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TRANSIENT KILLER WHALES OF CENTRAL AND NORTHERN CALIFORNIA AND OREGON: A CATALOG OF PHOTO-IDENTIFIED INDIVIDUALS

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Abstract

Photo-identification studies of transient killer whales (*Orcinus orca*) off western North America have primarily been conducted in the coastal inland waterways of Washington State, British Columbia, and southeastern Alaska. Less is known about transient killer whales along the outer coast and offshore waters of Oregon and central and northern California. We examined 13 years of photo-identification data to identify individuals and obtain a minimum census for this region, and to summarize information that could be useful for evaluating a hypothesis that whales using this area belong to a distinct assemblage. Data contributions came from opportunistic marine mammal surveys, whale watch ecotours, and dedicated line transect surveys. Transient killer whale photographs were obtained from 146 encounters between 2006–2018. These included 136 encounters in Monterey Bay, California, 5 encounters off central and northern California, and 5 encounters off Oregon. The number of unique individuals seen during this time totaled 155, of which 150 were considered to be alive (as of 2018). These included 34 adult males, 51 adult females, 24 sub-adults, and 41 juveniles. Through repeated observations of association patterns, a total of 30 matrilineal groups were identified. New whales were identified each year, including previously unidentified adults and new calves. Identification images of the dorsal fins, saddle patches and postocular patches were obtained. Details on sex, maternal ancestry, sighting history, and distribution are provided where known. These cataloged transient killer whales were predominantly encountered off the outer coast near the continental shelf break or in deep pelagic waters overlying the Monterey Submarine Canyon. The vast majority (>83 %) of whales identified in the study area could not be matched to transient killer whales in photo ID catalogs for coastal waters of the Pacific Northwest. These factors are consistent with there being a distinct “outer coast” assemblage within the west coast population of transient killer whales, but more research is needed to investigate this further.

Introduction

Killer whales (*Orcinus orca*) are upper trophic level predators that live throughout the world's oceans (Leatherwood and Dahlheim, 1978; Heyning and Dahlheim, 1988; Forney and Wade, 2006). Killer whales are known to forage on a diverse range of species, from small schooling fish to large cetaceans (Jefferson et al. 1991; Baird, 2000; Baird, 2002). Although they occur in offshore waters, killer whales are most commonly found in the coastal waters in both the Northern and Southern hemispheres (Forney and Wade, 2006). Killer whales are well known throughout the northeastern Pacific, including the coastal regions of Alaska (Consiglieri et al. 1982; Matkin et al. 1999), British Columbia (Bigg et al, 1987; Ford et al. 2000), Washington, Oregon, and California (Green et al. 1992; Black et al. 1997; Forney and Barlow, 1998; Barlow and Forney, 2007; Burrows et al. 2012; Muto et al. 2020). Long-term studies using photo-identification methodology and re-sighting information have described several distinct populations of killer whale along the west coast of North America (Bigg, 1982; Dahlheim et al. 1997; Baird, 2000; Ford et al. 2000). However, the population boundaries and geographic ranges for such a mobile species are complex and difficult to define (Parsons et al. 2013).

In the Northeastern Pacific, three sympatric ecotypes of killer whales have been described: 'residents' (fish-eating), 'offshore' (primarily shark-eating), and 'transient' (mammal-eating). These ecotypes differ remarkably in diet (Baird and Dill, 1995; Hanson et al. 2010; Ford et al. 2011), behavior (Baird and Dill, 1995; Baird, 2000; Riesch et al. 2012), morphology (Baird and Stacey, 1988; Ford et al. 2000), genetics (Barrett-Lennard and Ellis, 2001; Morin et al. 2010; Parsons et al. 2013), and acoustics (Rice et al. 2017; Sharpe et al. 2019). Resident and transient ecotypes have been known to comprise several populations (Carretta et al. 2020; Muto et al. 2020), whereas the offshores consist of a single population (Dahlheim et al. 2008; Ford et al. 2014). Most killer whale studies in this region have focused on the resident ecotype, which live in stable matrilineal pods and have restricted home ranges that tend to occur in neritic waters. Less is known about the transients and offshores.

Transient killer whales, also known as Bigg's killer whales, feed almost exclusively on marine mammals and are distributed from the Chukchi Sea Alaska to Southern California (Baird, 1994; Baird and Dill, 1995; Baird and Dill, 1996; Black et al. 1997; Ford and Ellis, 1999; Baird and Whitehead, 2000; Dahlheim and White, 2010; Ford et al. 2013; Houghton et al. 2015; McInnes et al. 2020a). Transient killer whales generally live in groups of 5 to 10 whales, comprising a mother and her offspring. In contrast to residents, this matrilineal system is fluid with individuals often dispersing for extended periods of time (Baird and Whitehead, 2000). Genetic studies comparing the mitochondrial genome of killer whales globally indicate that transients are a deeply divergent lineage that separated from all other killer whale populations approximately 700,000 years ago (Morin et al. 2010). This finding has prompted the Society for Marine Mammalogy's Committee on Taxonomy to recognize the transient ecotype as an unnamed sub-species of *Orcinus orca* (Committee on Taxonomy, 2012).

Differences in genetics, acoustics, behavior, and distribution suggest the transient ecotype consists of three putative populations: 1) the AT1's or Chugach transients centered in Southern Alaska's Prince William Sound and Kenai Fjords, 2) the Gulf of Alaska transients distributed throughout the Gulf of Alaska, Aleutian Islands, and the Bering Sea, and 3) the west coast transients distributed from Southeastern Alaska to Southern California (Ford and Ellis, 1999; Matkin et al. 1999; Matkin et al. 2007; Dahlheim and White, 2010; Matkin et al. 2012; Ford et al. 2013; Parsons et al. 2013; Muto et al. 2020). The AT1's and Gulf of Alaska populations are known to overlap in Prince William Sound and the Kenai Fjords regions. However, these two populations have never been observed to associate, and they do not share the same acoustic dialect or DNA haplotype (Saulitis et al. 2005; Parsons et al. 2013). Similarly, the Gulf of Alaska and west coast populations are known to overlap in the coastal waters of Southeastern Alaska and northern British Columbia (Matkin et al. 2012; Ford et al. 2013) but do not share DNA haplotypes or acoustic dialects (Barrett-Lennard, 2000; Barrett-Lennard and Ellis, 2001; Matkin et al. 2012; Ford et al. 2013; Sharpe et al. 2019).

Recent data suggest that within the west coast population there might be at least two distinct groups, loosely described as the "coastal" assemblage and the "outer coast" assemblage. The coastal assemblage is well studied. It inhabits the inland waterways of Washington, British Columbia, and Southeastern Alaska throughout the year (Baird and Dill, 1995; Ford and Ellis, 1999; Dahlheim and White, 2010; Houghton et al. 2015). These animals form a single acoustic clan, with a specific DNA haplotype (Barrett-Lennard and Ellis, 2001; Deecke, 2003). Considerably less is known about the outer coast assemblage. The two west-coast assemblages mix infrequently and for the most part inhabit different geographic regions within the northeast Pacific (Ford et al. 2013; Rice et al. 2017; Muto et al. 2020).

The first studies of transient killer whales in California began in the 1980's and led to a photo-identification catalog that included 105 unique transient killer whales in the waters off central California (Black et al. 1997). Transients from the California region share the west coast population DNA haplotype (Hoelzel et al. 1998) and are considered part of the west coast acoustic clan (Deecke, 2003), suggesting that coastal and outer-coast animals might form a single population. Moreover, a small subset of the whales photo-identified off California have also been encountered off Oregon, Washington, British Columbia, and Southeastern Alaska (Goley and Straley, 1994; Black et al. 1997; Dahlheim et al. 1997; Ford and Ellis, 1999). When encountered outside of California waters, these outer coast whales have been observed associating with other known coastal transient groups (Ford and Ellis, 1999; J. McInnes unpublished data). However, infrequent sightings of unidentified or rarely seen individuals on the outer coast, in deeper waters near the continental shelf indicates a subset of whales might occur off the central coast of California belonging to a distinct outer coast assemblage (Ford et al. 2013; Rice et al. 2017; Muto et al. 2020; J. McInnes unpublished data). These animals exhibit a unique vocal dialect group, distinct from transient dialects in the coastal waters of the Pacific Northwest (Rice et al. 2017).

Our objectives were to compile recent photographs of transient killer whales seen off central and northern California and Oregon, to identify transient whales of the outer coast region, and provide a minimum census of this nominal assemblage. This catalog of photographically identifiable individual whales can be used in long-term re-sighting studies to help evaluate hypotheses regarding the extent of mixing between coastal and outer coast groups, and to provide information about the spatial-temporal distribution and demography of outer coast transient killer whales.

