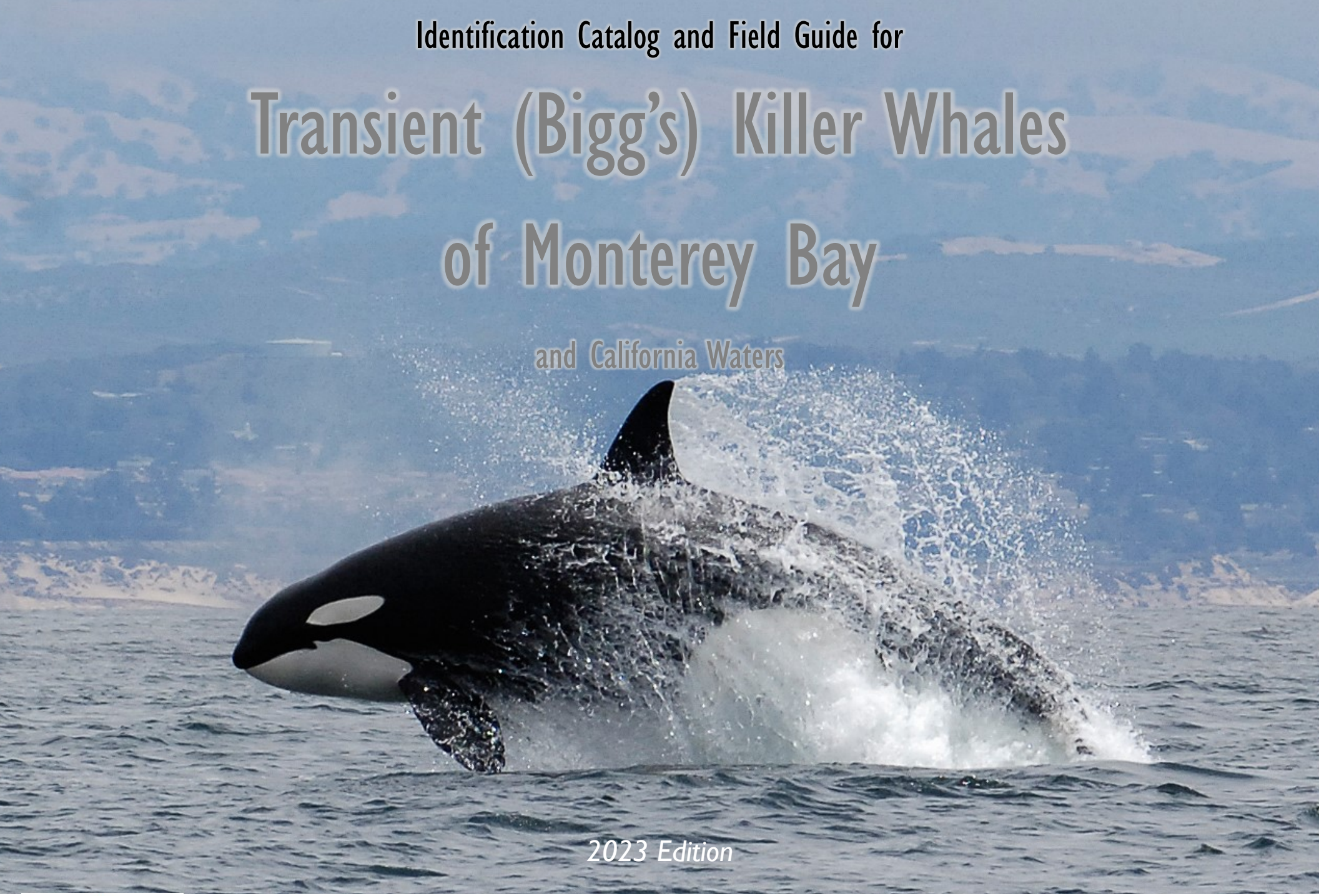
Identification Catalog and Field Guide for

Transient (Bigg's) Killer Whales of Monterey Bay

and California Waters



2023 Edition

Josh D. McInnes, Chelsea R. Mathieson, Peggy J. West-Stap, Stephanie L. Marcos,
Victoria L. Wade, Jeffrey E. Moore, Sarah L. Mesnick, and Lawrence M. Dill

NOAA FISHERIES

Cover: transient killer whale in Monterey Bay, CA—photograph by Peggy West-Stap 2013 | NOAA NMFS permit 15621

Unless otherwise specified, all data and photographs for this publication were collected under the following NOAA National Marine Fisheries Service permits (Principal Investigator: Peggy West-Stap):

1094-1836	April 30, 2006	to	June 2, 2011
15621	June 3, 2011	to	December 31, 2016
20519	January 1, 2017	to	December 31, 2021

Usage of photographs taken under MMPA Permit no. 782-1510 (Principal Investigator: Marilyn Dahlheim) approved by the Marine Mammal Laboratory

Marine Life Studies
Est. 2006
P. O. Box 163
Moss Landing, CA 95039
www.marinelifestudies.org
killerwhales@marinelifestudies.org
Registered 501(c)(3) non-profit organization
EIN #27-0318674

Transient Killer Whale Research Project
Est. 2011
Victoria, BC
V8V 3A1
transientproject@gmail.com

Suggested citation: McInnes, J.D., Mathieson, C.R., West-Stap, P.J., Marcos, S.L., Wade, V.L., Jeffrey E. Moore, Sarah L. Mesnick, and Lawrence M. Dill (2023). Identification catalog and field guide for transient (Bigg's) killer whales of Monterey Bay and California waters. NOAA Southwest Fisheries Science Center.

Identification Catalog and Field Guide for

Transient (Bigg's) Killer Whales of Monterey Bay

and California Waters

By

Josh D. McInnes[1, 2,3]

corresponding author j.mcinnes@oceans.ubc.ca

Chelsea R. Mathieson[3,4]

Peggy J. West-Stap[5]

Stephanie L. Marcos[5]

Victoria L. Wade[5]

Jeffrey E. Moore[6]

Sarah L. Mesnick[6]

Lawrence M. Dill[2,3]

Illustrations by Selena S. Rivera[1] Cartography by Josh Tawse[1]

[1]Marine Mammal Research Unit, Institute for the Oceans and Fisheries, University of British Columbia, Vancouver, BC V6T 1Z4

[2]Pacific Wildlife Foundation, Port Moody, British Columbia, Canada V3H 1V6

[3]Transient Killer Whale Research Project, Victoria, BC V8V 3A1

[4]Resource and Environmental Planning Program, School of Resource and Environmental Management, Simon Fraser University, Burnaby, BC V5A 1S6

[5]Marine Life Studies, Moss Landing, CA 95039

[6]Southwest Fisheries Science Center, National Oceanic and Atmospheric Administration, La Jolla, California, USA

NOAA FISHERIES

Dedicated to the community of Monterey Bay, whose continuous support made this publication possible.

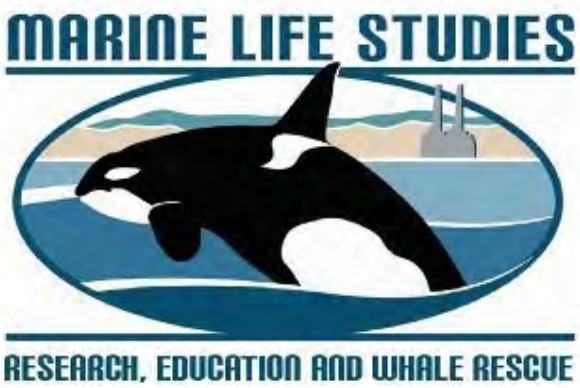
May you never stop loving and learning about killer whales!

Transient killer whales in Monterey Bay, CA—photograph by Stephanie Marcos 2016 | NOAA NMFS permit 15621

"I believe the future of killer whale research will likely continue in much the same way for some time to come. That is, individual initiative and imagination to recognize the research opportunity and then the commitment to check it out. That will always remain the driving force."

- Dr. Michael A. Bigg

Published with the support of:



SJSU SAN JOSÉ STATE UNIVERSITY

DISCOVERY
WHALE WATCH

OCEAN
SANCTUARIES

FURUNO
Marine Electronics

FLUKE

Table Of Contents

Killer whales surfacing on glassy waters in Monterey Bay, CA—photograph by Peggy West-Stap 2008 | NOAA NMFS permit 1094-1836

Preface

There is nothing quite like staring out at the open Pacific and seeing a group of killer whales (*Orcinus orca*). Whether from a local whale watch tour out of Monterey Bay or from the cliff tops overlooking the open ocean off Point Lobos, killer whales are keenly sought by naturalists and visitors alike. The Monterey Bay National Marine Sanctuary and surrounding waters of the California Current ecosystem are home to three ecotypes, or forms, of killer whale. One may encounter endangered southern residents following seasonally abundant Chinook salmon, glimpse a group of rarely sighted offshores hunting deep-water sharks, or witness the dramatic hunt of a group of transient killer whales trying to separate a gray whale calf from its mother!

Transient (Bigg's) killer whales are marine mammal-hunting specialists, and by far the most commonly encountered ecotype of killer whale in Monterey Bay. However, current information regarding their ecology in waters south of the Pacific Northwest is scattered and varied. Most of it can only be found in unpublished reports or conference abstracts. This publication, in conjunction with our recently published technical memorandum, *Transient Killer Whales of Central and Northern California and Oregon: a Catalog of Photo-identified Individuals*, provides the first widely available publication for transient killer whales in California waters since the production of a NOAA technical memorandum published in 1997. This guide focuses specifically on transient killer whales identified in the Monterey Bay National Marine Sanctuary (MBNMS). For a comprehensive catalog of transient killer whales that use the waters of the outer coast of California and Oregon, see our recently published technical memorandum.

From May 2006 to April 2020 Marine Life Studies and the Transient Killer Whale Research Project have collected data and photographs of killer whales in Monterey Bay and the surrounding waters of California. Here we provide information on our research findings, natural history, and a compilation of 134 different individual transient killer whales photographed during our surveys.

