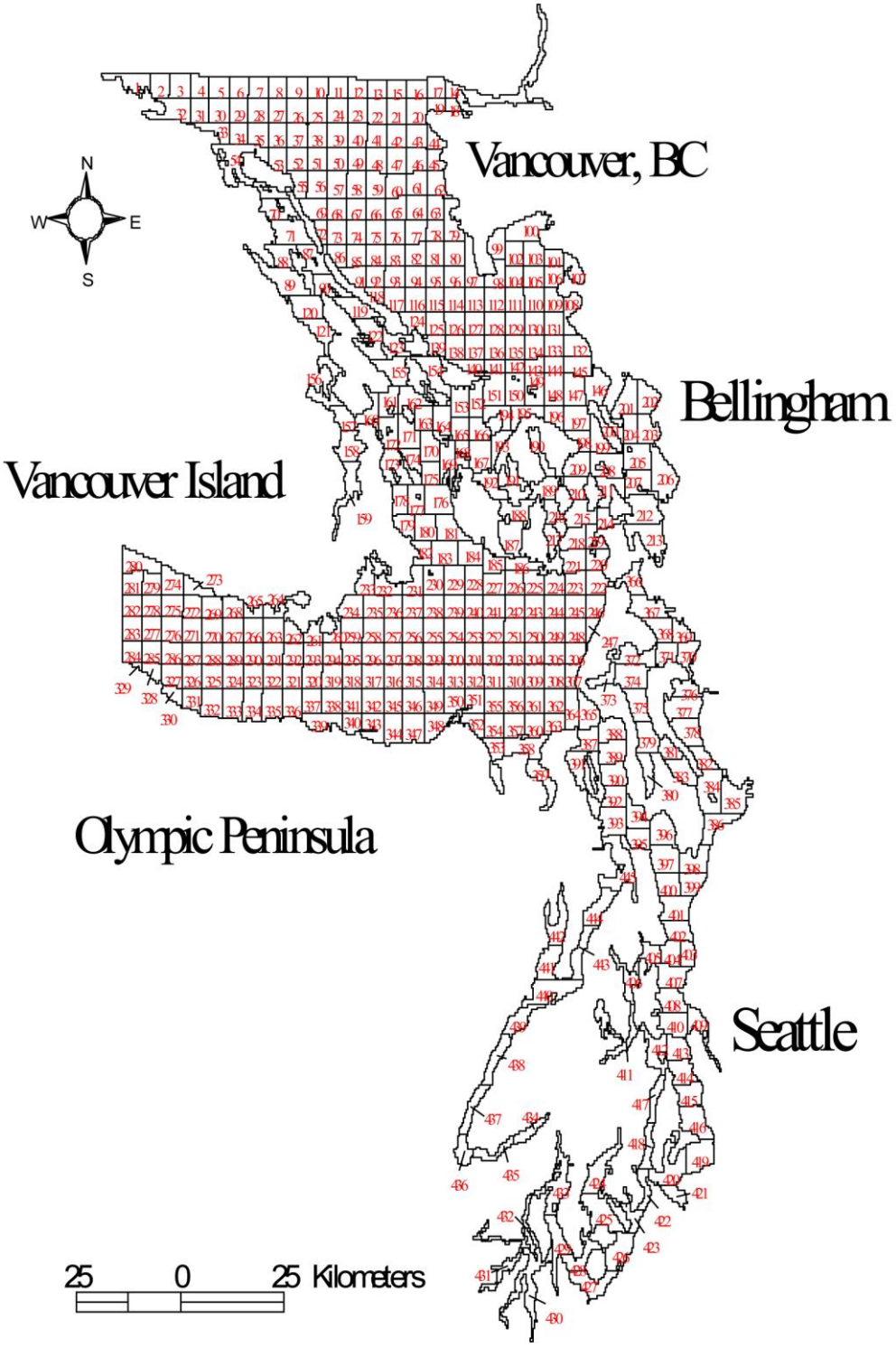
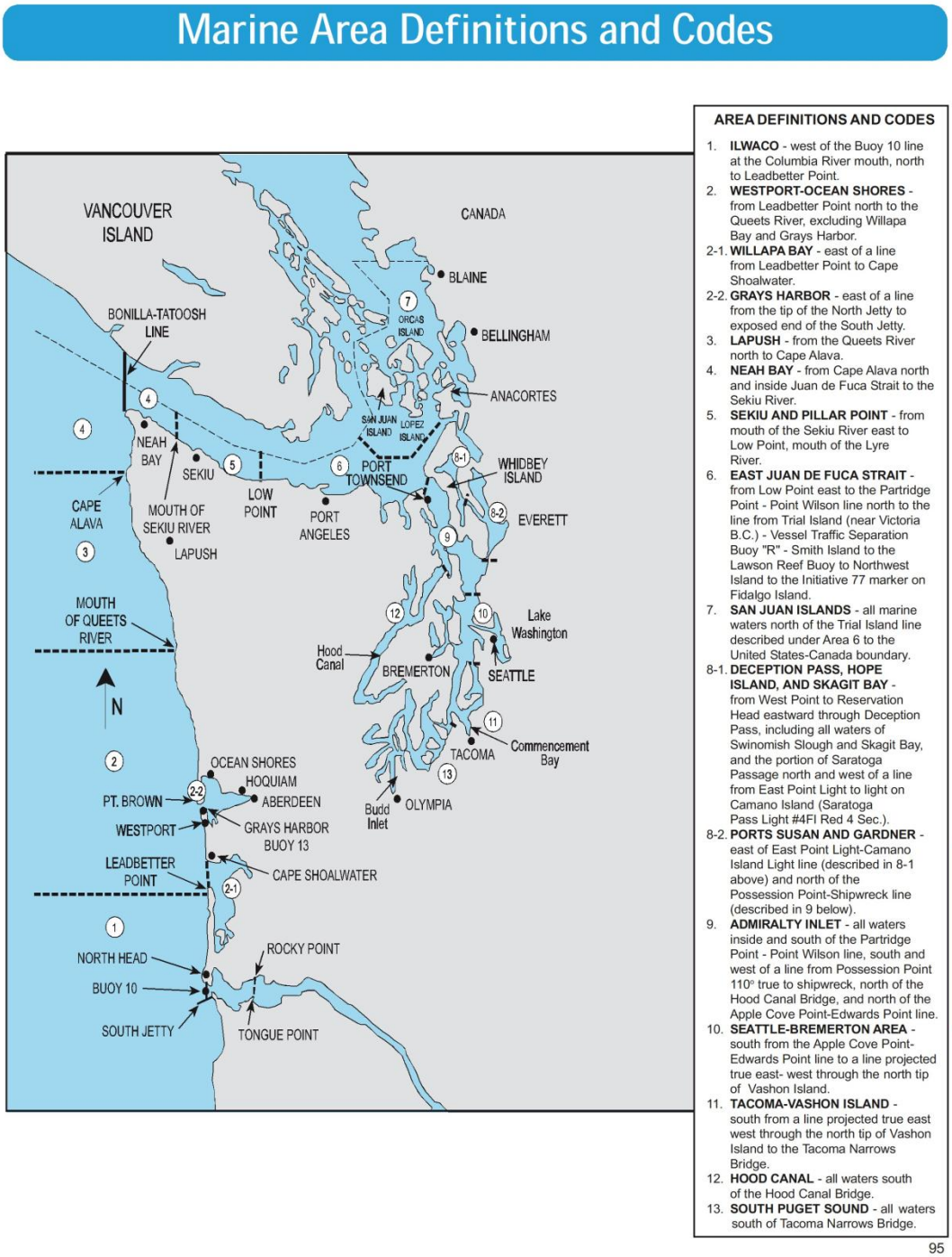
Figure 1. The Whale Museum marine mammal sighting Quadrants. (Heimlich-Boran 1988, Olson 1998)