Methods

Study Area

The outer coast of central and northern California and Oregon, as defined for this catalog, extends from Point Conception, California in the south to Astoria, Oregon in the north, and extends approximately 560 km offshore (Figure 1). This region is highly productive, and includes two priority conservation areas (Morgan, 2005). The Oregon region is highly dynamic and dominated by a high energy open ocean coastline that is subjected to strong seasonal upwelling. The continental shelf is relatively flat and narrow and ranges from approximately 20 km off Cape Blanco (approximately 160 km north of the California-Oregon border) to 75 km off the central coast. At the edge of the Oregon continental shelf are multiple productive offshore banks and two prominent deep-water canyons. The central and northern California regions are marked by a narrow continental shelf and steep continental slope that opens to several deep-sea canyons. The majority of photography effort contributed to this study occurred in Monterey Bay, located off the central coast of California. Monterey Bay is approximately 1200 km^2 and occurs within the Monterey Bay National Marine Sanctuary (MBNMS). Open to the Pacific, Monterey Bay is subjected to oceanographic influences of the California Current and localized seasonal upwelling, resulting in the region being one of the most productive marine ecosystems on the west coast of North America (Morgan, 2005). A convoluted series of canyons make up the Monterey Submarine canyon system, which bisects the bay, resulting in deeper water over the canyon in its center. These productive waters provide prey for transient killer whales where sightings occur throughout the year (McInnes et al. 2020b).

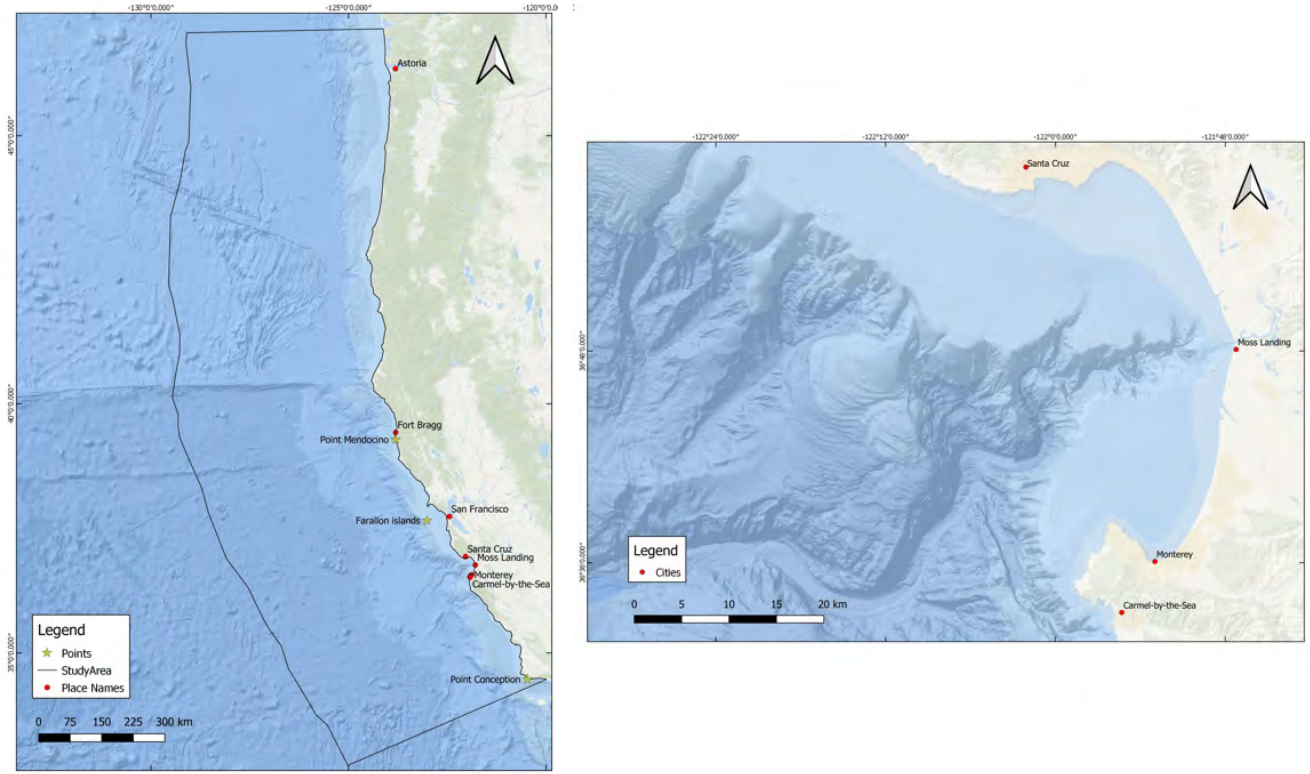

Figure 1: (**A**) Map of the primary study area of central and northern California and Oregon. This area encompasses the remote outer coast from Point Conception, California to Astoria, Oregon, extending ~560 km offshore (black line). (**B**) Map of Monterey Bay, California showing the deep-water Monterey Submarine Canyon. Map by Josh Tawse, Transient Killer Whale Research Project. Created using QGIS, version 3.12.0 ('Burcuresti').

Data Collection and Compilation

Data were obtained for 146 transient killer whale encounters between 2006 and 2018 (Table 1) from three main sources: 1) opportunistic marine mammal research surveys conducted by Marine Life Studies (MLS), a non-profit organization based in Monterey Bay, California, 2) opportunistic whale watch (WW) ecotours based primarily in Monterey Bay, California, and 3) line transect research cruises conducted by NOAA SWFSC off the coast of California and Oregon. All photographs used in this study that were not taken by the authors were obtained with express written permission for use in this research by the contributors.

Most photographic effort occurred in Monterey Bay, largely due to year-round ecotourism and whale watch operations. Marine Life Studies' opportunistic marine mammal surveys were conducted in Monterey Bay from May 2006 through December 2018. During an encounter with transient killer whales, the date, time, location (latitude and longitude), group size, and behavioral observations were recorded. In accordance with the methods outlined in Bigg et al. (1987), an effort was made to obtain high quality photographs of the left and right side of the dorsal fin and saddle patch, and left and right postocular patch of all individuals present. An approach of 20 to 30 m perpendicular to the whale was used to obtain the best quality photographs (per Dahlheim, 1997).

Naturalists aboard whale watch ecotours in Monterey Bay, California submitted transient killer whale identification photographs and associated data that were collected on a voluntarily basis between February 2013 and October 2018. To be included in our study, these submissions needed to include high-resolution photographs and information about group size, location, and date of encounter. While data and photographs were examined for the outer coast of British Columbia, Washington, and Southeastern Alaska, only photographs and data for central and northern California and Oregon were included in the study.

Within the time frame of our study (2006–2018), NOAA SWFSC conducted dedicated marine mammal line transect surveys off the coast of North America ranging (in various years) from California to Alaska in 2008, 2014, 2015, and 2018 (Barlow et al. 2010; Barlow et al. 2016, Weller et al. 2017, Henry et al. 2020). During encounters with transient killer whales, high-quality photographs were collected, and data were recorded on the latitude, longitude, date, and group size. From these surveys, only photographs and data for central and northern California and Oregon were included in the study.

Table 1: Number of days transient killer whales were encountered off central and northern California and Oregon by year from 2006-2018. MLS=Marine Life Studies, NOAA SWFSC, WW=Whale Watch.

Source	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	TOTAL
MLS	4	1	16	5	5	7	6	12	11	5	10	11	11	**104**
NOAA	0	0	2	0	0	0	0	0	3	1	0	0	1	**7**
WW	0	0	0	0	0	0	0	1	0	24	5	1	10	**35**
TOTAL	**4**	**1**	**18**	**5**	**5**	**7**	**6**	**13**	**14**	**30**	**15**	**12**	**21**	**146**

A total of 113,127 photographs were collected and analyzed: 95,256 from Marine Life Studies, 15,193 from naturalists aboard whale watch ecotours, and 2,678 from NOAA SWFSC. Individual killer whales were identified using at least two distinctive, unique markings (per Olson and Gerrodette, 2008), including notches or nicks on the dorsal fin, scarring on the saddle patch, and the shape of the dorsal fin and post ocular patches. Due to their generally non-descript dorsal fin and minimal saddle patch, calves and juveniles

were primarily identified using the shape of the post ocular patch and proximity to their mother. Identification photographs were compared to one another and compared to existing transient killer whale photo-identification catalogs, including Black et al. (1997); Dahlheim et al. (1997); Ford and Ellis (1999); and Towers et al. (2019). Matches to existing catalogs were explicitly documented.