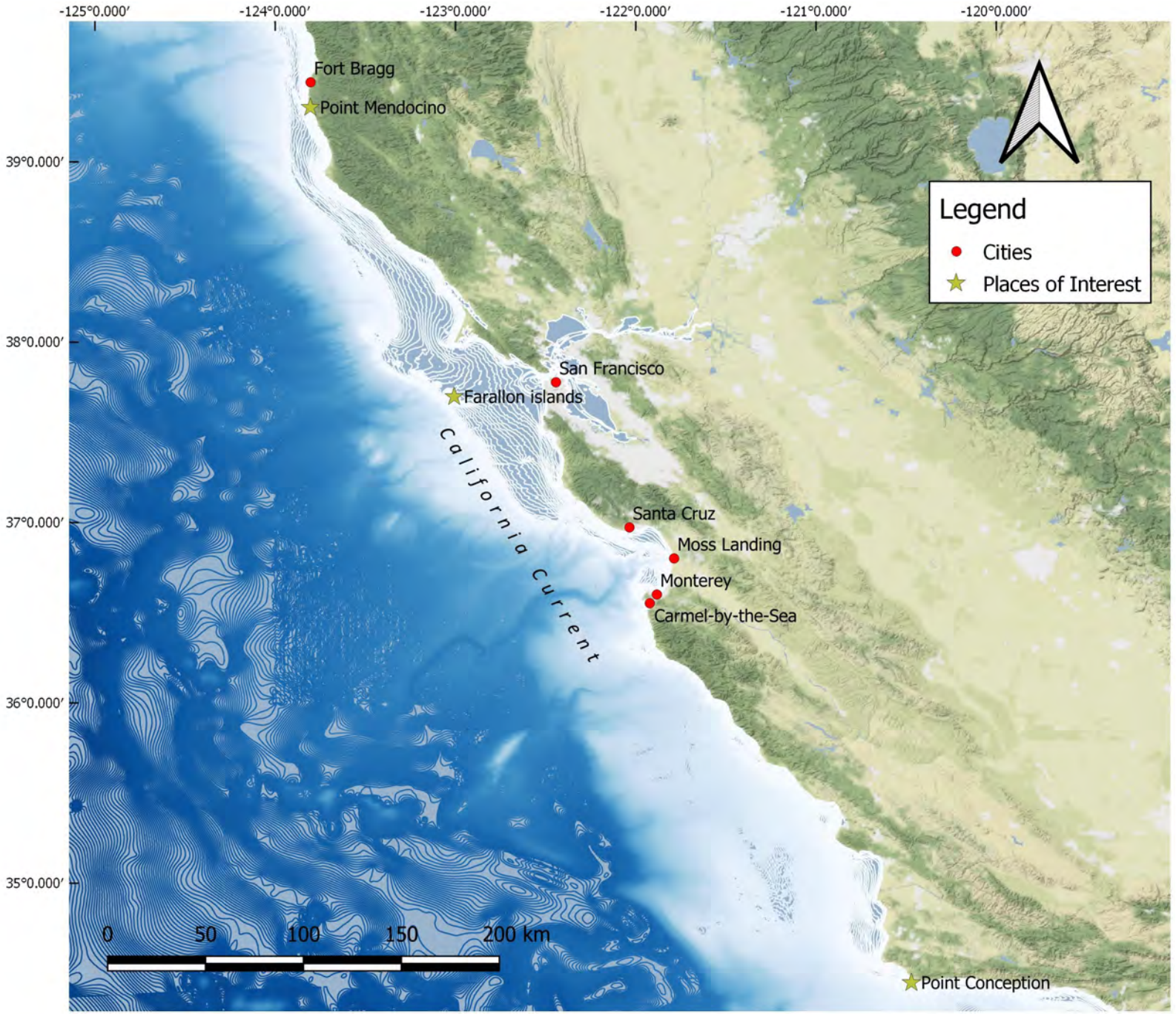
Acknowledgements

This publication would not have been possible without the support of numerous contributors and advisors. We are especially thankful to Dr. Marilyn Dahlheim NOAA (AFSC, retired) who reviewed this manuscript and provided suggested edits to further improve it. Additionally, we are deeply grateful to Dr. Andrew Trites at the Marine Mammal Research Unit, University of British Columbia , for providing logistical support and suggestions and edits for this publication. We are also eternally grateful to Annette Henry (NOAA, SWFSC), Kit Johnston (NOAA, SWFSC) Alix Smith (NOAA) for providing logistical support. Additionally, we want to thank the following individuals for their support, in alphabetical order: Robin Agarwal, Carol Best, Ted Cheeseman (Happywhale), Annette Dehalt, Danny Frank, Shauna Fry (NOAA), Harris Hartman, Alethea Leddy, Jane Mayer, John Mayer, Larry Mellum, Sydney Minges, James, Moskito, Paula Olson, Joan Palmer, Michael Pierson, Ron Rogers, Dr. Jan Roletto (ACCESS Oceans), Dr. John Ryan (MBARI), Trevor Schroeter, Lisa Schallop, Christine Smith, Jeffrey Smith, Bob Walcot, Amy Wandel-Hartman, and Eric Austin Yee. Finally, we would like to thank all of the generous donors and volunteers for their passionate hard work and support over the last 15 years. Last but not least we would like to thank Mary Whitney and Betsy Collins of Fluke Foundation for their years of support and encouragement.

To all our volunteers who assisted in bringing this together, we thank you!

Transient killer whales porpoising in Monterey Bay, CA—photograph by Hayley Newell 2014 | NOAA NMFS permit15621

We extend our appreciation to the entire fishing and whale watching community in the Monterey Bay National Marine Sanctuary!



Map of our primary study area, encompassing Monterey Bay and the Montereyan Pacific Transition Ecoregion (as defined by Morgan et al, 2005)

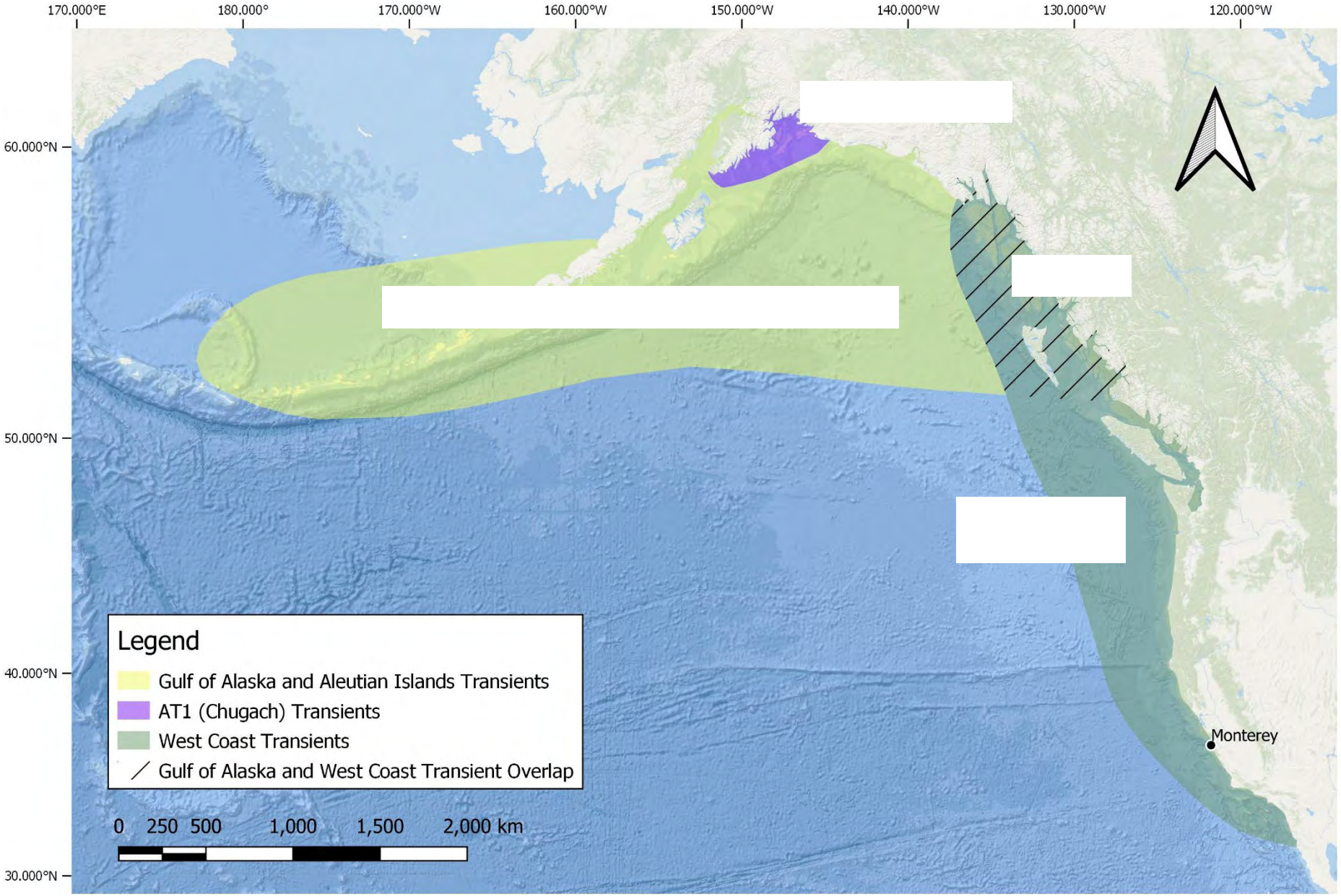
Populations & Distribution

Killer Whales

Killer whales (*Orcinus orca*) are the largest member of the dolphin family, and the only species of cetacean known to regularly consume marine mammals. They were given the name "whale killers" by early sailors who observed them preying upon large whale species. This eventually became the name "killer whale" that we use today.

Killer whales are apex predators with a cosmopolitan distribution meaning they are found in all major ocean basins. They are largely concentrated in high latitudes along coastal regions where prey are abundant, but have also been documented in oceanic or offshore ecosystems and at lower latitudes.

Currently, one species of killer whale is recognized globally, but 10 different ecotypes, or forms, have been described. Prey specialization among ecotypes has been the driving force in shaping many aspects of their ecology and natural history. In the Northeastern Pacific, long term studies have described three sympatric ecotypes known as residents, transients, and offshores. These ecotypes differ in their diet, behavior, distribution, morphology, acoustics, and genetics. Resident killer whales specialize in foraging for fish, in particular salmonids, live in stable matrilineal pods ranging in size from 10 to 50 whales, and consist of three adjacent distinct population segments that are socially isolated. These are the so-called southern residents distributed from the waters off southern British Columbia down to California's Central Coast, the northern residents, distributed from British Columbia to Southeastern Alaska, and the Alaskan residents that range from Southeastern Alaska to the Aleutian Islands. Offshore killer whales are also piscivorous, but appear to feed on upper trophic level species (e.g. sharks). They are rarely encountered, often travel in groups of 50 or more animals, and are found in offshore waters ranging from Alaska to Southern California. Transients (or Bigg's killer whales, named in honor of the late Dr. Michael Bigg), are marine mammal hunting specialists. They travel in smaller matrilineal groups usually consisting of three to 10 individuals, with a fluid social system, and are distributed from Alaska to Southern California.



Distribution of transient killer whale sub-populations in the eastern North Pacific. The West Coast Transients comprise two putative assemblages: inner coast and outer coast..

Transient (Bigg's) Killer Whales

Transient killer whales are believed to have diverged from residents and offshores approximately 700,000 years ago, and recent molecular studies suggest they may warrant separate species designation. In the northeastern Pacific, transient killer whales are split into three partially distinct populations that differ genetically, acoustically, and geographically.

Two of these populations, known as the AT1 transients and the GAB (Gulf of Alaska, Aleutian Islands, and Bering Sea) transients, are found in northern waters off the coast of Alaska. The AT1s, or Chugach, transients are centered in the coastal waters of Prince William Sound and the Kenai Fjords. When first studied by researchers in 1984, this small population, numbering 22 whales, was commonly observed hunting harbor seals (*Phoca vitulina*) near tidewater glaciers and Dall's porpoise (*Phocoenoides dalli*) in small bays. Following the Exxon Valdez Oil Spill in 1989, the AT1 population declined to 13 whales, and never fully recovered. As of 2018, just seven AT1 transients are believed to be alive (North Gulf Oceanic Society, 2018 unpublished catalog), and this population will eventually go extinct as they remain socially and reproductively isolated from other transient populations, and are without a reproductive female.

Unlike the AT1 transients that show a high degree of site fidelity, the GAB transients are broadly distributed through the Bering Sea, Aleutian Islands, and down to the waters off northern British Columbia. Numbering over 500 whales, the GAB transient population is

Breaching transient killer whale, Monterey Bay, CA—photograph by Peggy West-Stap 2012 | NOAA NMFS permit 15621

likely comprised of several distinct populations, and the population status is currently being reassessed. For example, during the months of May and June, over a hundred transients arrive in the productive waters of the Unimak Island region. Here, they intercept migrating gray whales (*Eschrichtius robustus*) as they enter the Bering Sea from the Pacific Ocean. It is unclear which population these Aleutian Island transients belong to, and while they are currently considered part of the GAB transients, studies suggest they may be part of a separate open ocean population.

The third population, known as the West Coast (WC) transients, are found in waters ranging from Southeast Alaska to Southern California. The WC transient population has an uneven ubiquitous distribution throughout their range and likely comprises multiple putative "assemblages". One assemblage tends to be sighted predominantly in coastal waters, while the other frequents the outer coast near the continental shelf break. As both assemblages occasionally interact and share acoustic and genetic similarities, the composition of the WC transient population is still not fully understood.

Most of what we know regarding the ecology of WC transients comes from long term studies in the coastal waters of British Columbia, Washington, and Southeast Alaska. In these areas, "inner coast" WC transients have been commonly documented throughout the year, foraging close to shore in bays, inlets, shallow reefs, and deep mainland fjords for pinnipeds and small cetaceans. Occurrence tends to increase during the harbor seal pupping season in the months of July through September. The inner coast assemblage has been extensively cataloged, and has roughly quadrupled in size since the 1970s (from 80 to 349 whales). This increase has been largely attributed to increased prey abundance, immigration of new whales, calf recruitment, and increased research efforts.