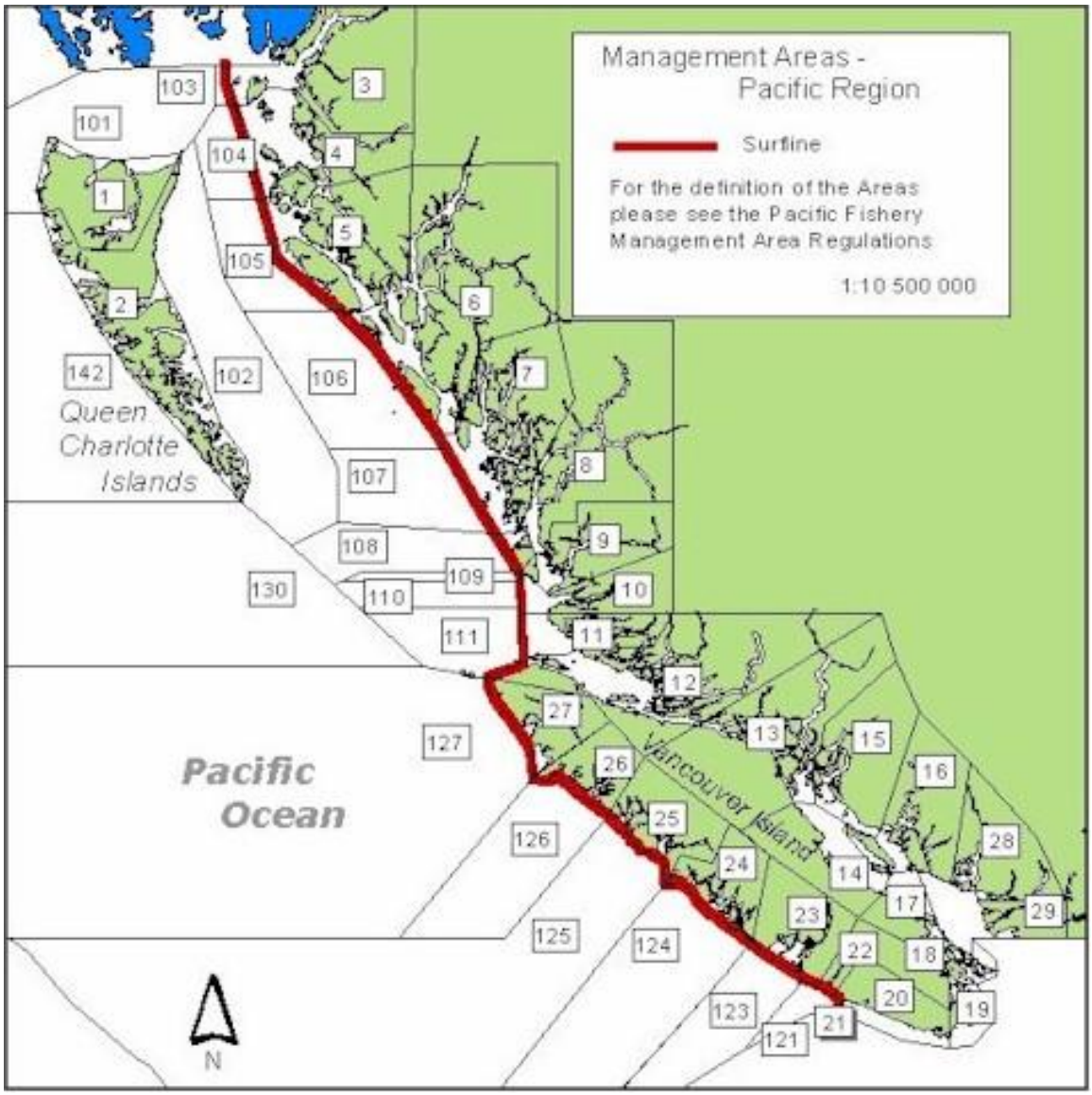
Note: This map is formatted to print on 11 x 17 paper. Please view file *TWMQuads.doc* included on this CD for viewing and printing options.