Population Nomenclature

Each killer whale was determined to be transient based on being observed in association with known transient type whales or matched to existing catalogs of transient killer whales. Morphological features were analyzed for each whale photographed during an encounter. For transient killer whales, this included the dorsal fin shape, which can be pointed in adult females, and the shape and pigmentation of the saddle patch, which is closed and uniformly gray (Baird and Stacey, 1988; Ford and Ellis, 1999).

Killer whales photographed off California and Oregon were designated as outer coast transients, denoted by the prefix "OCT" in our catalog. Recognizing that this assemblage mixes to some degree with coastal transients further north, this nomenclature is not meant to presume these animals constitute a demographically distinct unit, only that they predominantly occur in the California-Oregon region. The OCT prefix is followed by a unique alphanumeric code based on the genealogical methodology outlined in Ford and Ellis (1999) (Figure 2). For example, the matriarch and adult female OCT030 is the 30th whale identified. Her first observed offspring would be listed as OCT030A and her second offspring would be named OCT030B. Should OCT030B later reproduce, her first offspring would be listed as OCT030B1.

Figure 2: The outer coast transient killer whale alphanumeric naming system based on matrilineal decent.

Other transient killer whale catalogs exist for regions along the west coast of North America (Black et al. 1997; Dahlheim et al. 1997; Ford and Ellis, 1999; Towers et al. 2019). These have their own nomenclature and include some of the animals documented in our catalog. The most geographically relevant for our study area is that of Black et al. (1997), for which animal identifications include the prefix "CA" (encountered in California). Introducing a new naming system for the same region is not ideal, but was necessary for our catalog given that the CA identification numbers continue to be updated by Black and colleagues, but are not publicly available. Our naming system also conveys matrilineal information and encompasses animals expected to be encountered throughout a broader geographic area (California + Oregon), even if most photos in our dataset come from California at this time. All OCT individuals matched to other catalogs are cross-referenced in Appendix I. For example, OCT002 is known as T132 in British Columbia, AO10 in Southeastern Alaska, and CA20 in California.

Several females identified in Black et al. (1997) were associated with a calf. For cataloging, we treated these as the mothers' first calves (i.e., first observed calves), and therefore gave subsequent calves born to these individuals alphanumeric designations starting at "B". Most matrilines have been compiled solely based on our own data and other published catalogs. However, a small number of the associations we document are based in part on common knowledge that has accrued among the whale-watch community for decades, shared via word of mouth, on social media, or through public education and outreach efforts by dedicated individuals in the community (i.e. OCT013B/CA171B, OCT016s/CA50s, OCT030s/CA140s, and OCT044s/CA51s). Newly identified whales encountered in waters off California or Oregon who could be linked to other known transient individuals, but who were not encountered in Monterey Bay, were given an OCT500 or higher designation, as it is unclear which assemblage or population these whales belong to. On multiple occasions, killer whales of an unknown ecotype were observed feeding on marine mammals far offshore of the study area. Many of these whales exhibited black dots and circular scars on their saddle patches, likely the result of healed bite marks produced by cookiecutter sharks (*Isistius sp.*) (Jones, 1971). These whales could not be linked through association to known transients and may represent an undescribed oceanic mammal-eating population or could be part of the outer coast transient assemblage that have yet to be linked through association. These killer whales are not included in the results or in the main catalog, but identification photographs are provided in Appendix VI and they are assigned an alphanumeric identifier prefixed by "OCX" for "unidentified" outer coast killer whale.

On rare occasion, whales who are part of the coastal assemblage and have predominately been photo-identified in the coastal waters of the Pacific Northwest were encountered in the study area. These whales have been extensively studied and were not included in the results or the main catalog. Identification photographs for these animals are in Appendix VII with their representative "T" designations (Ford and Ellis, 1999; Towers et al. 2019).

Determining Sex, Age, and Death

Determining the sex, age, and death of transient killer whales can be difficult, especially in poorly studied regions. However, a subset of whales we identified were also identified in previous catalogs (e.g. Black et al. 1997; Dahlheim et al. 1997; Ford and Ellis, 1999). These catalogs were helpful for estimating ages and determining sex because some animals already had an estimated year of birth and were depicted at an earlier stage of development. Killer whales exhibit strong sexual dimorphism. We therefore used the sexual dimorphic characteristics of mature killer whales to determine the sex of adult whales. The dorsal fin of male killer whales develops rapidly during the onset of puberty around the age 13 to 15 years –reaching a height of approximately 2 meters at maturity (20 years). In contrast, females present dorsal fins reaching up to 0.9 m at maturity. Whales traveling consistently in close association with a calf were determined to be females. Whales were also classified as female if their estimated age was greater than 15 years and they had not started to develop the characteristic male dorsal fin. Sub-adults and juveniles were difficult to sex, as they do not share the same sexual dimorphic characteristics as adults. However, on rare occasions sex was determined by viewing the posterior ventral side around the genital area, which differs slightly in pigmentation between males and females. If sex could not be determined, it was categorized as unknown. Due to the fluid social structure of transient killer whales, and long periods of time between sightings, every whale identified in this catalog was given an age class based on known or estimated year of birth. When whales were first identified, they were assigned to one of four categories: adult males (≥15 years of age, or showing signs of maturity, i.e. onset of dorsal fin growth), adult females (≥15 years, or showing signs of maturity, i.e. close proximity with a calf), sub-adults (both sexes, 10-15 years of age), and juveniles and calves (both sexes, 0-9 years of age).

Determining the death of transient killer whales is difficult due to their fluid social structure, highly mobile nature, and long periods of time between sightings (up to 10 years or more). For this reason, individuals were declared deceased only if they were absent from multiple encounters with their known associates over long time scales of months to years. In addition, calves and young juveniles were classified as deceased if absent from their mother during multiple encounters. On rare occasions, the confirmation of death has been recorded for individual whales that have washed up on remote beaches along the California and Oregon coast, providing important insights into anthropogenic influences affecting killer whales in the region (Plye and Gilbert, 1996; Raverty et al. 2020; Marine Mammal Center, personal communication, 2015).

Results and Discussion

Data Summaries

Names (ID numbers), identification photographs, and sighting locations are contained in the following eight Appendices for 1) outer coast transient killer whales, 2) unknown individuals, and 3) infrequently seen transient killer whales that are commonly encountered further north in the coastal inland waterways of Washington, British Columbia, and Southeastern Alaska:

- **Appendix I – transient killer whales encountered off the outer coast of California and Oregon**. It includes the unique OCT identifier for each whale, sex (where known), cross-referenced identifications (ID numbers) from catalogs for Alaska, British Columbia, and California (where applicable), location(s) and year(s) sighted. Identification photographs for these whales are in Appendix VI.

- **Appendix II – unknown killer whales** documented in the study area that may be transient and could not be linked through association to other known transients, but were observed feeding on marine mammals or shared morphological characteristics with transient type whales. It includes the placeholder OCX identifier for each whale, sex (where known), and location(s) and year(s) sighted. Identification photographs for these whales are in Appendix VII.

- **Appendix III – transient killer whales commonly encountered further north** in the coastal inland waterways of Washington, British Columbia, and Southeastern Alaska, and are presumed to be part of the coastal assemblage but were documented in the study area. It includes the unique T identifier for each whale (published in Ford and Ellis, 1999; Towers et al. 2019), sex (where known), and location(s) and year(s) sighted. Identification photographs for these whales are in Appendix VIII.

- **Appendix IV – known or presumed matrilineal groups of outer coast transient killer whales** encountered in the study area and encounter locations of transient killer whales. It contains the name of the matriline, number of whales, and OCT identifications of members of the matriline.

- **Appendix V – map showing encounter locations of transient killer whales**, including both OCT and OCX killer whales, and also sightings from the more northern coastal assemblage. Encounters are displayed by data source: opportunistic marine mammal surveys, whale watch ecotours, and dedicated marine mammal line transect surveys conducted by NOAA SWFSC.

- **Appendix VI – identification photographs of outer coast transient killer whales** showing the left and right sides of each whale's dorsal fin, saddle patch, and postocular patches for all individuals, and assumed to be alive to date. Photos include the current OCT alphanumeric identifier, year photographed, and sex for each individual where known.