Outer Coast Transient Killer Whales

Considerably less is known regarding the distribution of transient killer whales in offshore and oceanic waters. The vastness of the open ocean often inhibits research due to unpredictable weather, infrequent sightings, and operational costs of large survey ships. Sightings of killer whales also tend to decrease further offshore from the continental shelf. There is growing evidence that at least a portion of the WC transient population utilizes offshore waters. A study conducted in British Columbia by the Department of Fisheries and Oceans Canada in 2013 identified 217 transient killer whales sighted predominantly off the continental shelf break, spatially discrete from the coastal assemblage. Interestingly, 46 of these transients were matched to whales previously cataloged off central California. .

Monterey Bay, off the central coast of California, provides a unique opportunity to research transients in a deep-water ecosystem with relative ease. Killer whale photo-identification studies in Monterey Bay began in the 1980's, and initially identified over 100 individual transients thought to be a subset of the WC population based on acoustic similarities and occasional mixing. However, since 1997, very little has been published regarding transients in this region. A reassessment by the Department of Fisheries and Oceans Canada published in 2007 stated there is not enough information to conclusively include this assemblage as part of the WC transient population.

Due to the lack of knowledge regarding transient killer whales in Monterey Bay and surrounding outer coast waters, we prepared this field guide, in conjunction with our

technical memorandum, *Transient Killer Whales of Central and Northern California and Oregon: A Catalog of Photo-identified Individuals*, in order to share information with our fellow researchers, naturalists, whale watchers, and whale enthusiasts. Here, we share 15 years of information collected on killer whales encountered in Monterey Bay, California and surrounding offshore waters. In addition to information regarding ecology and natural history, we are providing a catalog of 134 individual transient killer whales photographed in this study area.

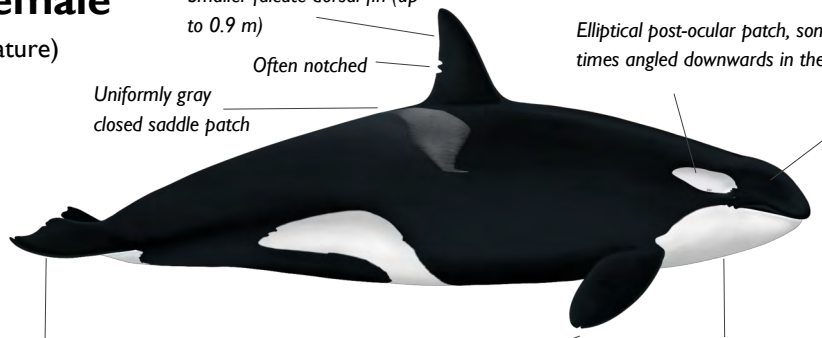
Transient killer whale OCT077 (dorsal fin) with her two offspring (spyhopping) in Monterey Bay, CA—photograph by Peggy Stap 2013| NOAA NMFS permit 15621

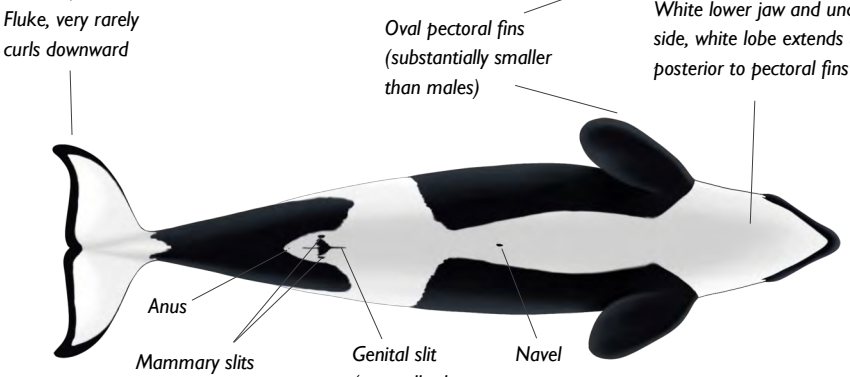
Morphology

Killer whale surfacing in the blue waters of Monterey Bay, CA -- photograph by Winnie Mulé 2017 | NOAA NMFS permit 20519

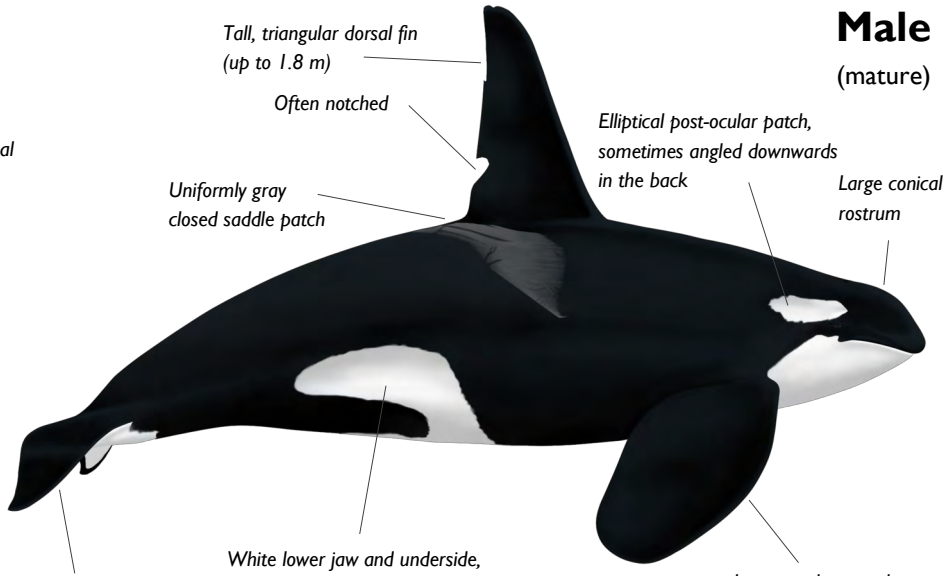
Killer Whale Anatomy and Behaviors

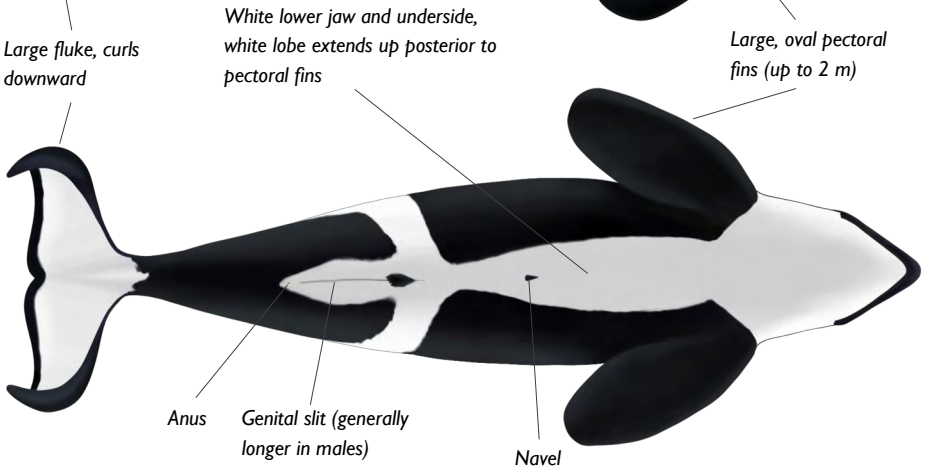
Female
(mature)





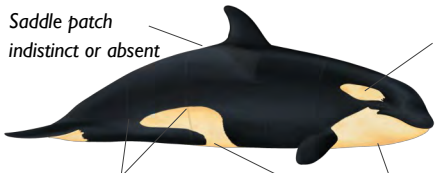
Male
(mature)



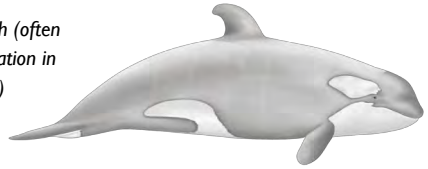


Calf
(newborn to two years)

Regular coloration

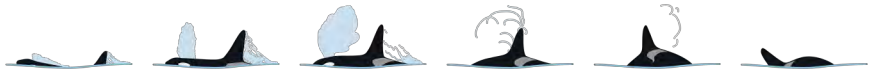


White coloration

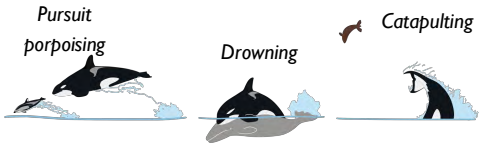


Pale gray to white coloration has been documented in a small number of whales; possibly the result of albinism or leucism

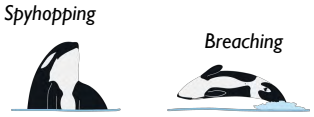
Dive sequence



Hunting behaviors



Social behaviors



Killer Whale Ecotypes of the Northeastern Pacific

Transient (Bigg's)

Dorsal fin: pointed
Saddle patch: closed
Teeth: curved, blunt
Diet: marine mammals

Dorsal fins of transient killer whales are generally pointed at the tip, especially in adult females. The saddle patch is uniformly gray, always closed (containing no black pigmentation), and larger than in resident and offshore killer whales. They have occasionally been identified with pseudo-stalked barnacles (*Xenobalanus sp.*) and circular scars caused by cookiecutter sharks (*Isistius sp.*). Their teeth tend to be slightly curved and blunt at the tip. These features might aid in grasping large, struggling marine mammal prey and impacting mammalian bone.

Resident

Dorsal fin: rounded at the tip
Saddle patch: open or closed
Teeth: pointed, worn on sides
Diet: fish, primarily salmon

Dorsal fins of resident killer whales are predominantly rounded, and sometimes have a distinct angle towards the rear edge of the tip. The curve of the dorsal fin varies between individuals and communities (i.e. southern and northern resident). The saddle patch can be open (containing various amounts of black pigment) or closed. Their teeth tend to be slightly worn on the sides. This might be a result of biting into the soft flesh of fish, which can lead to friction and rubbing as the teeth interlock.

Offshore

Dorsal fin: completely rounded
Saddle patch: open or closed
Teeth: heavily worn
Diet: piscivorous, primarily sharks

Dorsal fins of offshore killer whales are completely rounded at the tip, and often heavily scarred and notched. Their saddle patch can be open or closed, similar to residents. They commonly have circular bite marks from cookiecutter sharks, suggesting an oceanic distribution. Their teeth are extremely worn, sometimes down to the gum—drastically different from those of transients and residents. This is likely related to their diet of eating sharks, which have highly abrasive skin.

Stranding & Entanglement

Entanglements and bycatch of cetaceans involving various forms of fishing gear account for approximately 300,000 deaths worldwide each year. Off the west coast of the United States, there were 504 confirmed whale entanglements between 1982 and 2019. Although more common in smaller cetaceans like dolphins and porpoises, there are also records of killer whale entanglements. These events can lead to injury, stranding, and even death. In 2016, we documented a killer whale that became entangled in fishing gear, and then subsequently self-released (*An Entanglement Encounter*). Killer whales are curious and inquisitive animals, and this encounter demonstrates how their behavior could lead to future entanglements.

Please report injured, entangled, and ship-struck whale sightings on the West Coast of the U.S. to the 24/7 NOAA hotline at

(877) SOS WHALe (767 9425)

or hail the U.S. Coast Guard on VHF CH-16.

Do not assist distressed marine mammals without guidance from authorities. Stay a safe distance away 100 yards minimum.

To learn more about the Whale Entanglement Team (WET)®, visit WhaleEntanglementTeam.org

An Entanglement Encounter

On April 5, 2016, during Marine Life Studies' Research Scientist Program, we witnessed a male killer whale become entangled in crab pot gear and subsequently free himself.