Figure 2. Washington Department of Fish and Wildlife fishery management areas



Source: Washington Department of Fish and Wildlife, Sport Fishing Rules 2004/2005 Pamphlet edition. http://wdfw.wa.gov/

Figure 3. Department of Fisheries and Oceans Canada fishery management areas.



Source: Fisheries and Oceans Canada, www.pac.dfo-mpo.gc.ca/ops/fm/Areas/areamap_e.htm

Figure 4. Monthly Scale Pod Occurrence in the Inland Waters (1976-2017)

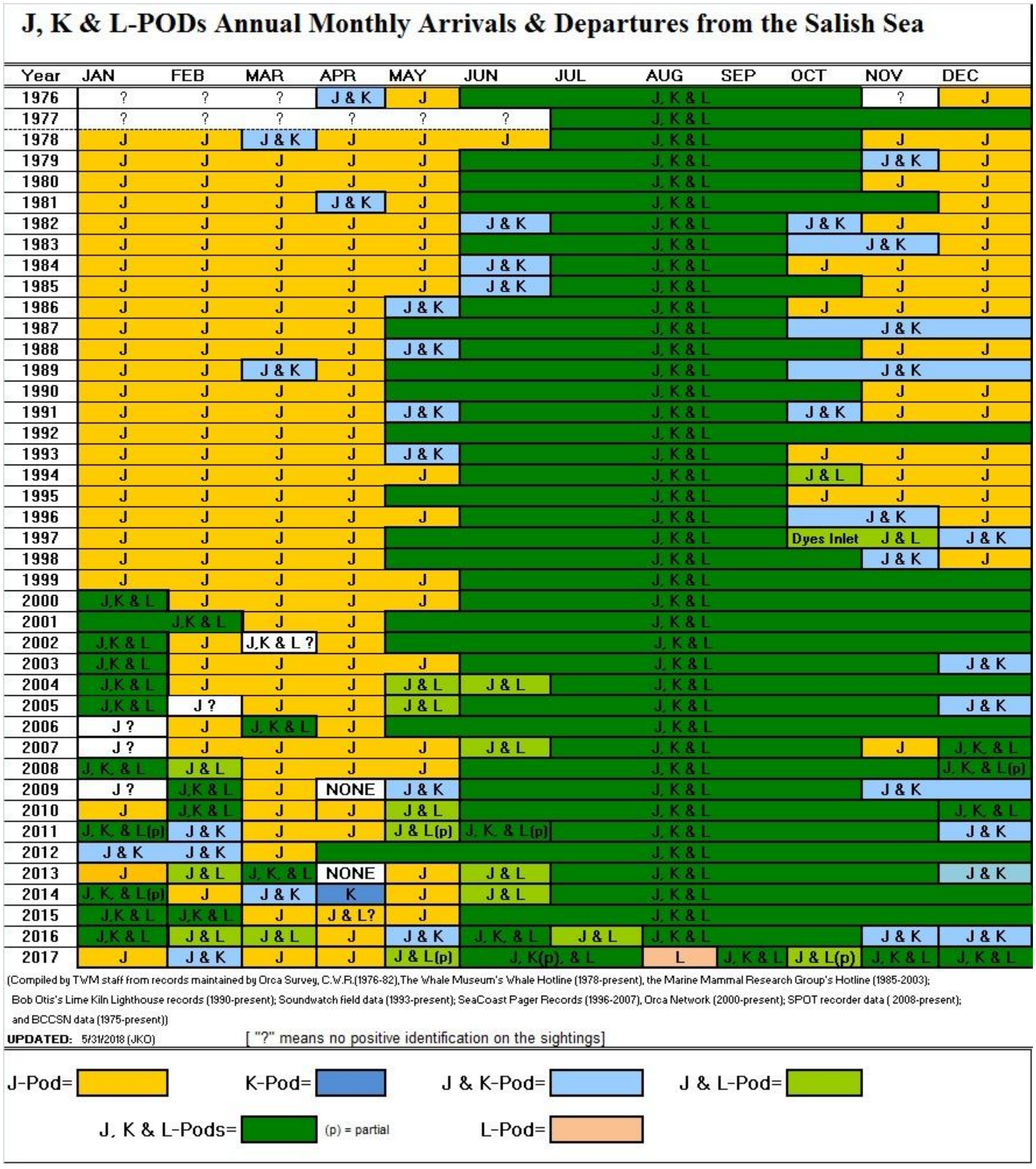
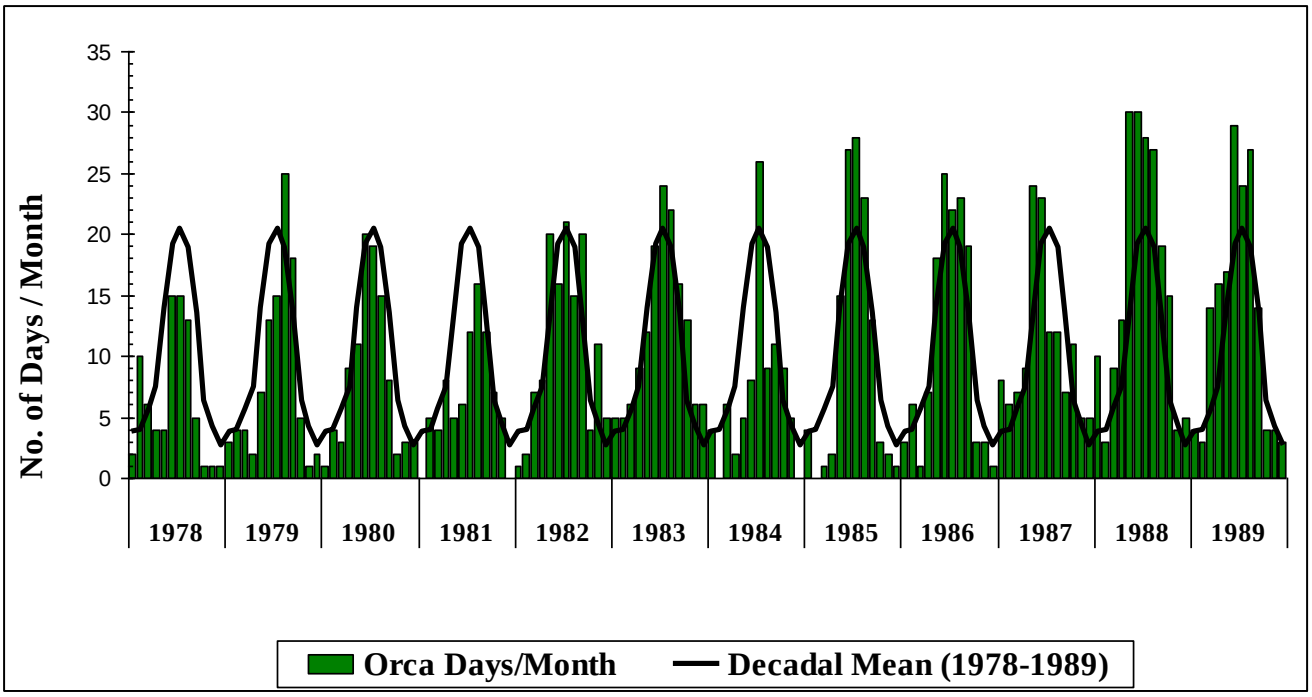
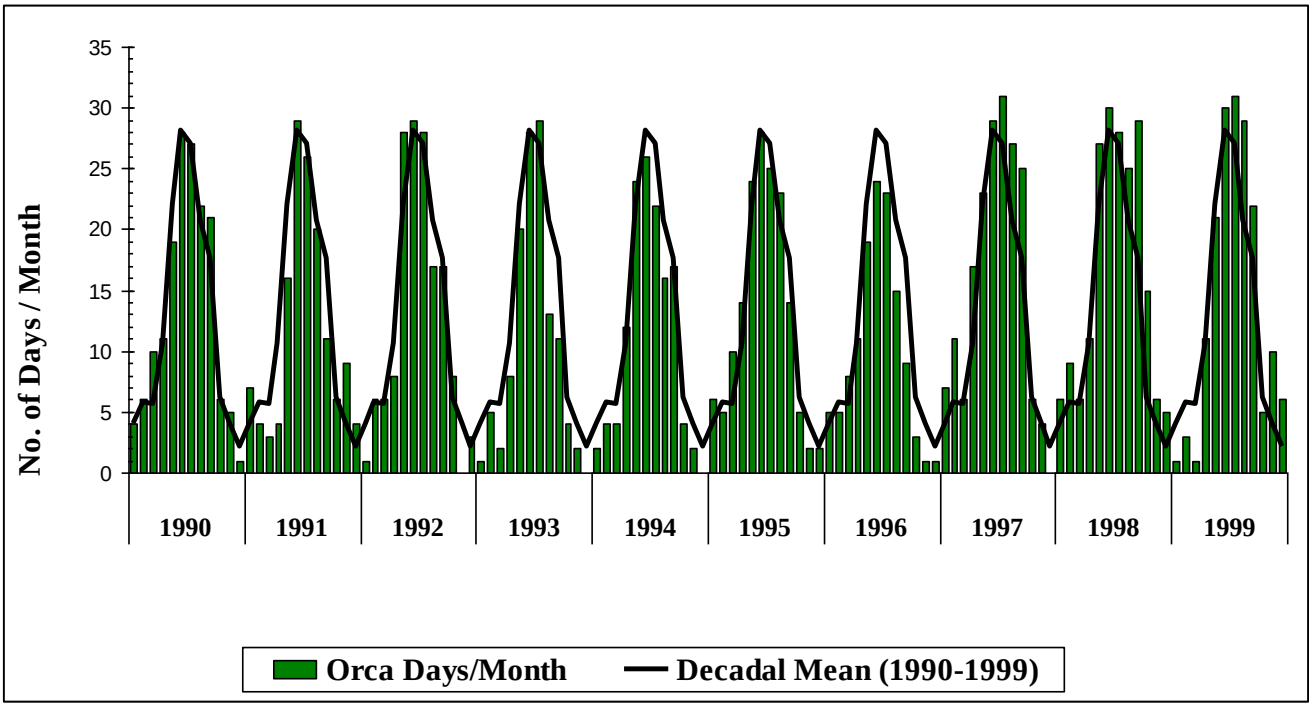
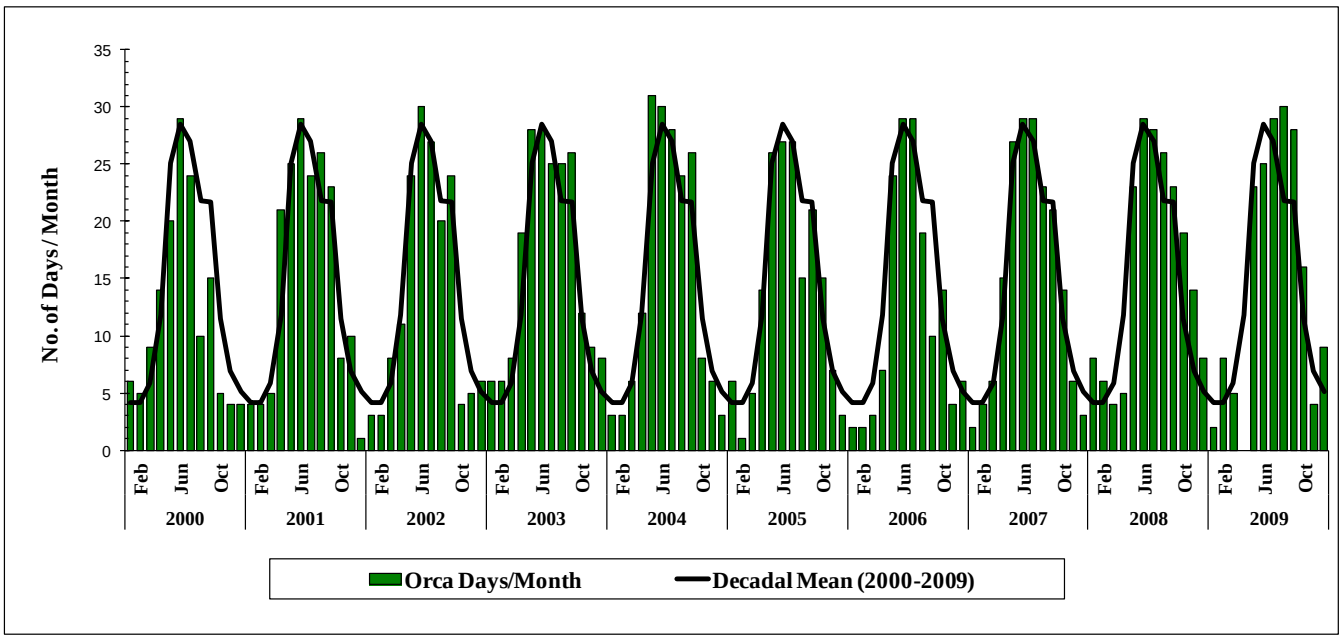