- **Appendix VII – identification photographs of all killer whales of unknown ecotype** showing the left and right sides of each whale's dorsal fin, saddle patch, and postocular patch for individuals identified in the study area that could not be confirmed as transient ecotype, but were observed feeding on marine mammals or shared morphological characteristics with transient type whales. Photos include the "OCX" alphanumeric identifier, year photographed, and sex for each individual where known.

- **Appendix VIII – identification photographs of transient killer whales commonly sighted further north** in the coastal inland waterways of Washington, British Columbia, and Southeastern Alaska that were encountered in the outer coast study area. Photographs show the left and right sides of each whale's dorsal fin, saddle patch, and postocular patch for all individuals. Photos include the "T" alphanumeric identifier, year photographed, sex, and year of birth (published in Ford and Ellis, 1999; Towers et al. 2019).

Re-sightings and Movements

Between 2006 and 2018, 155 unique transient killer whales were encountered in the study area, of which 150 were considered to be alive as of 2018 (Appendix I). These 150 include 34 adult males, 51 adult females, 24 sub-adults, and 41 juveniles. The identification photos of an additional five juveniles born in 2019 and 2020 have been added to the appendices. Through repeated observations of association patterns, a total of 30 matrilineal groups were identified (Appendix IV). New whales were identified each year throughout the course of the study (Figure 3), as a result of the birth of new calves and encounters with previously unidentified individuals. This suggests that the total number of transients that use the study area is likely greater than the 150 whales identified in this catalog. This is therefore a minimum count for the region, not a population estimate, due to high dispersal and long periods between re-sightings of individuals.

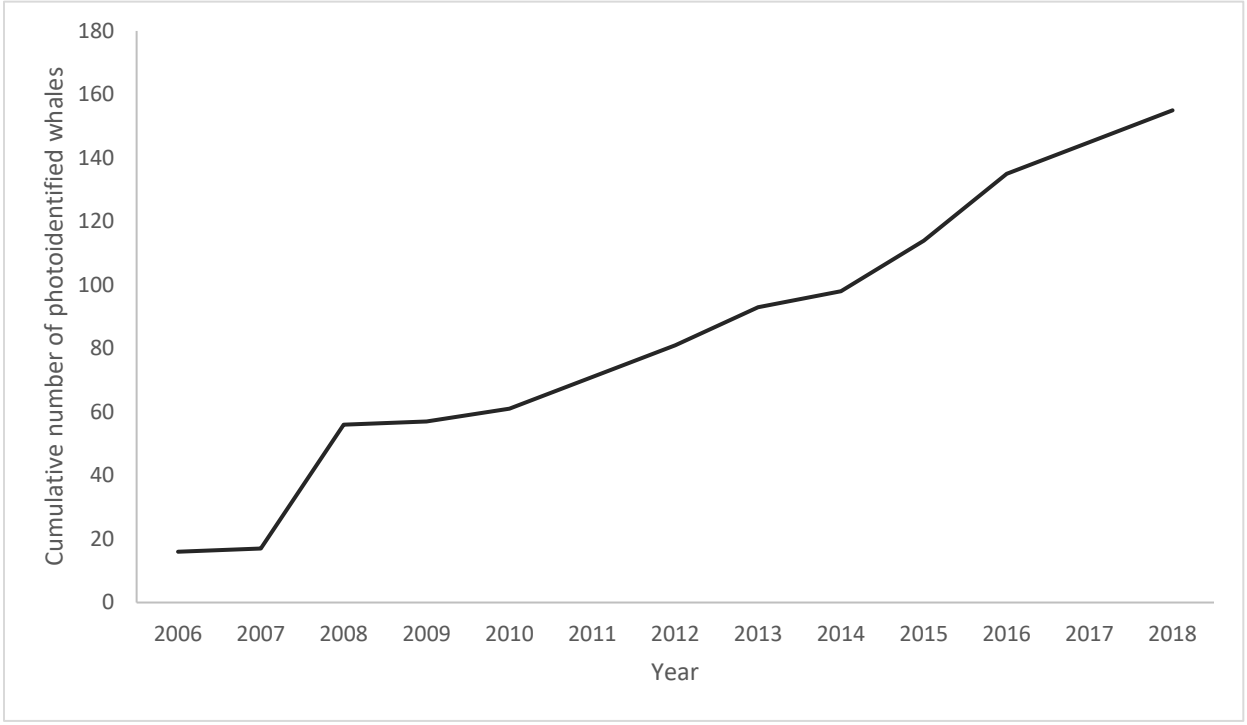

Figure 3: Cumulative number of transient killer whales photo-identified in the study region 2006-2018

Of the 150 whales included in the analysis, 141 were photographed in Monterey Bay, California. The number of years in which individual transient killer whales were re-sighted ranged from 1 to 10 years (Figure 4). More than half of the whales identified (59%) were re-identified in at least two separate years. Some individuals were encountered relatively frequently, with 41 individuals documented during at least five different years, while 63 individuals were documented in only one year. The most frequently documented individual was OCT044B, the second known calf of OCT044 (CA51 in Black et al. 1997) and a member of the OCT044 matriline (Appendix IV), which was predominantly encountered in Monterey Bay, California. OCT044B was photo-identified during 10 years in the study region.

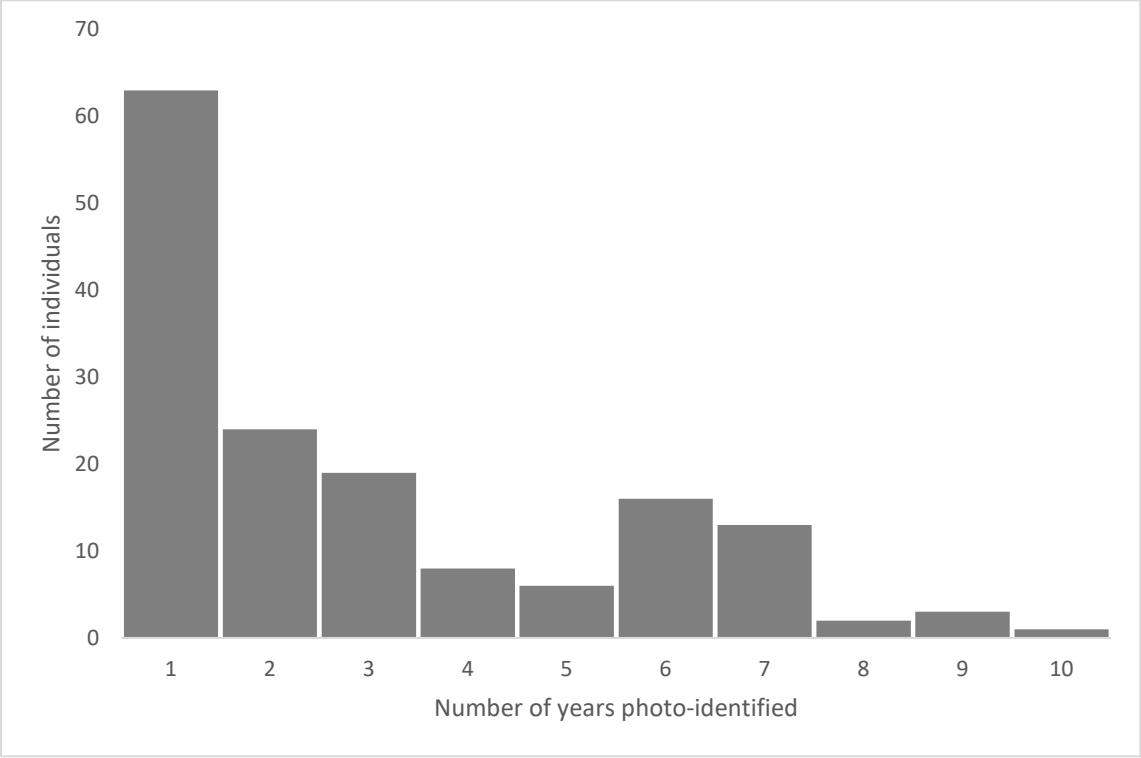

Figure 4: Total number of years individual transient killer whales were photo-identified off central and northern California and Oregon 2006-2018.

We compared the 150 whales in this catalog with preexisting identification catalogs and found 40 whales matched to the earlier catalog of killer whales from California (Black et al. 1997). Of these 40 whales, 6 were also matched to catalogs of transients from British Columbia waters (Ford and Ellis, 1999; Towers et al 2019), and of those 6, 3 were also matched to an Alaska catalog (Dahlheim et al 1997). Of the 40 whales matched to the Black et al. (1997) catalog, 39 were matched to known transients. The remaining individual, OCT001 (CA60) was initially matched to a whale of unknown ecotype that can now be confirmed as transient.