There were several killer whales in the area feeding on a gray whale calf that they killed that morning. The killer whales were moving in and out of a relatively small area where there were several different sets of crab pot gear, with buoys floating at the surface. We saw a large male killer whale, known to us as OCT060, heading toward a set of two crab pot buoys, one orange and one white. He dove before reaching the buoys, and then surfaced right next to them. Knowing the risk of entanglement, we were all very concerned. Unfortunately, in less than a minute, we realized that he had indeed become entangled in the line that attached the two buoys to the crab pot on the sea floor. When he dove beneath the surface, the buoys went underwater with him. He surfaced a second time with the buoys trailing, then dove again, pulling the buoys under. He surfaced again, this time with the line from the buoys across the top of his body just in front of his tall dorsal fin. Again he dove. Fortunately, when he came to the surface for a fifth time, he was clear of both the line and the buoys. Once freed, he continued swimming, rejoining the other killer whales in the area.

Entangled killer whale—photograph by Doug Croft 2016 | NOAA NMFS 15621 | MMHRSP permit 18786-01

Entangled killer whale—photograph by Stephanie Marcos 2016 | NOAA NMFS 15621 | MMHRSP permit 18786-01

Needless to say, we were relieved that he had self-released, but as the rapid response boat for the Whale Entanglement Team (WET)®, we were ready to respond and assess the entanglement, if necessary. Assessing and documenting the entanglement are the first steps for a whale rescue, but can only be done with authorization from NOAA. When documenting entangled cetaceans, we work under a special permit as a part of NOAA's Marine Mammal Health and Stranding Response Program (MMHSRP). Killer whales are very curious and playful, and this encounter demonstrates how this behavior could lead to future entanglements. In this instance, luckily the killer whale was able to free himself.

If you see an entangled whale, stay a safe distance away and report the entanglement to NOAA.

The Fort Bragg Killer Whale

On April 18, 2015 local residents reported a dead killer whale stranded on MacKerricher Beach, just north of Fort Bragg, California. A team of scientists from the Marine Mammal Center, California Academy of Sciences, and the Noyo Center for Marine Science arrived on scene to perform a necropsy. The whale was described as a 7.9 m adult male in robust nutritional condition, which had been entangled in fishing gear. The rope and floats were wrapped tightly around the base of the whale's tail stock extending under the body, and encircling the left pectoral flipper.

Morphometric and histological samples were collected to look at the overall health of the animal. In order to try and identify the whale, photographs were taken of the dorsal fin and saddle patch, and sent to multiple research organizations, including the authors of this catalog. Unfortunately the whale was never identified, but examination of the stomach suggested that this individual was likely transient as it contained six harbor seals, with one seal fully intact. Genetic samples were also sent to Northwest Fisheries Science Center who identified the whale as an Alaskan transient killer whale. To the best of our knowledge, this is the first confirmed report of an Alaskan transient killer whale in the coastal waters of California. The final necropsy report found no serious physical injuries or illness, stating that the whale had likely died of drowning as a result of the entanglement.

Photographs of deceased killer whale, entangled in ropes and floats from fishing gear, washed up on MacKerricher Beach, CA—all photographs on this page by David Flaim 2015

Research Process

Field Research

From May 2006 through April 2020, data on transient killer whales was collected throughout the year based on at-sea observations and sighting reports collected along the west coast of North America.

Research efforts ranged from Monterey Bay, California north to Vancouver Island, British Columbia. At-sea research surveys were conducted in the Monterey Bay National Marine Sanctuary (MBNMS) and around southern Vancouver Island, and information from the Washington and Oregon coastlines was collected through volunteer sighting efforts. Sightings were shared with us by whale watchers, researchers, fisherman, lighthouse keepers, and the general public. Data recorded during a sighting included the date, time, location, direction of travel, identity of whales present, and behaviors.

The majority of the data was gathered

Researchers collecting killer whale data in Monterey Bay, CA—photograph by Chelsea Mathieson 2019 | NOAA NMFS permit 20519

through opportunistic research surveys conducted by Marine Life Studies in the MBNMS. Observations were made by researchers aboard the 5.8 m R/V Sweet Pea (prior to June 2015) and the 12.2 m R/V Current'Sea from the top of the 3.6 m wheelhouse (after June 2015) using 7x50 mm binoculars. When killer whales were spotted, researchers conducted a focal follow, collecting detailed ecological and behavioural data. Information collected included date, time, location (latitude and longitude), weather conditions (Beaufort scale, swell height, visibility, percent cloud cover), number of killer whales present, group composition, behavioral state, and identification photographs. Data on other marine mammal species sighted within the general vicinity of the killer whales was also recorded. This included the species, number of animals present, and the behavior exhibited by that animal (e.g. humpback whale trumpet blowing in presence of killer whales).

Researchers aboard Marine Life Studies research vessel R/V Current'Sea in Monterey Bay, CA—photograph by Tim Zoliniak

Our research encounters were ended due to: inclement weather conditions, low light, fuel constraints, losing sight of whales, or emergency calls for assistance with large whale disentanglement (Marine Life Studies' Whale Entanglement Team (WET)® prioritizes responding to whales in distress from life-threatening entanglements).

Photograph Collection & Identification Catalog

When killer whales were encountered, our field research team would approach the whales to photograph the left and right sides of their dorsal fin, saddle patch, and post-ocular patches. Both Canon and Nikon DSLR cameras equipped with 100 to 300 mm lenses were used, following the methodologies described in Ford and Ellis's 1999 publication *Transients: Mammal-Hunting Killer Whales*. An approach of within 30 m was ideal to obtain high-quality photographs. In the MBNMS, research was conducted under the following NOAA National Marine Fisheries Service (NMFS) permits: 1094-1836, 15621, and 20519. We made every effort to photograph all whales during an encounter. Identification of whales and group size was confirmed through analysis of

photographs back at the lab. Additional photographs were collected and compiled from whale watchers, naturalists, and members of the community. We compiled a catalog over time, which allowed us to compare individual whales during subsequent encounters. Identification photographs were also compared to existing catalogs to determine matches between regions.

Due to the continuous geographic distribution and their predominant occurrence in outer coast waters, we have assigned whales in this catalog the OCT (outer coast transient) designation. All killer whales in this catalog have been identified off the central coast of California, and a small subset have also been identified in open waters off Oregon, Washington, British Columbia, and even Alaska. A key to equivalent designations from British Columbia (T ID), Alaska (AK ID), and California (CA ID) are provided in an appendix table. Over 95,000 photographs were reviewed and verified by at least two individuals proficient in photo-identification methodology. When a whale was 'reidentified' among years, a new photograph was added to a folder for each year, which allowed us to monitor new scars and notches acquired throughout each whale's life. To be included in the catalog, the best photographs were selected that clearly showed the dorsal fin shape, notches and scars present on the dorsal fin and saddle patch, and a clear depiction of the shape and size of the post-ocular patch.

R/V Current'Sea conducting a killer whale research survey in Monterey Bay, CA—photograph by Jane Mayer 2019

Foraging & Ecology

Foraging Behavior

Transient killer whales have developed unique, culturally transmissible foraging behaviors in response to the distribution, population dynamics, and behavior of their marine mammal prey. In Monterey Bay, transient killer whales forage primarily in open water, where they use stealth to locate prey. When foraging, a group of whales will spread out, performing asynchronous long dives exceeding five to ten minutes, followed by a series of shorter dives less than a minute in length. Movements are erratic and unpredictable, with whales zigzagging back and forth. On numerous occasions we have encountered transient killer whales patrolling or following contours of the Monterey Submarine Canyon in search of prey. The deep water of the canyon may benefit the whales when hunting gray whale calves, but this ecological interaction warrants further study.

In comparison to the large, stable resident pods, which primarily spread out and forage for fish individually, transient killer whales cooperatively hunt in small groups. Foraging in a small group enables the whales to coordinate their hunts efficiently, while avoiding being visually detected by their marine mammal prey. Group size may also be related to the amount of energy obtained and expended when hunting different species of prey. For example, a harbor seal weighing 130 kg can be killed relatively easily by a single individual such as a nomadic male, but may not provide enough food for a larger group, resulting in the whales having to expend more energy foraging multiple times. Conversely, attacking an adult male California sea lion weighing close to 390 kg provides a substantial meal. However, adult sea lions can be potentially dangerous to a lone attacking killer whale, and require a coordinated attack by multiple killer whales.

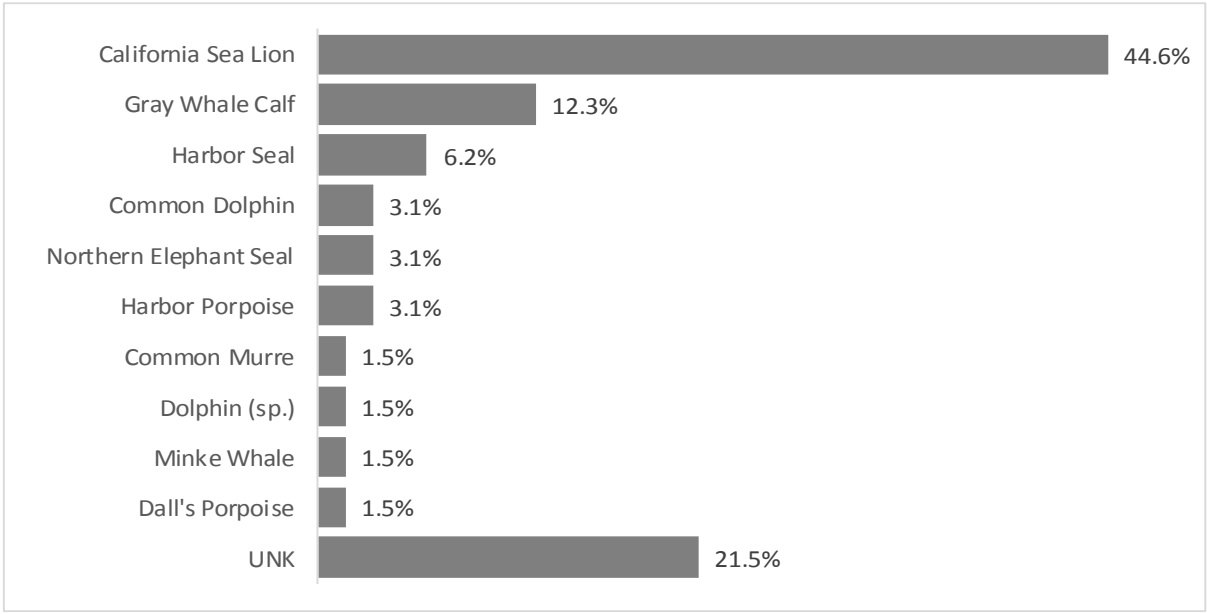
Transient killer whales, like most species of toothed cetacean, rely on calls, whistles, and echolocation for communicating and navigating in an aquatic environment. Marine mammal prey have excellent underwater hearing, within the communication frequencies used by transient killer whales. Experimental studies have even demonstrated

that harbor seals are able to discriminate between the sounds produced by transients and those of fish eating resident killer whales. Furthermore, when gray whales were exposed to underwater sound playback of killer whale vocalizations, scientists documented them displaying predator avoidance behaviors by hiding in kelp beds and actively swimming away from the sound source. Therefore, the ecological costs of communicating in areas frequented by marine mammals has resulted in transient killer whales relying heavily on passive listening, and sparse echolocation clicks, in order to locate prey.

It is likely that transient killer whales rely on eyesight once prey are within attacking range. Their unique high-contrast coloration may further enhance their ability to see hunting partners, or act as a social signaling device, when coordinating movements. The black and white coloration may also allow killer whales to blend in with their surroundings, a method known as counter shading. Killer whales when viewed dorsally in the water column blend in with the dark water below. Looking upwards toward the surface, the white ventral side of the whale blends in with the sunlit water above. This could be useful for transient killer whales foraging in an open water environment, where the whales can be easily seen by vigilant prey.