Figure 5. Days/Month SRKW Detected in the Central Salish Sea. The decadal means are also included to highlight long-term trends.



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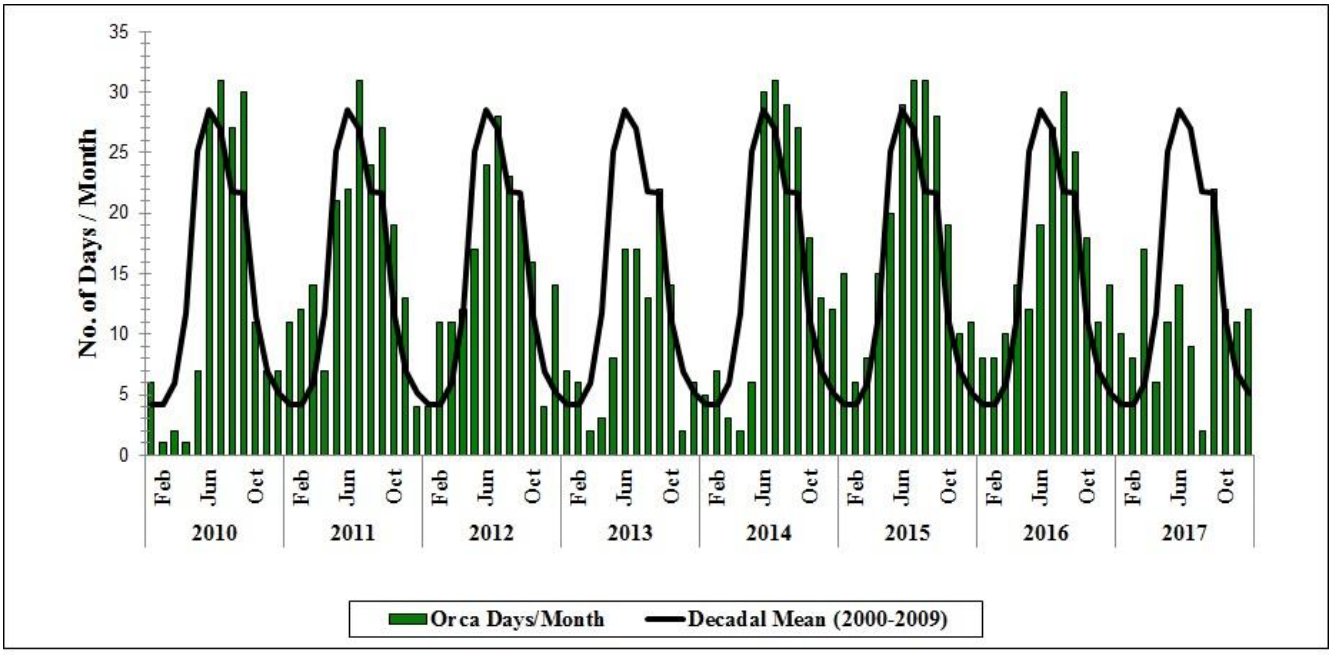
Orca Days/Month
Decadal Mean (2000-2009)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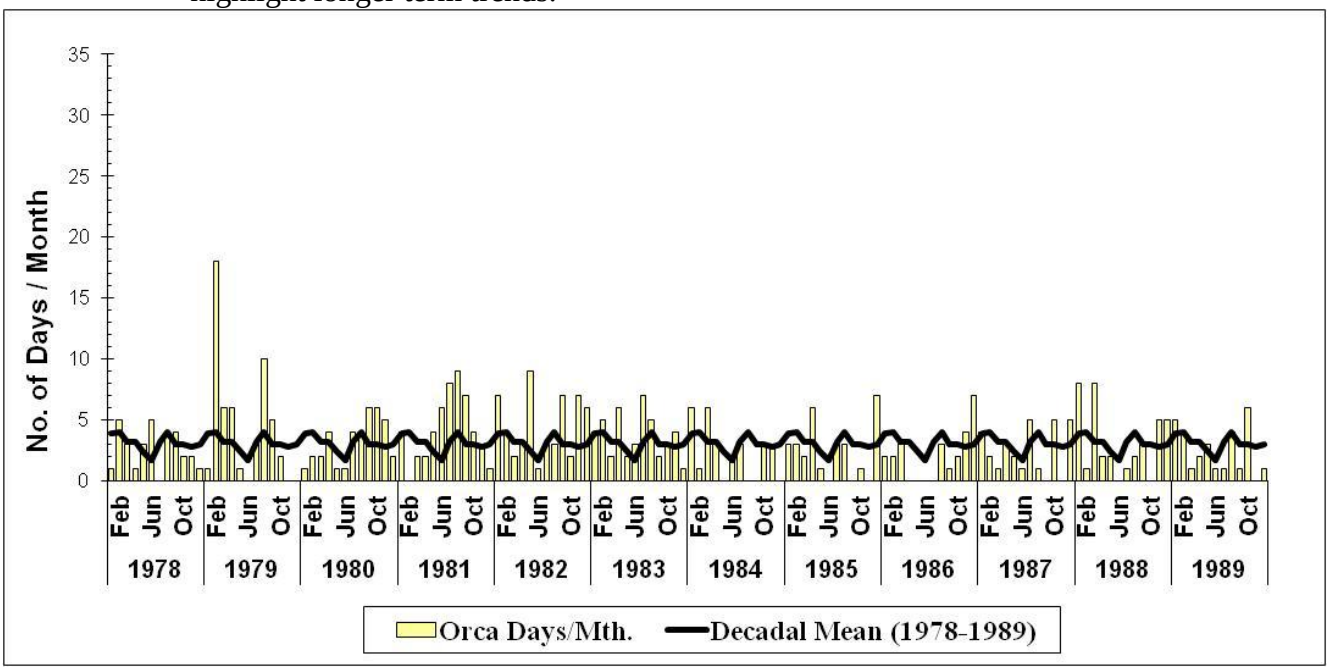