According to published catalog information, most (124 of 150) transient killer whales we identified have only been documented in the waters of California and Oregon. However, 26 of these whales have also been seen in the coastal waters of the Pacific Northwest. For example, OCT001 is a male that has been photographed in Monterey Bay, California, but has also been encountered off Vargas Island on the west coast of Vancouver Island, Race Rock, BC, Swiftsure Bank, BC and Haida Gwaii, BC. When encountered off Race Rocks, BC in 2009, OCT001 was associating with a large aggregation of transient killer whales from the coastal assemblage (J. McInnes unpublished data). OCT003, OCT004, and OCT005, have been documented on numerous occasions in Monterey Bay, but have also been sighted as far north as Campbell River, BC. OCT070, an adult male has been photographed multiple times off central California, but has also been identified off Cape Flattery and Port Angeles, Washington. Three individuals (OCT002, OCT028, and OCT064) have been sighted as far north as Southeastern Alaska (Goley and Straley, 1994; Black et al. 1997; Dahlheim et al. 1997).

The transient killer whales in this catalog were predominantly encountered in the open ocean, either off the outer coast near the continental shelf, or in deep pelagic waters overlying the Monterey Submarine Canyon. Consistent with the findings of Black et al. (1997), the majority of transient killer whales identified in the study area could not be matched to whales primarily encountered in coastal waters of Washington, British Columbia, and Southeastern Alaska, although a non-trivial number of matches between these areas were documented. While these two factors (habitat differences and low match rate) support the potential for the existence of putative outer coast transient killer whale assemblage, more research is needed to understand the overall spatial and temporal distribution patterns of these whales, and how their movements are influenced by prey populations. Additionally, further examination of the connection between transient killer whales inhabiting different regions along the coast and a further understanding of the social organization and behavioral interactions between individuals and matrilineal groups will strengthen understanding of the dynamics of the West Coast transient population. Finally, further acoustic and genetic studies will likely provide invaluable information into the variation and differentiation within and between populations and assemblages.

Our catalog of transient killer whales off the outer coast of central and northern California and Oregon provides an updated minimum count for this region. Continued photo-identification work on transient killer whales off the outer coast will lead to better understanding of the ecology and population demographics of the West Coast transient population.

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Appendix I

All individual transient killer whales photo-identified in our study off central and northern California and Oregon. Each whale was given an outer coast transient (OCT) unique alphanumeric identifier. In addition, all published equivalent names from the California (CA-ID) naming system and published names used for individuals identified in British Columbia (BC-ID) and Alaska (AK-ID) are included where known. For each whale, the sex (male=M, female=F, and unknown=UNK), location, and year identified are included. Data on locations and years sighted were collected in the study area through Marine Life Studies' opportunistic research surveys, whale watch ecotours, or National Oceanic and Atmospheric Administration Southwest Fisheries Science Center designated line transect surveys. Superscripts: a=Black et al. (1997); b=Transient Killer Whale Research Project unpublished data; c=Bigg's Killer Whales of Clayoquot Sound (2016); d=Dahlheim et al. (1997); e=NOAA SWFSC unpublished data; f=Ford and Ellis, (1999); and g= Towers et al. (2019).* indicates calves that were born in 2019 and 2020, which are included in the photo-identification appendix, but are not included in the analyses.

All individual killer whales photo-identified off northern and central California and Oregon.

Whale ID	Sex	CA-ID	BC-ID	AK-ID	Location (Year Sighted)
OCT001	M	CA60			Humbolt County, CA (1980[a]; 1992[a]) Monterey Bay, CA (1985[a]; 1992[a]; 2013) Haida Gwaii, BC (2009[b]); Race Rocks, BC (2009[b]); Swiftsure Bank (2009) Vargas Island, BC (2008[c])
OCT002	M	CA20	T132	AO10	Farallon Islands, CA (1988[a]; 1992a) Glacier Bay, AK (1989[a,d]) Kenny, CA (2015) Monterey Bay, CA (1987[a]; 1992[a]; 1993[a]; 1994[a]; 2003; 2008; 2014; 2015; 2016; 2017; 2018) Oak Bay, BC (2011[b])
OCT003	F	CA180			Campbell River, BC (2011[b]) Monterey Bay, CA (1997[a]; 2011; 2012; 2019)
OCT004	M	CA24			Campbell River, BC (2011[b]) Monterey Bay, CA (1990[a]; 1992[a]; 1993[a]; 1995[a]; 1997[a]; 2011; 2012) Santa Barbara, CA (1994[a]; 1996[a])
OCT005	M	N25			Campbell River, BC (2011[b]) Monterey Bay, CA (2011; 2012)
OCT008	F	CA26			Farallon Islands, CA (1992[a]) Monterey Bay, CA (1982[a]; 1991[a]; 1992[a]; 1996[a]; 1997[a]; 2003; 2018) Santa Barbara, CA (1994[a])
OCT009	F	CA45			Monterey Bay, CA (1992[a]; 1993[a]; 1994[a]; 1996[a]; 1997[a]; 2003; 2012; 2016)
OCT009C	UNK				Monterey Bay, CA (2016)
OCT010	F	CA46			Monterey Bay, CA (1992[a]; 1993[a]; 1994[a]; 1996[a]; 1997[a]; 2003; 2012)
OCT010C	UNK				Monterey Bay, CA (2012)
OCT012	M	CA43			Monterey Bay, CA (1990[a]; 1992[a]; 1993[a]; 1994[a]; 1996[a]; 1997[a]; 2003; 2006; 2008) Santa Barbara, CA (1994[a]; 1996[a]) Tofino, BC (2003[c])
OCT013B[*]	M				Monterey Bay, CA (2006; 2008; 2011; 2013; 2014; 2015; 2016; 2017; 2018) Race Rocks, BC (2017[b])

[*] This whale is widely known in the Monterey Bay area as CA171B (per N. Black). He is the second calf of whale CA171. The first calf died prior to 2006, this fact is also widely known, hence the 'B' designation. CA171 is also known to be deceased prior to 2006.

Whale ID	Sex	CA-ID	BC-ID	AK-ID	Location (Year Sighted)
OCT014	F	CA40			East Sooke Park, BC (2016[b]) Monterey Bay, CA (1991[a]; 1992[a]; 1995[a]; 1997[a]; 2003; 2008; 2011; 2014; 2016; 2017) Salmon Bank, WA (2018[b])
OCT015	M	CA137			East Sooke Park, BC (2016[b]) Monterey Bay, CA (1995[a]; 1996[a]; 1997[a]; 2003; 2008; 2011; 2014; 2016; 2017) San Josef Bay, BC (2015[e]) Salmon Bank, WA (2018[b])
OCT016	F	CA50			Kenny, CA (2015) Monterey Bay, CA (1991[a]; 1992[a]; 1993[a]; 1994[a]; 1995[a]; 1996[a]; 1997[a]; 2003; 2009; 2013; 2014) San Jose, CA 40 km offshore (2014)
OCT016B	M				Kenny, CA (2015) Monterey Bay, CA (2008; 2009; 2013; 2014; 2017; 2018) San Jose, CA 40 km offshore (2015)
OCT017	F	CA111			Monterey Bay, CA (1990[a]; 1994[a]; 1996[a]; 1997[a]; 2003; 2006)
OCT018	M	CA28	T160		Half Moon Bay, CA (1994[a]) Monterey Bay, CA (1992[a]; 1993[a]; 2008; 2011; 2014) Tofino, BC (1995[a,c,f])
OCT019	F	CA39			Monterey Bay, CA (1991[a]; 1992[a]; 1994[a]; 1995[a]; 1996[a]; 1997[a]; 2010; 2012; 2014; 2017; 2018) Santa Barbara, CA (1994[a]) San Josef Bay, BC (2015[e])
OCT019C	UNK				Monterey Bay, CA (2014)
OCT020	UNK				Monterey Bay, CA (2012; 2014; 2017)
OCT025	M				Monterey Bay, CA (2008; 2009; 2012; 2013; 2015) Newport, OR 10 km offshore (2014)
OCT027	M	CA165			Farallon Islands, CA (2017) Monterey Bay, CA (1997[a]; 2017)
OCT028	F	CA54	T134	AO12	Farallon Islands, CA (1988[a]) Glacier Bay, AK (1989[a,d]) Monterey Bay, CA (1987[a]; 1992[a]; 1993[a]; 1994[a]; 2008; 2014; 2016; 2017; 2018) Oak Bay, BC (2011[b])
OCT029	F	CA177			Monterey Bay, CA (1997[a]; 2008; 2014; 2016; 2017)
OCT030	F	CA140			East Sooke Park, BC (2016[b]) Monterey Bay, CA (1995[a]; 1996[a]; 1997[a]; 2008; 2014; 2015; 2016; 2017; 2018)