Prey Species

In Monterey Bay, we have observed 65 attacks on marine mammals, 59 of which resulted in the prey being killed and eaten. California sea lions (*Zalophus californianus*) (44.6%) and gray whale calves (12.3%), represent the majority of attacks and kills. Other observed prey species include harbor seal (*Phoca vitulina*), common dolphin (*Delphinus sp.),* northern elephant seal (*Mirounga angustirostris*), minke whale (*Balaenoptera acutorostrata*), Dall's porpoise (*Phocoenoides dalli*), harbor porpoise (*Phocoena phocoena*) and Pacific white-sided dolphins (*Lagenorhynchus obliquidens*), which all represent less than 10% of predation events. Various species of sea birds are often attacked, injured, or killed. Common murres (*Uria aalge*) and rhinoceros auklets (*Cerorhinca monocerata*) make up the majority of bird predations. On many occasions when we have encountered whales feeding, we were unable to discern the species of prey being eaten. These events account for 21.5% of our observations. Additionally, we have documented transient killer whales harassing humpback whales and a blue whale, though we did not witness any attacks.



Observed predations, broken down by species, by transient killer whales in the Monterey Bay National Marine Sanctuary (2006 to 2018)

Predation on pinnipeds

Attacks on California sea lions are often dramatic events. Their large size and formidable canine teeth make these animals a risky prey choice for killer whales on the hunt. When a sea lion is encountered, a group of whales will surround the animal, preventing it from escaping. Whales in the group will take turns rushing in to repeatedly ram or strike the sea lion with their flukes. This may last for over an hour, until the sea lion is weakened and unable to defend itself. At this point the whales will often grasp the sea lion, dragging it beneath the surface to drown it. Once the sea lion is killed, members of the group will divide the carcass and share it.

Killer whales hunting a sea lion—photograph by Nina Rosen 2016 | NOAA NMFS permit 15621

In pinniped predations in general, transient killer whales often batter the carcass with their bodies, or use their flukes to catapult their prey into the air. Such behavior may be used to debilitate, kill the prey, and even soften the pinniped's tough outer hide. On one occasion, we witnessed a female transient killer whale catapult a live harbor seal 30 m into the air; where it subsequently died upon impact with the water.

Infrequently, transient killer whales will engage in surplus killing, a behavior where prey are killed but not consumed. These events provide us with the rare opportunity to examine the carcasses of prey. Injuries typically observed include lacerations and tooth rake marks, puncture wounds, blood in the body cavity, broken ribs, and punctured lungs. Surplus killing may coincide with training younger whales during periods of high prey density (i.e., pupping and animal migrations), when energy intake is at its highest.

Significant breeding colonies of northern elephant seals are located within the study area, including Año Nuevo, Piedras Blancas, Point Reyes, and the Farallon Islands, yet predation attempts on elephant seals by transient killer whales are rarely observed. (Great white sharks (*Carcharodon carcharias*) are the primary predator of elephant seals in the region.) As with attacks on sea lions, transient killer whales use similar foraging methods on elephant seals; we have only observed predation events involving sub-adult elephant seals. The superior diving capabilities of adult elephant seals might be an effective predator avoidance behavior, enabling these pinnipeds to dive to depths beyond the capabilities of the whales.

Killer whale catapulting a harbor seal—photograph by Peggy West-Stap 2008 | NOAA NMFS permit 1094-1836

Killer whale hunting northern elephant seal—photograph by Peggy West -Stap 2008 | NOAA NMFS permit 1094-1836

Killer whales hunting a sea lion—photograph by Chelsea Mathieson 2019 | NOAA NMFS permit 20519

Killer whale ramming a sea lions—photograph by Josh McInnes 2019 | NOAA NMFS permit 20519

Killer whales hunting sea lions—photograph by Peggy West-Stap 2008 | NOAA NMFS permit 1094-1836

Killer whales hunting a sea lion—photograph by Chelsea Mathieson 2019 | NOAA NMFS permit 20519

Predation on gray whales

Killer whales play an important ecological role as apex predators, influencing the behavior of numerous marine species. In fact, it has been suggested that killer whales may be the ecological driving force behind the migrations of large baleen whales. Predation on gray whales by transient killer whales has been documented on numerous occasions, with the majority of hunts taking place in the waters of Unimak Pass, Alaska, a transboundary area separating the Pacific Ocean from the Bering Sea, and Monterey Bay, California.

Early indirect evidence of killer whale attacks on gray whales was described by researchers based on the parallel tooth rake marks present on 57 (18%) of 316 whales examined at the Point San Pablo, California whaling station between 1959 and 1969. Published accounts describing transient killer whales actively attacking gray whales off the coast of California began appearing in the 1970's. Since then, there have been numerous documented accounts of transient killer whales predating gray whales off the coast of California, including a dramatic hunt featured in BBC's Blue Planet.

Every spring, in the Northeastern Pacific, gray whales leave their protected breeding lagoons in Baja California, Mexico, and migrate 6000 km north to productive feeding grounds in the Bering and Chukchi Seas, Alaska. Adult females and their neonate calves are the last to leave the warm lagoon waters, likely because calves need sufficient time to grow and gain strength before the journey north. Gray whales migrating north along the coast pass through Monterey Bay, where transient killer whales utilize the deep bathymetric features of the Monterey Submarine Canyon to ambush females and their calves.

To avoid being detected by killer whales, grays may perform longer dives, while exhaling beneath the surface, which may make it more difficult for transient killer whales to acoustically detect them. We have also witnessed gray whale mothers and their calves being escorted by traveling companions, with calves positioned in the center.

Once a gray whale mother and calf are located, transients begin to corral the pair by swimming on either side of them. Gray whale

Transient killer whales hunting gray whales in Monterey Bay, CA—photograph by Peggy West-Stap 2005 | Photo usage approved by the Marine Mammal Laboratory and taken under MMPA Permit no. 782-1510 (Principal Investigator: Marilyn Dahlheim)

Killer whale ramming a gray whale calf—photograph by Peggy West-Stap 2004 | Photo usage approved by the Marine Mammal Laboratory and taken under MMPA Permit no. 782-1510 (Principal Investigator: Marilyn Dahlheim)

mothers tend to increase their speed in order to evade the killer whales. This can last hours. As a result, the calf can become exhausted and unable to keep up with its mother.

Killer whale adults, juveniles, and calves all take part in the attack. Female killer whales initiate and lead the majority of the hunts. As matrilineal leaders, female transients may have considerable knowledge in locating and successfully killing gray whale calves. It is not uncommon to see juvenile killer whales with their mothers during hunts. On numerous encounters we have documented juvenile transients diving and surfacing within meters of protective gray whale mothers. By engaging in hunts, juveniles learn how to cooperatively hunt and tackle dangerous prey. On some occasions, we have observed male killer whales patrolling the periphery, or joining in at the end of hunts.

Gray whale mothers employ various anti-predator tactics when defending their calves. Their large 3.0-3.6 m barnacle studded flukes, when undulated back and forth, can cause serious to potentially fatal injuries to an attacking killer whale. Gray whale mothers have also been documented rolling onto their back, while positioning their calves out of the water on their ventral side.

Transient killer whales will hold the flukes and pectoral fins of gray whales to impede their movements while trying to separate the calf from its mother. Once the calf is separated, transients typically change their behavior to biting, ramming, and "body slamming", which is frequently directed at the calf's rostrum. By repeatedly ramming the gray whale calf, killer whales may cause extensive internal injuries. Adult male transients often join in at this stage, using their larger body size to deliver major blows. Ramming the calf's head region may also be a tactic for injuring or breaking the lower jaw, making it difficult for the calf to raise its head to breathe. By leaping on top of the gray whale calf, the killer whales prevent the calf from respiring normally, attempting to drown it.

Once the calf is dead, the killer whales feed on the carcass, sometimes for days on end, usually resulting in a social gathering of multiple groups. Feeding behavior often involves grasping onto the gray whale carcass while rolling or shaking their rostrums from side to side to dislodge sections of tissue and blubber. While feeding, whales may cooperatively divide a chunk of tissue by grasping it, and pulling in opposite directions, effectively splitting it apart and thus sharing the food.

Occasionally, we have documented deceased gray whale calves where only the soft tissues of the lower jaw, tongue, and lips were consumed. This behavior seems to be a shared attribute of other killer whale populations around the globe that feed on large cetaceans. While there are likely many

Killer whale ramming a gray whale calf —photograph by Eric Austin Yee

Gray whale mother and calf hiding in the kelp beds off Big Sur, CA—photograph by Doug Croft

reasons why killer whales partially consume their prey, it is worth noting that cetacean carcasses tend to be negatively buoyant, and killer whales may only have time to feed on the softer tissues before the carcass sinks beyond their diving capabilities in Monterey Bay, California. In comparison, the shallow waters of Unimak Pass, Alaska, allow transient killer whales to feed on gray whale carcasses for extended periods of time. These "stored carcasses" are visited by multiple different transient groups throughout a period of time.

Group size of transient killer whales while hunting gray whale calves averaged 15, but ranged from 6 to 28 members. Group size and composition often changes throughout hunts, as new matrilines join over time. Killer whales that have located a gray whale calf likely face ecological and social costs and benefits from being joined by others. Ecologically, the group benefits in their ability to overcome large and dangerous prey, from the individual skill sets each member brings to the hunt (skill pool effect), and being able to prevent the carcass from sinking. Conversely, energy intake for each individual in the group will be reduced as they now share the gray whale calf among more individuals. In addition to being an important energy source, gray whale calf predations may indirectly benefit the killer whales by providing opportunities to mate and socialize.

Transient killer whale predation on gray whale calves may have ecological influences spanning multiple trophic levels and marine communities. Gray whale carcasses have been discovered at the bottom of the Monterey Bay Submarine Canyon with an unusual assemblage of deep-sea animals, potentially providing thousands of kilograms of organic matter to an otherwise oligotrophic ecosystem. For example, an

Killer whale ramming a gray whale calf —photograph by Eric Austin Yee

Killer whales eating gray whale blubber—photograph by Peggy West-Stap 2004 | Photo usage approved by the Marine Mammal Laboratory and taken under MMPA Permit no. 782-1510 (Principal Investigator: Marilyn Dahlheim)

Depiction of a gray whale calf being hunted, then sinking to the sea floor where it provides nutrients to thousands of organisms—artwork by Selena Rivera

Transient killer whales feeding on the carcass of a gray whale calf—photograph by Peggy West-Stap 2004 | Photo usage approved by the Marine Mammal Laboratory and taken under MMPA Permit no. 782-1510 (Principal Investigator: Marilyn Dahlheim)

adult 10 m gray whale discovered in 2002, delivered approximately 20,000 kg of nutrients to a community of opportunistic scavengers during different stages of decomposition. Whale carcasses attract an assemblage of taxonomically diverse species including polychaete worms, echinoderms, crustaceans, hagfish, and deep-sea Pacific sleeper sharks.

It is unknown what impact transient killer whales may have on deep-sea ecological community structure. More research is needed to understand how gray whale calf carcasses contribute to energy cycling in the region. However, not all gray whale calf carcasses sink into the depths. We have examined three different beach cast specimens, days after observing the attacks. Most carcasses were heavily scarred with parallel cuts approximately 4.6 to 5.6 cm apart and 5.0 to 9.0 cm deep. Two calves were missing their lower jaws and tongues, and had lacerated pectoral fins and flukes.

The majority of gray whale predations take place in April through late May, as gray whales make their way north past Monterey Bay. In June, sightings of transient killer whales and attacks on gray whale calves begin to decrease, and by July, encounters with transients in Monterey Bay become sporadic. Where these whales go is a bit of a mystery, but it is possible that they follow the continental shelf north along with the gray whales. It is also possible that these transient killer whales patrol and frequent adjacent offshore deep-sea canyons where they switch to foraging on other offshore species like northern elephant seals (*Mirounga angustirostris*), northern fur seals (*Callorhinus ursinus*), and oceanic dolphins.