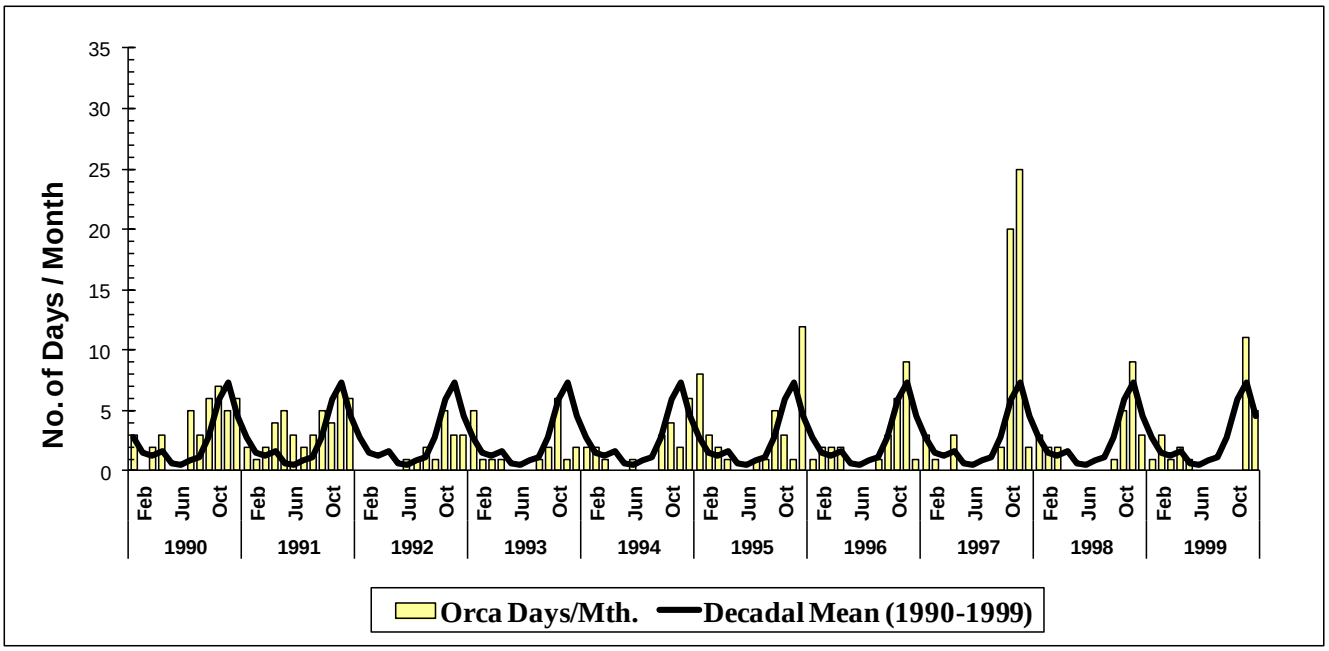
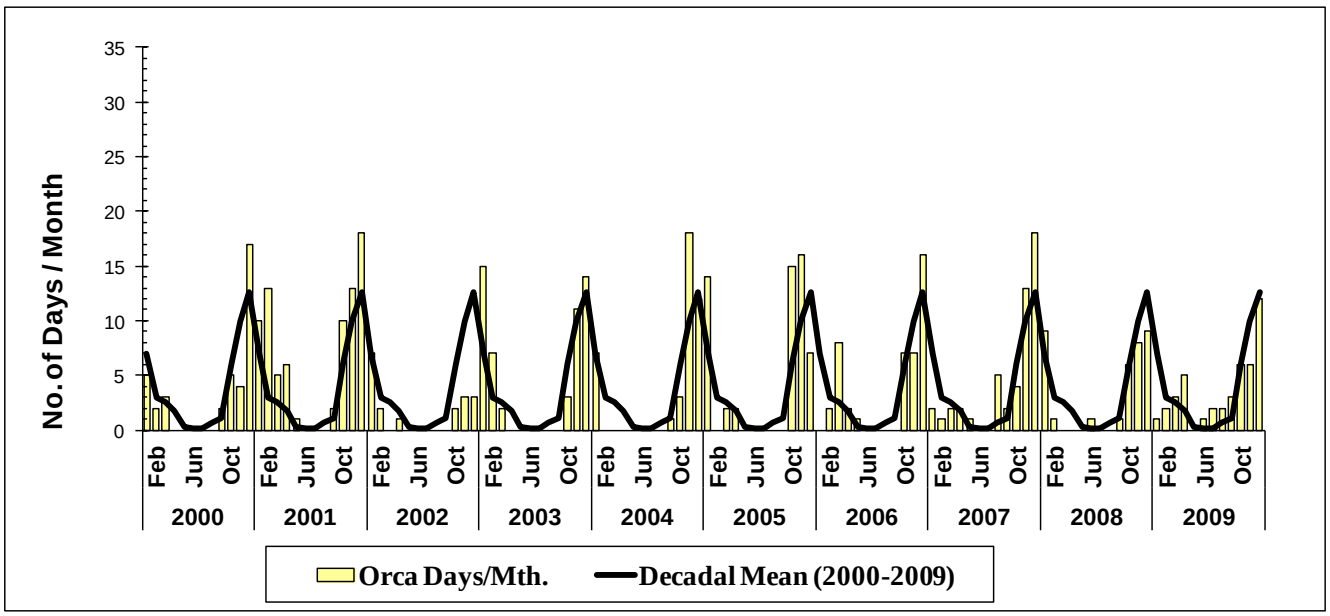
Orca Days/Month
Decadal Mean (2000-2009)

Figure 6. Days/Month SRKW Detected in Puget Sound. The decadal means are also included to highlight longer term trends.