Whale ID	Sex	CA-ID	BC-ID	AK-ID	Location (Year Sighted)
OCT030B	F				East Sooke Park, BC (2016[b]) Monterey Bay, CA (2008; 2011; 2014; 2015; 2016; 2017; 2018)
OCT030B1	UNK				East Sooke Park, BC (2016[b]) Monterey Bay, CA (2014; 2015; 2016; 2017; 2018)
OCT030B2	UNK				Monterey Bay, CA (2017; 2018; 2018)
OCT030B3	UNK				Monterey Bay, CA (2020*)
OCT030C	M				East Sooke Park, BC (2016[b]) Monterey Bay, CA (2008; 2014; 2015; 2016; 2017; 2018)
OCT030D	UNK				Monterey Bay, CA (2016; 2017; 2018)
OCT030E	UNK				Monterey Bay, CA (2020*)
OCT031	F	CA49			Monterey Bay, CA (1992[a]; 1993[a]; 1994[a]; 1995[a]; 1996[a]; 2003; 2008; 2011)
OCT031B	M				Monterey Bay, CA (2003; 2008; 2011; 2013; 2014; 2015; 2016; 2017)
OCT031C	F				Monterey Bay, CA (2014; 2015; 2017; 2018) San Jose, CA 40 km offshore (2014)
OCT031C1	UNK				Monterey Bay, CA (2019*)
OCT032	F				Monterey Bay, CA (2006; 2011; 2018)
OCT033	M				Monterey Bay, CA (2006; 2011; 2018)
OCT034	M				Monterey Bay, CA (2013; 2018)
OCT035	F	CA38	T161		Farallon Islands, CA (1988[a]) Half Moon Bay, CA (1994[a]) Monterey Bay, CA (1982[a]; 1992[a]; 1993[a]; 1994[a]; 2008; 2011; 2016; 2018) Tofino, BC (1995[a,c,f])
OCT036	F				Monterey Bay, CA (2011; 2018)
OCT036A	UNK				Monterey Bay, CA (2011)
OCT037	F				Monterey Bay, CA (2013; 2014; 2016)
OCT037A	UNK				Monterey Bay, CA (2013)
OCT037B	UNK				Monterey Bay, CA (2013; 2014; 2016)
OCT037C	UNK				Monterey Bay, CA (2016)
OCT038	F				Monterey Bay, CA (2006; 2010; 2011; 2013; 2014; 2015; 2016; 2018)
OCT038B	UNK				Monterey Bay, CA (2015; 2016)
OCT039	UNK				Monterey Bay, CA (2006)
OCT040	F	CA169			Coos Bay, OR (1996[a]) Kenny, CA (2015) Monterey Bay, CA (1997[a]; 2003; 2016)

Whale ID	Sex	CA-ID	BC-ID	AK-ID	Location (Year Sighted)
OCT041	F				Monterey Bay, CA (2006; 2008; 2015; 2017) San Jose, CA 40 km offshore (2014)
OCT041A	M				Monterey Bay, CA (2008; 2015; 2017) San Jose, CA 40 km offshore (2014)
OCT041B	UNK				Monterey Bay, CA (2008)
OCT042	F	CA138			Monterey Bay, CA (1995[a]; 1996[a]; 2006; 2008; 2009; 2012; 2015; 2016; 2017)
OCT042A	M				Monterey Bay, CA (2008; 2009; 2012; 2015; 2016; 2017)
OCT042B	UNK				Monterey Bay, CA (2012; 2014; 2015; 2016; 2017)
OCT042C	UNK				Monterey Bay, CA (2015; 2016; 2017)
OCT043	F				Monterey Bay, CA (2010; 2012; 2014; 2015; 2016; 2017; 2018) San Jose, CA 40 km offshore (2014)
OCT043A	UNK				Monterey Bay, CA (2010; 2012; 2014; 2015; 2016; 2017; 2018) San Jose, CA 40 km offshore (2014)
OCT043C	UNK				San Jose, CA 40 km offshore (2014)
OCT044	F	CA51			Monterey Bay, CA (1991[a]; 1992[a]; 1993[a]; 1994[a]; 1995[a]; 1996[a]; 2006; 2008; 2012; 2014; 2015; 2016; 2017; 2018) San Diego, CA (2018[e])
OCT044A	F				Monterey Bay, CA (2006; 2008; 2011; 2012; 2014; 2017; 2018) San Jose, CA 40 km offshore (2014)
OCT044A2	UNK				Monterey Bay, CA (2011; 2012; 2015; 2016; 2018) San Jose, CA 40 km offshore (2014)
OCT044A3	UNK				Monterey Bay, CA (2012; 2014; 2017; 2018) San Jose, CA 40 km offshore (2014)
OCT044B	M				Monterey Bay, CA (2006; 2008; 2011; 2012; 2014; 2015; 2016; 2017; 2018) San Diego, CA (2018[e])
OCT044C	M				Monterey Bay, CA (2006; 2008; 2011; 2012; 2014; 2015; 2016; 2017; 2018) San Diego, CA (2018[e])
OCT044D	UNK				Monterey Bay, CA (2011; 2012; 2014; 2015; 2016; 2017; 2018) San Diego, CA (2018[e])
OCT045	M	CA10			Monterey Bay, CA (1984[a]; 1986[a]; 1987[a]; 1995[a]; 1996[a]; 2010; 2016; 2018)
OCT046	F	CA126			Cordell Banks, CA (1994[a]) Monterey Bay, CA (2016; 2017)
OCT046A	UNK				Monterey Bay, CA (2016)
OCT046B	UNK				Monterey Bay, CA (2016)

Whale ID	Sex	CA-ID	BC-ID	AK-ID	Location (Year Sighted)
OCT047	F	CA21			Kenny, CA (2015) Monterey Bay, CA (1987[a]; 1997[a]) North Channel Islands, CA (1989[a]) Tofino, BC (2003[c])
OCT048	F	CA170			Coos Bay, OR (1996[a]) Monterey Bay, CA (1997[a]; 2016; 2018) Tofino, BC (2003[c])
OCT049	UNK				Monterey Bay, CA (2011)
OCT050	F				Monterey Bay, CA (2008; 2009; 2012; 2015; 2016; 2018)
OCT050A	F				Monterey Bay, CA (2008; 2009; 2012; 2015; 2016; 2018)
OCT050B	F				Monterey Bay, CA (2008; 2009; 2012; 2015; 2016; 2018)
OCT050B1	UNK				Monterey Bay, CA (2014; 2015; 2016; 2018)
OCT050B2	UNK				Monterey Bay, CA (2020*)
OCT050C	F				Monterey Bay, CA (2008; 2009; 2012; 2015; 2016; 2018)
OCT050C1	UNK				Monterey Bay, CA (2019*)
OCT050D	UNK				Monterey Bay, CA (2008; 2015; 2016; 2018)
OCT050E	UNK				Monterey Bay, CA (2018)
OCT055	UNK				Monterey Bay, CA (2012)
OCT056	UNK				Monterey Bay, CA (2008; 2009)
OCT058	UNK				Monterey Bay, CA (2008; 2009)
OCT059	M				Monterey Bay, CA (2012; 2016)
OCT060	M	CA163			East Sooke Park, BC (2016[b]) Monterey Bay, CA (1997[a]; 2008; 2014; 2015; 2016; 2017; 2018) San Jose, CA 40 km offshore (2014)
OCT062	M				Monterey Bay, CA (2008)
OCT063	F				Monterey Bay, CA (2008; 2016)
OCT063A	UNK				Monterey Bay, CA (2016)
OCT064	F	CA27	T135	AO13	Farallon Islands, CA (1988[a]) Glacier Bay, AK (1989[a,d]) Kenny, CA (2015) Monterey Bay, CA (1992[a]; 1993[a]; 1994[a]; 2003; 2008; 2010; 2014; 2015; 2016; 2017) Olympic Peninsula, WA (1995[a])
OCT064A	F				Kenny, CA (2015) Monterey Bay, CA (2010; 2014; 2015; 2016; 2017; 2018)