Dead gray whale calf washed up on the beach after falling victim to a transient killer whale predation, Morro Bay, CA—photograph by Joyce Cory

Deceased gray whale calf missing lower jaw from killer whale predation, washed up on a beach in Monterey Bay, CA—photograph by Peggy West-Stap 2012

Killer whale rake marks on deceased gray whale calf—photograph by Joyce Corey

Predation on small cetaceans

The tactics used by transient killer whales to capture and kill small cetaceans generally involve coordinated high speed chases in open water. In Monterey Bay, it is not uncommon to see large schools of several hundred Pacific white-sided dolphins and common dolphins. When hunting dolphins, transient killer whales will try to separate an individual or a small group from the much larger school. To do this, the whales charge into the school, causing the dolphins to panic and flee. This behavior may also be used to check for young or weak dolphins that become disorientated and left behind during the frenzy. Chases involving small groups of porpoises are exciting events. This is particularly true for hunts involving Dall's porpoises. Dall's porpoises are agile, and can reach speeds of up to 55 km/hr, a possible antipredator behavior adapted for evading transients. When a Dall's porpoise is located, a chase ensues with one member of the group leading the hunt, often 'porpoising' high into the air directly behind the fleeing porpoise.

Killer whales predating Pacific white-sided dolphins—photographs by Peggy West-Stap 2003 | Photo usage approved by the Marine Mammal Laboratory and taken under MMPA Permit no. 782-1510 (Principal Investigator: Marilyn Dahlheim)

Transient killer whales hunting common dolphins—photograph by Peggy West-Stap 2011 | NOAA NMFS 1094-1836

When hunting small cetaceans, transient killer whales are masters of cutting off the path of retreat. A group of attacking whales will encircle a fleeing dolphin or porpoise at multiple angles, making it impossible to escape. When one whale tires, another will take over until the dolphin or porpoise is exhausted and unable to continue. Often the whales will surface below the dolphin or porpoise, launching it through the air.

Once killed, the whales may feed only on specific areas of the carcass, generally leaving the heart and lungs.

Fin of a dolphin killed by transient killer whales—photograph by Peggy West-Stap 2011 | NOAA NMFS 1094-1836

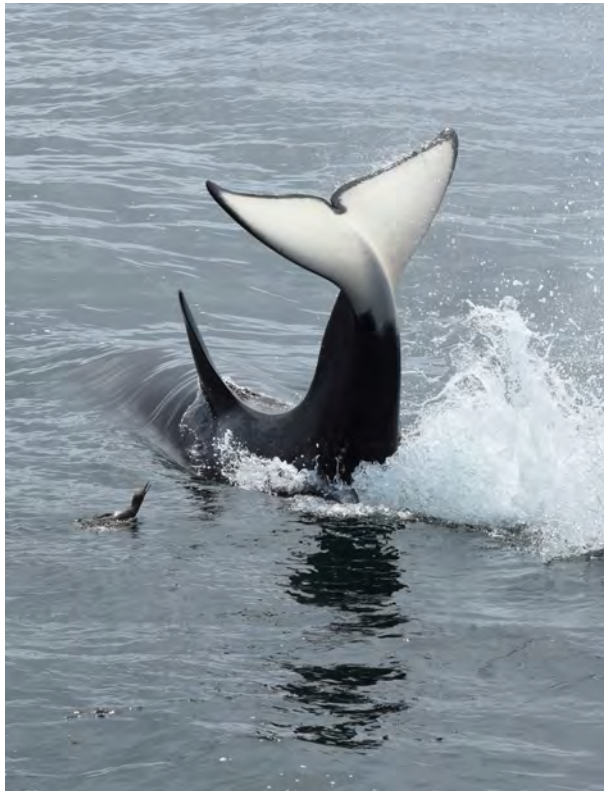
Dall's porpoise killed and abandoned by transient killer whales, an example of surplus killing —photograph by Josh McInnes

Transient killer whale feeding on common dolphin, surrounded by blood in the water—photograph by Peggy West-Stap 2011 | NOAA NMFS 1094-1836

Marine birds

It is not uncommon to see transient killer whales interacting with marine birds. On numerous occasions we have spotted killer whales based on the presence of birds on the horizon. These incidents often involve transient killer whales feeding on a marine mammal carcass, with birds scavenging bits of tissue that float to the surface. The most commonly observed scavengers are sooty shearwaters (*Ardenna grisea*), northern fulmars (*Fulmarus glacialis*), various species of gull (*Larus spp*.) and black-footed albatrosses (*Phoebastria nigripes*). We have even observed black-footed albatrosses following transient killer whales, waiting for them to locate prey. This behavior may benefit the birds, as killer whales are able to access prey beneath the surface. This theory is supported by research in the Southern Ocean, where cameras mounted on black-browed albatross (*Thalassarche melanophris*) confirmed that these birds actively follow killer whales in order to scavenge prey.

Aside from the predominantly mammalian diet, transient killer whales occasionally attack marine birds. Most instances involve younger whales sneaking up on common murres and rhinoceros auklets from beneath the surface, perhaps as a sort of "hunting practice". Usually, the whale either strikes the bird with its fluke, or grasps onto the bird from underneath, dragging it beneath the surface. Younger whales often release the bird, which is left incapacitated and struggling at the surface. This behavior may last several minutes before the bird is consumed or abandoned.



Killer whale attacking common murre—photograph by Stephanie Marcos 2018 | NOAA NMFS permit 20519

Killer whales surrounded by gulls—photograph by Peggy West-Stap 2014 | NOAA NMFS permit 15621

Juvenile killer whale catching common murre—photograph by Chelsea Mathieson 2019 | NOAA NMFS permit 20519

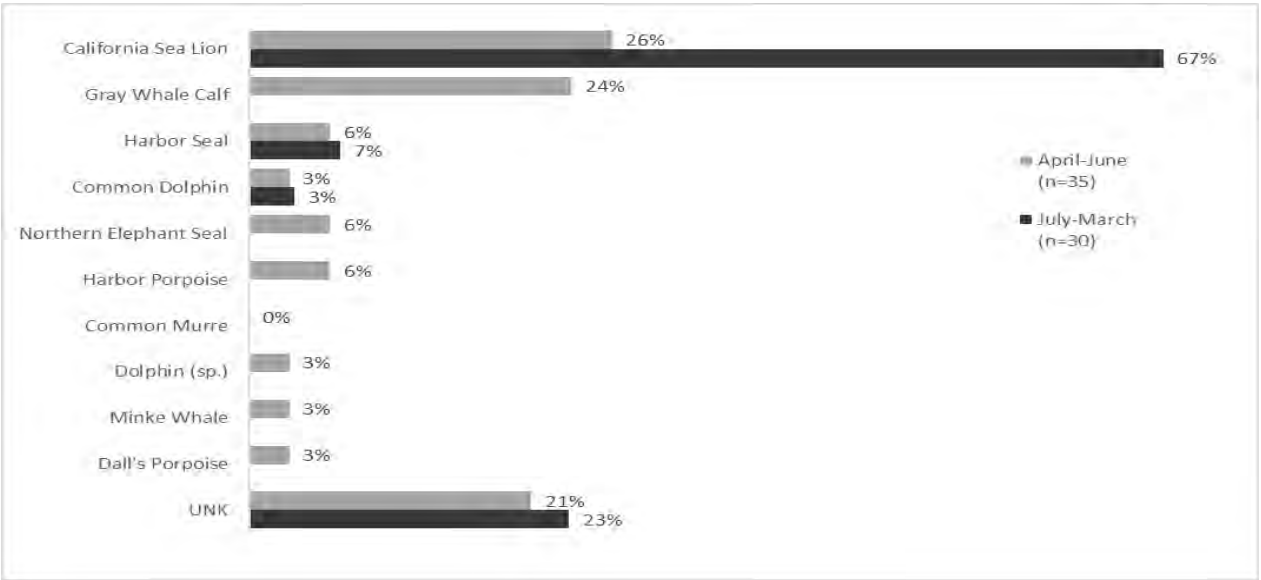
Killer whale underneath a common murre—photograph by Doug Croft 2018 | NOAA NMFS permit 20519

Sub-adult transient killer whale grasping a marine bird between its jaws—photograph by Peggy West-Stap 2004 | Photo usage approved by the Marine Mammal Laboratory and taken under MMPA Permit no. 782-1510 (Principal Investigator: Marilyn Dahlheim)

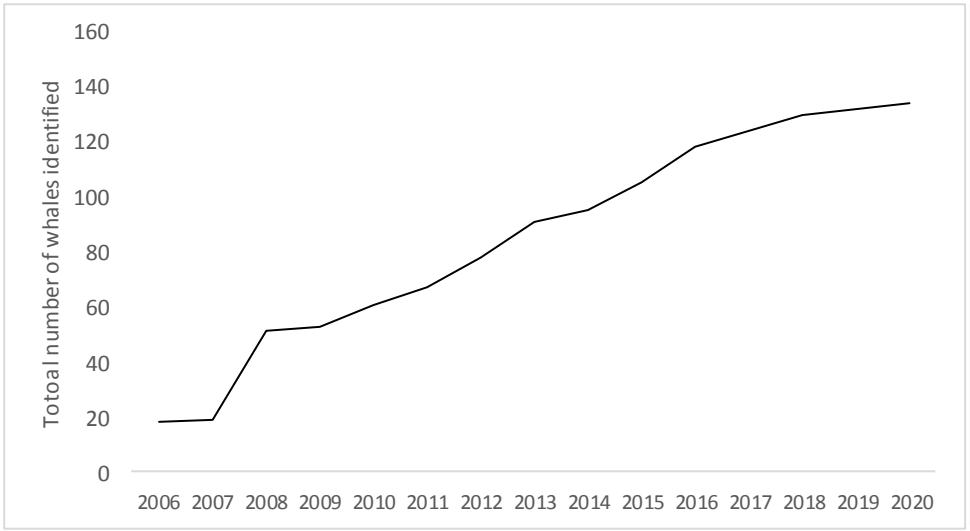
Seasonal and temporal occurrence

Between May 2006 and April 2020 we identified 134 unique individual killer whales, with new individuals being identified each year.

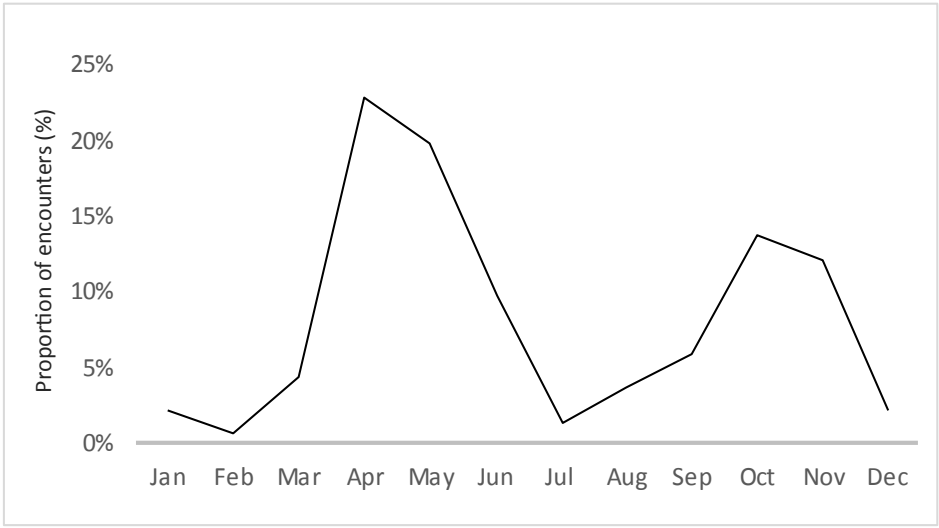
We have encountered transient killer whales in Monterey Bay throughout the year, with the majority of encounters taking place in the spring and fall. Search effort by researchers and ecotourism operators is relatively constant throughout the year, so the seasonal distribution of sightings is a fairly unbiased representation of transient killer whale presence in Monterey Bay. Two clear seasonal peaks are apparent, in spring (April through June) and fall (October and November). The spring peak is associated with the presence of gray whales on their semi-annual migration, as reflected in the whales' diet. During the rest of the year, California sea lions and other pinnipeds make up the majority of the transients' diet. The second peak in the fall has no obvious explanation, and further research is needed.