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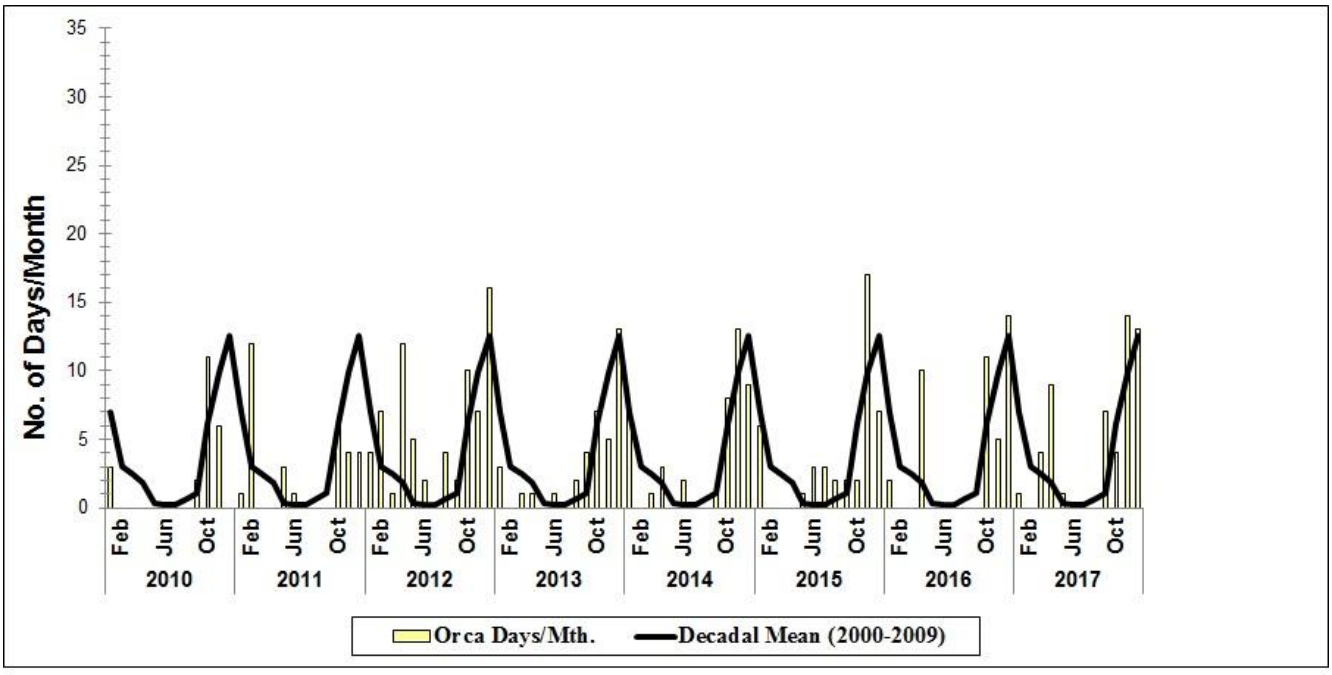
Decadal Mean (2000-2009)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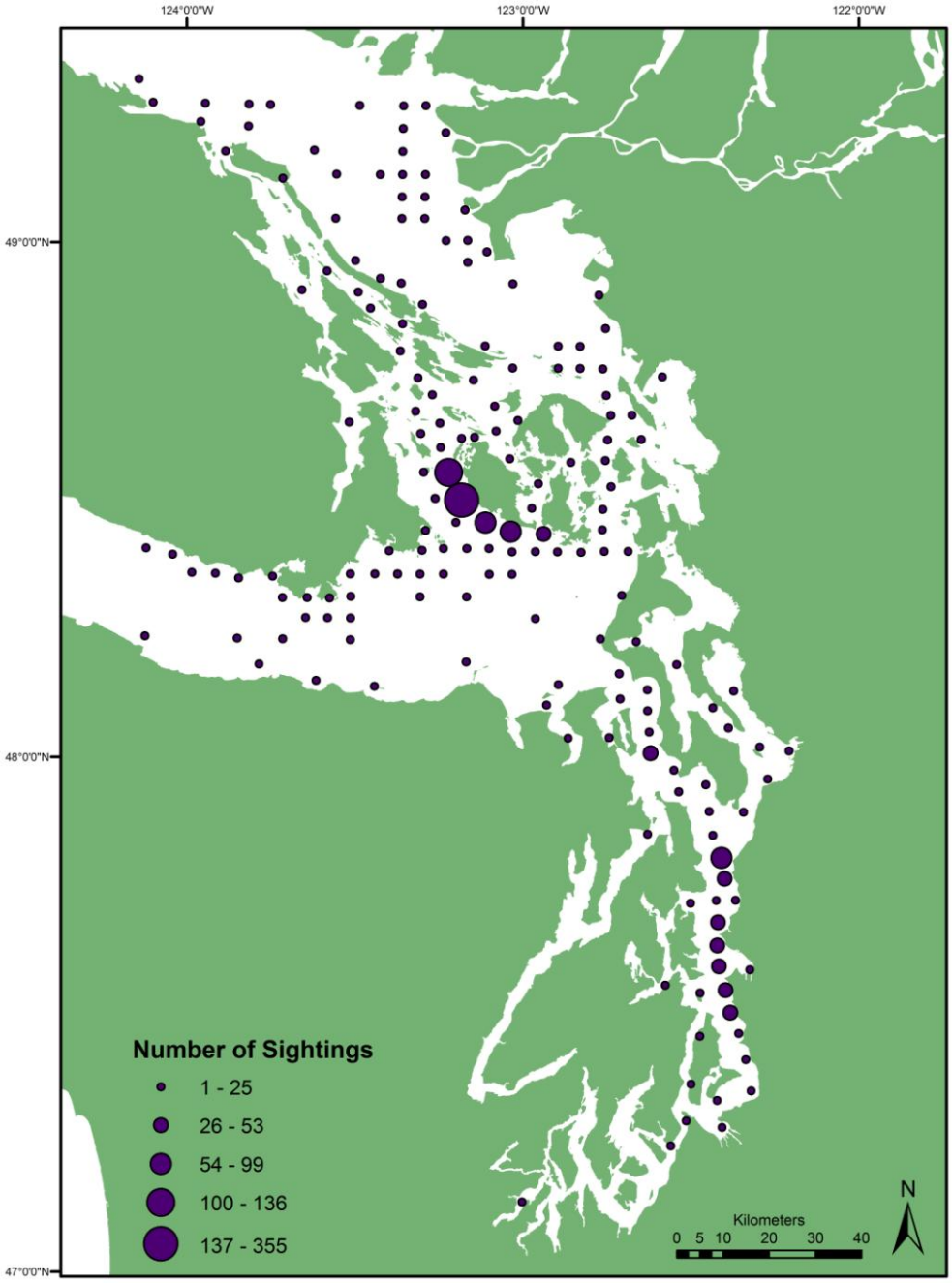
Orca Days/Mth.
Decadal Mean (2000-2009)

Figure 7. Map depicting the number of SRKW sightings reported by area in 2017. Each symbol is the centroid of a quadrant. Its size is proportional to the number of reports for that quadrant in 2017 which are driven by how often the whales are present there and how often people are likely to view and report whales in that location.



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