Whale ID	Sex	CA-ID	BC-ID	AK-ID	Location (Year Sighted)
OCT064B	F				Kenny, CA (2015) Monterey Bay, CA (2010; 2014; 2015; 2016; 2017; 2018)
OCT064B1	UNK				Kenny, CA (2015) Monterey Bay, CA (2010; 2014; 2015; 2016; 2017; 2018)
OCT064C	M				Kenny, CA (2015) Monterey Bay, CA (2010; 2014; 2015; 2016; 2017; 2018)
OCT064D	UNK				Kenny, CA (2015) Monterey Bay, CA (2010; 2014; 2015; 2016; 2017; 2018)
OCT064E	UNK				Kenny, CA (2015) Monterey Bay, CA (2010; 2014; 2015; 2016; 2017; 2018)
OCT070	M	CA79			Cape Flattery, WA (1994[a]) Monterey Bay, CA (1993[a]; 1995[a]; 2008) Port Angeles, WA (2016[b]) Westport, CA 15 km offshore (2008)
OCT071	F				Monterey Bay, CA (2008) Westport, CA 15 km offshore (2008)
OCT072	F				Monterey Bay, CA (2008) Westport, CA 15 km offshore (2008)
OCT072A	UNK				Monterey Bay, CA (2008)
OCT073	F				Monterey Bay, CA (2013; 2016; 2017)
OCT074	UNK				Monterey Bay, CA (2013)
OCT075	F				Monterey Bay, CA (2013; 2018)
OCT075B	UNK				Monterey Bay, CA (2018)
OCT076	UNK				Monterey Bay, CA (2013; 2018)
OCT077	F	CA23			Cordell Banks, CA (1986[a]) Half Moon Bay, CA (1994[a]) Monterey Bay, CA (1987[a]; 1989[a]; 1992[a]; 1993[a]; 1996[a]; 2013; 2016; 2018)
OCT077A	UNK				Monterey Bay, CA (2013)
OCT077B	UNK				Monterey Bay, CA (2013)
OCT078	F				Monterey Bay, CA (2013; 2016; 2018)
OCT078A	UNK				Monterey Bay, CA (2016)
OCT079	UNK				Monterey Bay, CA (2013)
OCT080	F	CA155			Farallon Islands, CA (1994[a]) Monterey Bay, CA (1983[a]; 2016; 2017)

Whale ID	Sex	CA-ID	BC-ID	AK-ID	Location (Year Sighted)
OCT081	F				Monterey Bay, CA (2013; 2015; 2016; 2018)
OCT081A	UNK				Monterey Bay, CA (2015; 2017)
OCT082	M				Monterey Bay, CA (2013; 2015; 2018)
OCT083	UNK				Monterey Bay, CA (2013; 2015; 2017)
OCT084	M				Monterey Bay, CA (2012)
OCT085	F	CA58			Monterey Bay, CA (1993[a]; 2016; 2017)
OCT086	M				Monterey Bay, CA (2016; 2017; 2018)
OCT087	F	CA133			Monterey Bay, CA (1996[a]; 1997[a]; 2016)
OCT088	F				Monterey Bay, CA (2016)
OCT088A	UNK				Monterey Bay, CA (2016)
OCT089	UNK				Monterey Bay, CA (2016)
OCT089A	UNK				Monterey Bay, CA (2016)
OCT090	M				Coos Bay, OR 32 km offshore (2015) Kenny, CA (2015) Monterey Bay, CA (2017) Newport, OR ~140 km offshore (2008)
OCT091	UNK				Monterey Bay, CA (2017)
OCT092	F	CA36			Half Moon Bay, CA (1994[a]) Monterey Bay, CA (1992[a]; 1993[a]; 1994[a]; 2018)
OCT093	UNK				Monterey Bay, CA (2018)
OCT094	M				Monterey Bay, CA (2015)
OCT095	M				Monterey Bay, CA (2015)
OCT096	UNK				Monterey Bay, CA (2015)
OCT097	F	CA131			Monterey Bay, CA (1996[a]; 1997[a]; 2015)
OCT098	F	CA132			Monterey Bay, CA (1996[a]; 1997[a]; 2015)
OCT099	UNK				Monterey Bay, CA (2015)
OCT100	UNK				Monterey Bay, CA (2015)
OCT101	UNK				Monterey Bay, CA (2015)
OCT102	UNK				Monterey Bay, CA (2015)
OCT103	F				Monterey Bay, CA (2015)
OCT103A	UNK				Monterey Bay, CA (2015)
OCT104	M				Eastern Juan de Fuca Strait (2018[b]) Monterey Bay, CA (2018)

Whale ID	Sex	CA-ID	BC-ID	AK-ID	Location (Year Sighted)
OCT105	M				Eastern Juan de Fuca Strait (2018[b]) Monterey Bay, CA (2018)
OCT106	F				Eastern Juan de Fuca Strait (2018[b]) Monterey Bay, CA (2018)
OCT107	F				Eastern Juan de Fuca Strait (2018[b]) Monterey Bay, CA (2018)
OCT500	M				Kenny, CA (2015)
OCT501	M				Kenny, CA (2015)
OCT502	M				Kenny, CA (2015)
OCT503	M				Farallon Islands, CA (2017)
OCT506	F				~140 km offshore Newport, OR (2008)
OCT507	F				~140 km offshore Newport, OR (2008)
OCT508	UNK				~140 km offshore Newport, OR (2008)
OCT509	UNK				~140 km offshore Newport, OR (2008)
OCT510	UNK				~140 km offshore Newport, OR (2008)

Appendix II

All killer whales of unknown ecotype encountered in our study off central and northern California and Oregon. These whales could not be linked through association to known transient type whales but were observed feeding on marine mammals or shared specific morphological attributes observed in transient killer whales (i.e. pointed dorsal fin and closed, uniformly gray saddle patch). Data on locations and years sighted were collected in the study area by whale watch ecotours and National Oceanic and Atmospheric Administration Southwest Fisheries Science Center designated line transect surveys. Each whale was given a unique outer coast alphanumeric (OCX) identifier, for unidentified killer whale. If these whales are eventually encountered with known transient killer whales, they will be assigned an OCT designation. For each whale, the sex (male=M, female=F, and unknown=UNK), location(s), and year(s) identified are included.

Whale ID	Sex	Location (Year Sighted)
OCX010	F	~360 km offshore Monterey, CA (2014)
OCT011	M	~360 km offshore Monterey, CA (2014)
OCX012	M	~360 km offshore Monterey, CA (2014)
OCX013	M	~360 km offshore Monterey, CA (2014)
OCX014	F	~300 km offshore Newport, OR (2015)
OCX015	UNK	~300 km offshore Newport, OR (2015)
OCX016	UNK	~300 km offshore Newport, OR (2015)
OCX017	UNK	~300 km offshore Newport, OR (2015)
OCX018	UNK	~300 km offshore Newport, OR (2015)
OCX019	M	~300 km offshore Newport, OR (2015)
OCX020	M	~300 km offshore Newport, OR (2015)
OCX021	UNK	~300 km offshore Newport, OR (2015)
OCX022	UNK	~300 km offshore Newport, OR (2015)
OCX023	M	~60 km offshore Ophir, OR (2018)
OCX024	UNK	~60 km offshore Ophir, OR (2018)
OCX025	M	~60 km offshore Ophir, OR (2018)
OCX026	UNK	~60 km offshore Ophir, OR (2018)
OCX027	UNK	~60 km offshore Ophir, OR (2018)
OCX028	UNK	~60 km offshore Ophir, OR (2018)
OCX029	UNK	~60 km offshore Ophir, OR (2018)
OCX030	UNK	~60 km offshore Ophir, OR (2018)
OCX031	UNK	Monterey Bay, CA (2015)
OCX032	M	Monterey Bay, CA (2015)
OCX033	UNK	Monterey Bay, CA (2015)
OCX034	UNK	Monterey Bay, CA (2015)
OCX035	UNK	Monterey Bay, CA (2015)

Appendix III

All individual transient killer whales encountered during this study off central and northern California and Oregon that are more commonly encountered in the coastal inland waterways of Washington, British Columbia, and Southeastern Alaska. Data on locations and years sighted were collected in the study area through Marine Life Studies' opportunistic research surveys and whale watch ecotours. Each whale's alphanumeric "T" designation as published in Ford and Ellis, 1999 and Towers et al. 2019 are included, as well as location(s) and year(s) sighted within the study area.