Killer whale prey species, based on percentage of total observed predations, in Monterey Bay, CA over two time periods: April-June and July-March (n=65)



Total number of killer whales identified between 2006 and 2020



Monthly killer whale encounters in Monterey Bay, CA 2006 to 2020 (n=153)

Photo-Identification Catalog

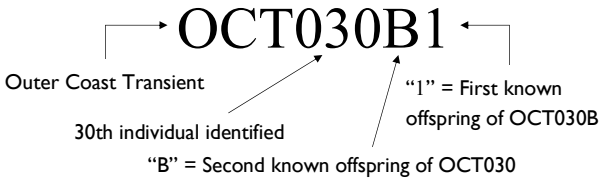
Photo-identification studies have been an effective non-invasive method for studying the population dynamics, social structure, and distribution patterns of cetaceans. Photo-identification studies on killer whales were initiated and developed by killer whale research pioneer Dr. Michael Bigg and his colleagues at the Department of Fisheries and Oceans Canada in the 1970's. They realized that each whale in a population could be cataloged based on distinctive characteristics of the dorsal fin and saddle patch, including notches, scars, shape and pigmentation.

ID System and Who is Included

This catalog includes photographs of all transient killer whales we have observed during annual research surveys in the MBNMS from May 2006 through April 2020. These whales are predominantly sighted in open water off Central California, and are for the most part not represented in catalogs of transient killer whales in the coastal waters off the Pacific Northwest. A number of the whales in this catalog were previously identified in Black et al.'s 1997 publication, *Killer Whales of California and Western Mexico: A Catalog of Photo-Identified Individuals*, and included the prefix "CA" (identified off 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 published or publically available.

For this reason we have given each whale identified an OCT abbreviation, meaning 'outer coast transient'. Here we use an alphanumeric naming system similar to that developed by killer whale expert and photo analyst Graeme Ellis. The OCT abbreviation is followed by an unique number for each whale identified. Offspring of known mothers are assigned the same number as their mother, followed by a letter indicating birth order. Offspring of individuals with known grandmothers are further designated in numerical order; and so forth.

Example:



Several females identified in Black et al.1997 were associated with a calf. For cataloging, we treated these as the mothers' first calves, and therefore gave subsequent calves born to these individuals 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 (e.g. OCT013B/CA171B).

We have also included identification photographs of individual whales sighted during surveys in offshore waters. To the best of our knowledge these whales have not been identified in the MBNMS, but have been sighted traveling with known transient killer whales. These whales were given OCT500 or higher designations.

Other Designations

A subset of the transient killer whales identified in this catalog have been documented in catalogs produced for waters off British Columbia, Alaska, and California and Mexico. Therefore, some of these whales have equivalent identification designations. For example, OCT002 is also known as T132 (British Columbia ID), A010 (Alaska ID) and CA20 (California ID). We have provided these equivalent identifications, where known, in an appendix table at the back of this catalog.

Sex and Age

Mature killer whales display sexual dimorphism (see "Morphology" section). Adult males are the easiest to differentiate, as they can be distinguished from females by their tall dorsal fin that can be up to 1.8 m in height. In contrast, dorsal fins of female killer whales only reach up to 0.9 m at maturity. Physical maturity for female killer whales is reached at 10 years of age, at which point they can give birth to offspring. Killer whales traveling consistently in close association with a calf, or who were estimated to be greater than 15 years of age and had not started to develop the characteristic male dorsal fin were classified as female. With sub -adult and juvenile whales, determining the sex was more difficult, as they lack the sexual dimorphism of adult whales. Occasionally, we were able to catch a glimpse of the ventral side of an individual, often through breaching, tail lobbing, or rolling on its side. In these cases, we were able to determine the sex based on the different appearances and pigmentation of the genital areas. In cases where the sex could not be determined, the sex was listed as unknown.

The fluid social structure of transient killer whales, and often-long periods of time between sightings, makes determining the exact age of whales a challenge. Therefore, every whale identified in this catalog was given an age class: "adult male" (≥15 years of age or showing signs of maturity, i.e. onset of dorsal fin growth, or "sprouting"), "adult female" (≥15 years of age or showing signs of maturity, i.e. close proximity with a calf), "sub-adult" (10-15 years of age), or "juvenile" (<10 years of age).

As previously noted, some whales in this catalog have been documented in existing catalogs for waters off British Columbia, Alaska, and California and Mexico. For these

individuals, we were able to use information provided in these catalogs to help determine age class and sex.

Catalog Format

The photo-identification catalog is laid out to include as much information about each whale as possible. On the left side of the page is the animal's unique identification number (eg. OCT002), followed by the sex (where known), and age class. Below that is a brief summary of information about that whale, which may include who the whale is related to, where it has been sighted, how commonly it has been sighted, who it tends to travel with, and any distinguishing characteristics. The rest of the page contains photographs depicting the left and right sides of the dorsal fin and saddle patch (where available), and the left and right eye patches (where available). The catalog is laid out with two whales per page, with the information on the left corresponding to the photographs on the right. See the example below.

Key

Sex:

♂	Male
♀	Female
UNK	Unknown

Age class (AC):

Adult male	≥15 years of age
Adult female	≥15 years of age
Sub-adult	10-15 years of age
Juvenile	<10 years of age

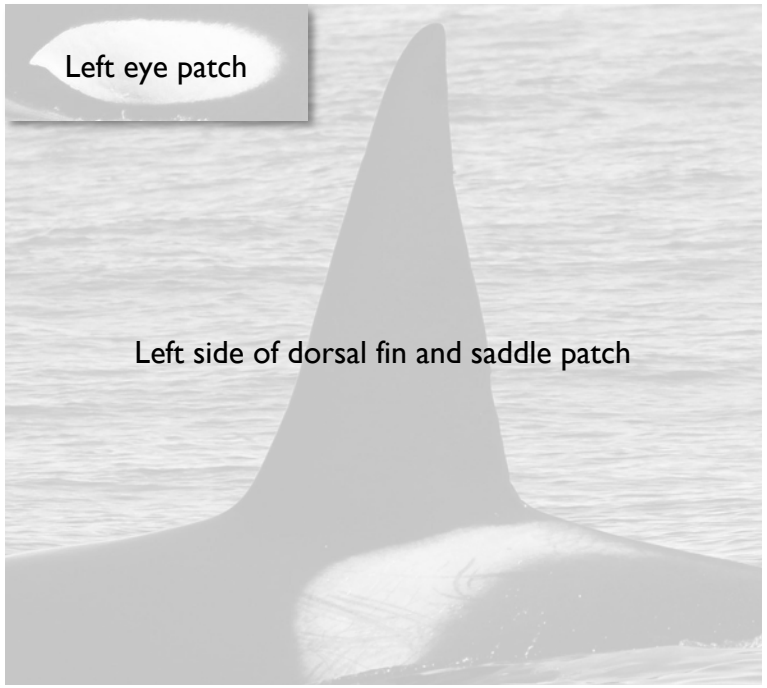
Example:

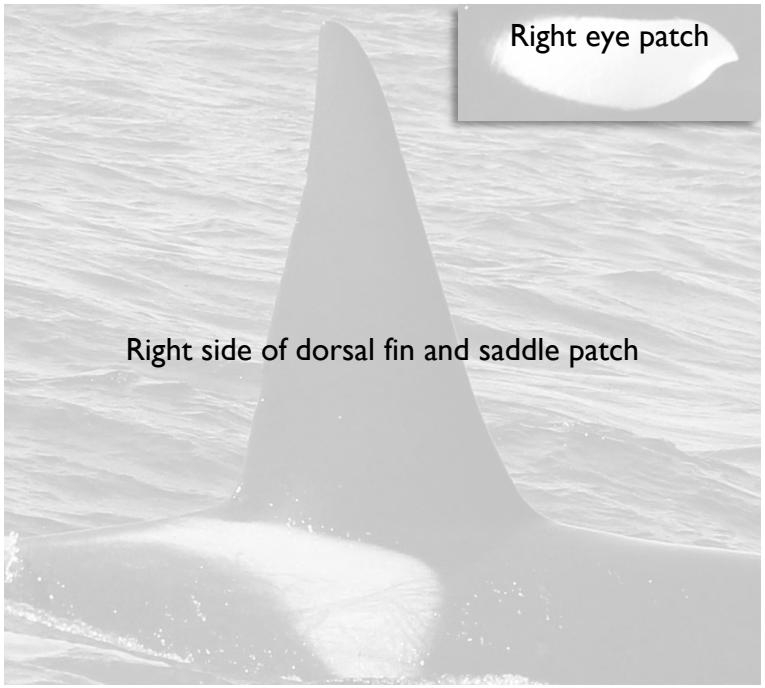
OCT002

Sex: ♂

AC: Adult male

Commonly sighted in Monterey Bay, CA but documented as far north as Glacier Bay, AK. Often travels alongside presumed mother, OCT028, and traveling companion, OCT029.





Through the Ages

The distinctive characteristics of a killer whale's dorsal fin and saddle patch can change dramatically over the years. As a whale ages, it acquires new notches and scars from interactions with conspecifics and the environment. Male killer whales go through a dramatic growth spurt at the age of 13 to 15 years, where the dorsal fin grows rapidly reaching a height of 1.8 m at maturity (see morphology section). Newborn killer whale calves are born with an indistinct or missing saddle patch. As the calf grows, the saddle patch gradually becomes more distinct until it fully forms at the age of two. These changes throughout a whale's life can make photo-identification studies particularly difficult. Every year we try to photograph and update each whale's image. Here we show an example of the physical changes to the dorsal fin and saddle patch of an adult male transient killer whale known as OCT044C.

Outer Coast Transients

OCT001

Sex: ♂

AC: Adult male

One of the largest transients ever identified; first sighted in 1980 off Humboldt County. Rarely sighted, but has been seen as far north as Vargas Island in Clayquot Sound, BC and as far south as Monterey Bay, CA; possibly deceased or dispersed.

OCT002

Sex: ♂

AC: Adult male

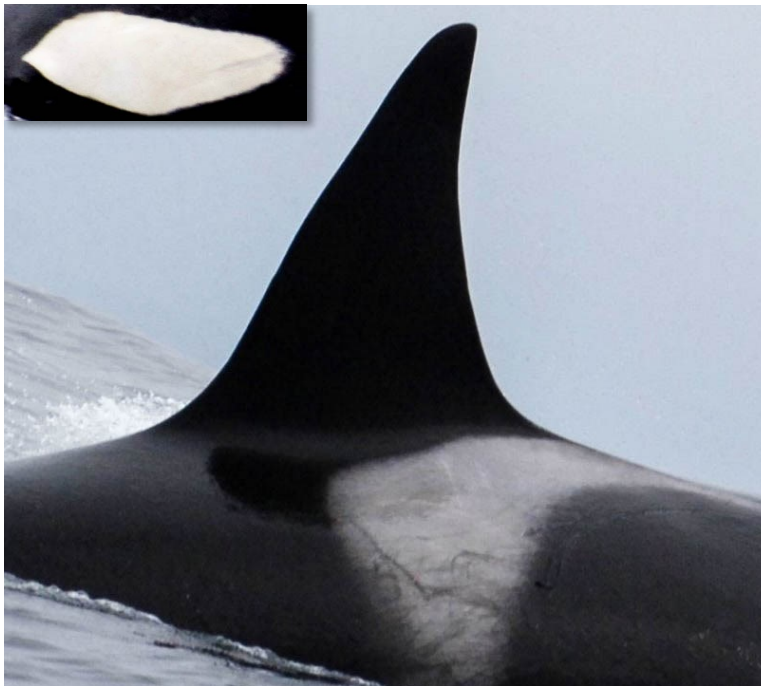
Commonly sighted in Monterey Bay, CA but documented as far north as Glacier Bay, AK. Often travels alongside presumed mother, OCT028, and traveling companion, OCT029.

OCT003

Sex: ♀

AC: Adult female

Presumed mother of OCT004 and OCT005; known to associate with two other post-reproductive females (OCT008 and OCT092). Encountered infrequently in Monterey Bay, CA. Northernmost sighting was near Campbell River, BC.