Whale ID	Sex	Location (Year Sighted)
T010	F	Kenny, CA (2015)
T010C	M	Kenny, CA (2015)
T036	F	Kenny, CA (2015)
T036A	F	Kenny, CA (2015)
T036A1	F	Kenny, CA (2015)
T036A2	UNK	Kenny, CA (2015)
T036A3	UNK	Kenny, CA (2015)
T036B	F	Kenny, CA (2015)
T036B1	UNK	Kenny, CA (2015)
T036B2	UNK	Kenny, CA (2015)
T099	F	Kenny, CA (2015)
T099B	UNK	Kenny, CA (2015)
T099C	UNK	Kenny, CA (2015)
T124A1	F	Kenny, CA (2015)
T124D	F	Kenny, CA (2015)
T124D1	UNK	Kenny, CA (2015)
T124E	M	Kenny, CA (2015)
T137	F	Mendocino, CA
T137A	M	Mendocino, CA
T137B	UNK	Mendocino, CA
T137D	UNK	Mendocino, CA

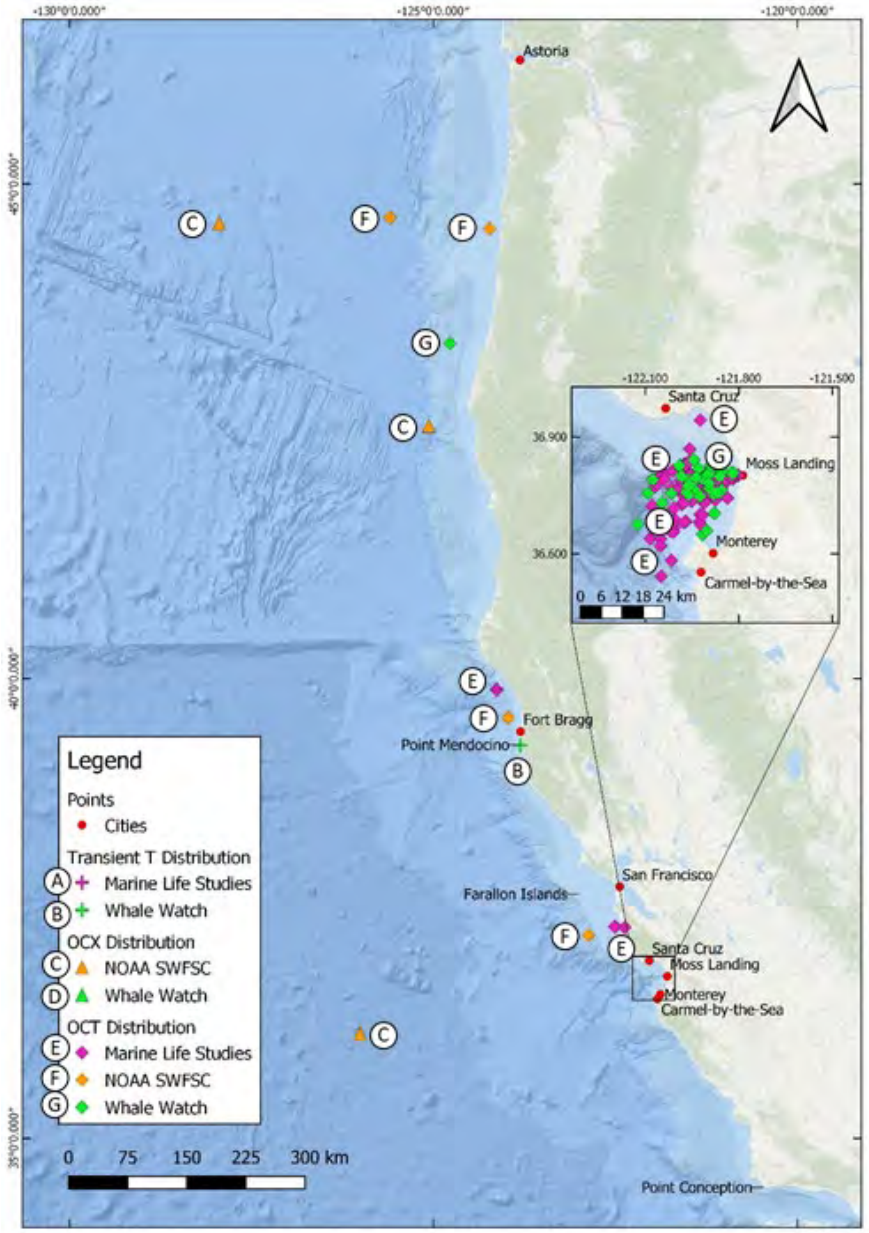
Appendix IV

All known transient killer whale matrilineal groups identified off central and northern California and Oregon based on repeated observations of association. The table includes the matriline's name, group size, and each whale's unique outer coast transient (OCT) alphanumeric identifier within that matriline.

Matriline	Size	Members
OCT003s	3	OCT003, OCT004, OCT005
OCT009s	3	OCT009, OCT059, OCT009C
OCT010s	2	OCT010, OCT010C
OCT016s	2	OCT016, OCT016B
OCT019s	3	OCT019, OCT020, 0CT019C
OCT028s	2	OCT028, OCT002
OCT014s	2	OCT014, OCT015
OCT030s	8	OCT030, OCT030B, OCT030B1, OCT030B2, OCT030B3, OCT030C, OCT030D, OCT060
OCT031s	4	OCT031, OCT031B, OCT031C, OCT031C1
OCT036s	2	OCT036, OCT036A
OCT037s	4	OCT037, OCT037A, OCT037B, OCT037C
OCT038s	2	OCT038, OCT038B
OCT041s	3	OCT041, OCT041A, OCT041B
OCT042s	4	OCT042, OCT042A, OCT042B, OCT042C
OCT043s	2	OCT043, OCT043A, OCT043C
OCT044s	4	OCT044B, OCT044C, OCT044D
OCT044As	3	OCT044A, OCT044A2, OCT044A3
OCT046s	3	OCT046, OCT046A, OCT046B
OCT050s	9	OCT050, OCT050A, OCT050B, OCT050B1, OCT050B2, OCT050C, OCT050C1, OCT050D, OCT050E
OCT063s	2	OCT063, OCT063A
OCT064s	7	OCT064, OCT064A, OCT064B, OCT064B1, OCT064C, OCT064D, OCT064E
OCT072s	2	OCT072, OCT072A
OCT075s	2	OCT075, OCT075B
OCT077s	3	OCT077, OCT077A, OCT077B
OCT078s	2	OCT078, OCT078A
OCT081s	2	OCT081, OCT081A, OCT082, OCT083
OCT085s	2	OCT085, OCT086
OCT088s	2	OCT088, OCT088A
OCT089s	2	OCT089, OCT089A
OCT103s	2	OCT103, OCT103A

Appendix V

Distribution map of killer whale encounters off central and northern California and Oregon 2006-2018. Included are the locations of outer coast transients (diamonds), coastal transients (crosses), and killer whales of unknown ecotype (triangles) that shared transient characteristics or were observed feeding on marine mammals. Data are displayed by the three primary sources: opportunistic marine mammal surveys by Marine Life Studies (purple), whale watch ecotours (green), and dedicated line transect surveys by NOAA SWFSC (orange). Map created by Josh Tawse, Transient Killer Whale Research Project using QGIS*, Version 3.12.0 ('Burcuresti').*


-130°0'0.000"
-125°0'0.000"
-120°0'0.000"
45°0'0.000"
40°0'0.000"
35°0'0.000"
Astoria
Fort Bragg
Point Mendocino
San Francisco
Farallon Islands
Santa Cruz
Moss Landing
Monterey
Carmel-by-the-Sea
Point Conception
-122.100
-121.800
-121.500
36.900
36.600
0 6 12 18 24 km
Legend
Points
Cities
Transient T Distribution
A Marine Life Studies
B Whale Watch
OCX Distribution
C NOAA SWFSC
D Whale Watch
OCT Distribution
E Marine Life Studies
F NOAA SWFSC
G Whale Watch
0 75 150 225 300 km

Appendix VI

Photo-identification catalog of all "outer coast" assemblage of transient killer whales encountered off central and northern California and Oregon. These whales could be linked through association based on the criteria in this report. Photographs of the left and right side of the dorsal fin and saddle patch and left and right postocular patch are presented where available. In addition, each whale's unique outer coast transient (OCT) alphanumeric identifier, sex (where known) and age class is included (* indicates calves that were born in 2019 and 2020, which are included in this photo-identification appendix, but are not included in the analyses). Photographs were selected based on photo quality and the display of distinct characteristics present on the dorsal fin and saddle patch. This occasionally involved using photographs collected outside the scope of this study. The sighting histories for these whales are given in Appendix I.

OCT001

Adult male

2009

2008

OCT002

Adult male

2016

2017

Download full report with all high-resolution photos (103 MB) here:
https://swfsc-publications.fisheries.noaa.gov/publications/CR/2021/2021McInnes.pdf