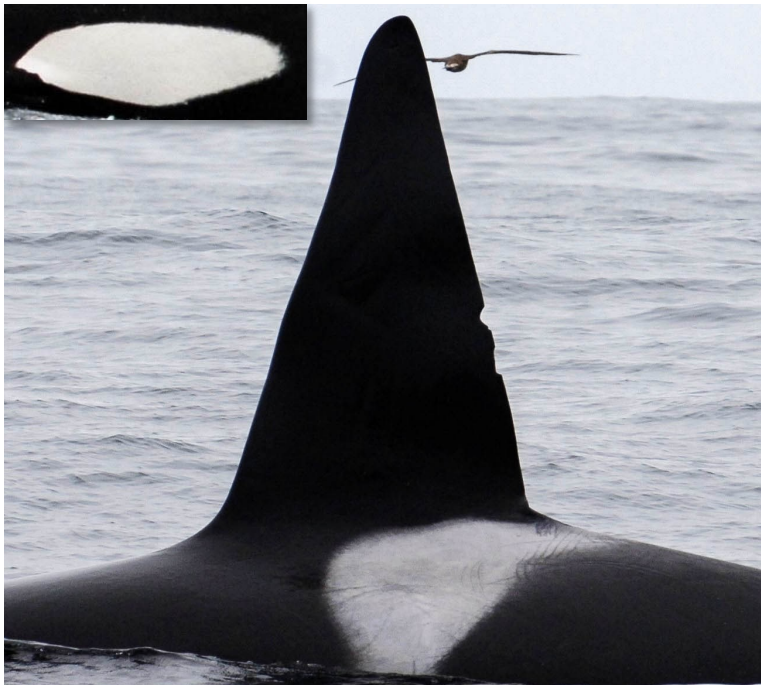


OCT004

Sex: ♂

AC: Adult male

One of largest transients documented (along with OCT001); seen in Monterey Bay, CA and as far north as BC. Not seen in recent years; typically traveled with presumed mother, OCT003, and presumed brother, OCT005. Possibly deceased or dispersed.



OCT005

Sex: ♂

AC: Adult male

Presumed offspring of OCT003; often sighted in Monterey Bay, CA, but documented as far north as Campbell River, BC. Traveled with presumed mother, OCT003, and presumed brother, OCT004. Possibly deceased or dispersed.

OCT008

Sex: ♀

AC: Adult female

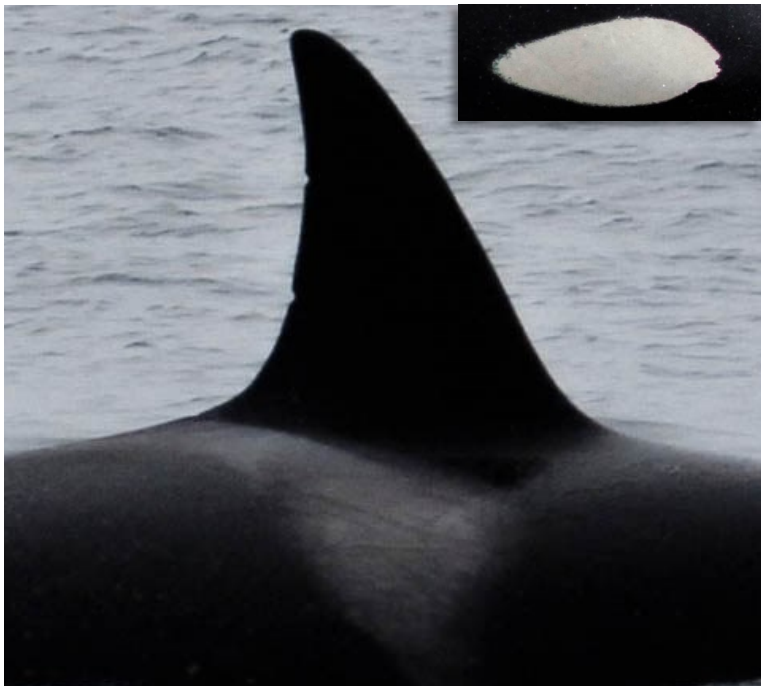
Post reproductive female; known to associate with two other post-reproductive females, OCT003 and OCT092. Rarely sighted, has been documented a handful of times in California waters and as far north as Westport, WA.

OCT009

Sex: ♀

AC: Adult female

Rarely sighted individual, documented in Monterey Bay, CA on occasion. Travels with presumed son, OCT059, and known offspring OCT009C.



OCT009C

Sex: UNK

AC: Sub-adult

Rarely sighted individual, encountered in Monterey Bay, CA. Offspring of OCT009. Travels with mother and presumed sibling (OCT059).

OCT010

Sex: ♀

AC: Adult female

Mother of OCT010C, travels with offspring. Rarely sighted; has been observed in Monterey Bay, CA.

No Image Available

OCT010C

Sex: UNK

AC: Sub-adult

Offspring of OCT010, travels with mother. Rarely encountered; has been sighted in Monterey Bay, CA.

OCT012

Sex: ♂

AC: Adult male

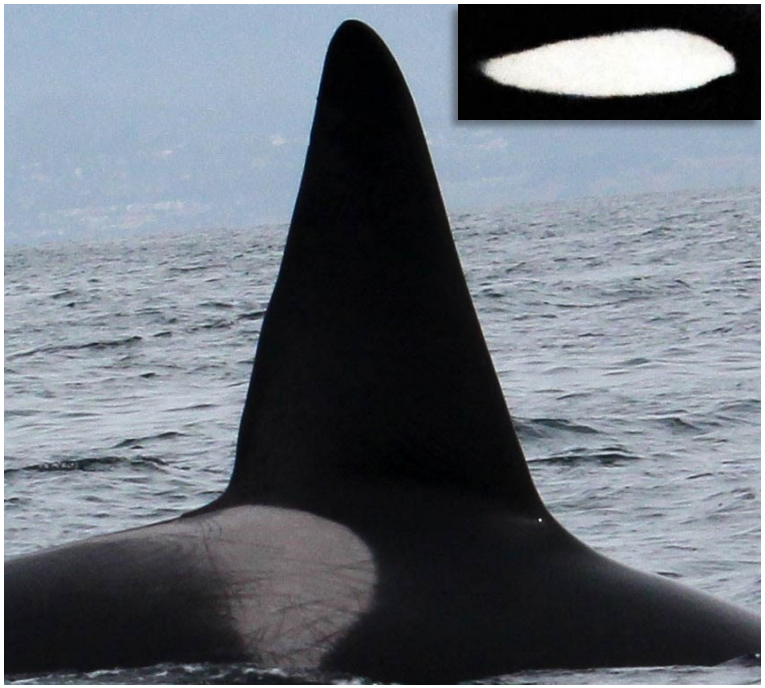
Very distinctive collapsed dorsal fin. Most commonly seen in Monterey Bay, CA but has been sighted as far north as Tofino, BC. Last documented in Monterey Bay in 2008; possibly deceased or dispersed.

OCT013B

Sex: ♂

AC: Adult male

Most commonly sighted in Monterey Bay, CA; has also been documented as far north as Race Rocks, BC. Usually travels alone, but occasionally associates with OCT025, and the OCT042 and OCT044 matrilines. Mother (OCT013) deceased c. 2004.



OCT014

Sex: ♀

AC: Adult female

Presumed mother of OCT015 and OCT030; often travels with OCT015. Commonly seen in Monterey Bay, CA but documented as far north as San Juan Islands, WA.

OCT015

Sex: ♂

AC: Adult male

Presumed son of OCT014 and presumed brother of OCT030; usually travels in association with his presumed mother, OCT014. Commonly documented in Monterey Bay, CA but sighted as far north as Haida Gwaii, BC.

OCT016

Sex: ♀

AC: Adult female

Frequently sighted in Monterey Bay, CA; traveled with her son OCT016B. Our last sighting was in 2013; likely deceased or dispersed. Has been observed predating on gray whales, and was featured in BBC's *The Blue Planet*.

OCT016B

Sex: ♂

AC: Adult male

Offspring of OCT016; typically associates with the OCT044A matriline. Frequently encountered in Monterey Bay, CA but has been sighted as far south as San Diego, CA.

OCT017

Sex: ♀

AC: Adult female

Rarely sighted individual; not commonly encountered. Documented sporadically in Monterey Bay, CA; occasionally observed associating with the OCT019 matriline.

No Image Available

OCT018

Sex: ♂

AC: Adult male

Infrequently sighted individual; encountered in Monterey Bay, CA, and sighted as far north as Tofino, BC. Rarely seen alone, usually travels with various other transient groups.

OCT019

Sex: ♀

AC: Adult female

Mother of OCT019C and presumed mother of OCT020. Encountered intermittently in Monterey Bay, CA. Commonly travels with her offspring and the OCT043 matriline. Often involved in gray whale predations.

OCT019C

Sex: UNK

AC: Juvenile

Offspring of OCT019. Observed in Monterey Bay, CA traveling alongside mother.

OCT020

Sex: ♀

AC: Adult female

Presumed offspring of OCT019; usually seen traveling with presumed family in Monterey Bay, CA.

OCT021

Sex: ♂

AC: Adult male

First identified in Monterey Bay, CA; frequently seen in Juan de Fuca Straight off Southern Vancouver Island, BC. Travels with presumed mother, OCT023, and presumed siblings, OCT022 and OCT024.

OCT022

Sex: ♀

AC: Adult female

Frequently seen in Juan de Fuca Straight off Southern Vancouver Island, BC; sighted as far south as Monterey Bay, CA. Travels with offspring, OCT022C, presumed mother, OCT023, and presumed siblings, OCT021 and OCT024.

OCT022C

Sex: UNK

AC: Juvenile

Offspring of OCT022. Travels with mother and presumed family, the OCT023 matriline.

No Image Available

OCT023

Sex: ♀

AC: Adult female

First identified in Monterey Bay, CA; frequently seen in Juan de Fuca Straight off Southern Vancouver Island, BC. Travels with presumed offspring OCT021, OCT022, and OCT024, and presumed grandchild, OCT022C.

OCT024

Sex: ♀

AC: Adult female

Frequently seen in Juan de Fuca Straight off Southern Vancouver Island, BC; sighted as far south as Monterey Bay, CA. Travels with presumed mother, OCT023, and presumed siblings, OCT022 and OCT021.

OCT025

Sex: ♂

AC: Adult male

Significantly disfigured dorsal fin. Frequently encountered in Monterey Bay, CA; has also been seen in southern California and as far north as Vancouver Island, BC. Commonly associates with OCT013B and the OCT050 matriline.

OCT027

Sex: ♂

AC: Adult male

Solitary male, commonly sighted in Monterey Bay, CA. Typically travels alone; occasionally associates with fellow lone male, OCT013B. In 2017, he was sighted in the Farallon Islands, CA in association with rarely-encountered male OCT503.

OCT028

Sex: ♀

AC: Adult female

Commonly encountered in Monterey Bay, CA; has also been documented in BC waters, and as far north as Glacier Bay, AK. Often travels with OCT029 and her presumed son, OCT002.

OCT029

Sex: ♀

AC: Adult female

Commonly encountered in Monterey Bay, CA; has been sighted in Juan de Fuca Strait off Vancouver Island, BC. Often associates with OCT002 and OCT028.

OCT030

Sex: ♀

AC: Adult female

Matriarch of the OCT030 matriline; the most commonly sighted killer whales in Monterey Bay, CA. Frequently involved in gray whale predations. Typically encountered in Monterey Bay, CA; also seen off Vancouver Island, BC and Dana Point, CA.

OCT030B

Sex: ♀

AC: Adult female

Daughter of OCT030, mother of three, and member of the OCT030 matriline. Regularly seen in Monterey Bay, CA, but has also been documented off Vancouver Island, BC and Dana Point, CA. Frequently involved in gray whale predations.

OCT030B1

Sex: UNK

AC: Juvenile

First-born offspring of OCT030B; member of the OCT030 matriline. Regularly encountered in Monterey Bay, CA.

OCT030B2

Sex: UNK

AC: Juvenile

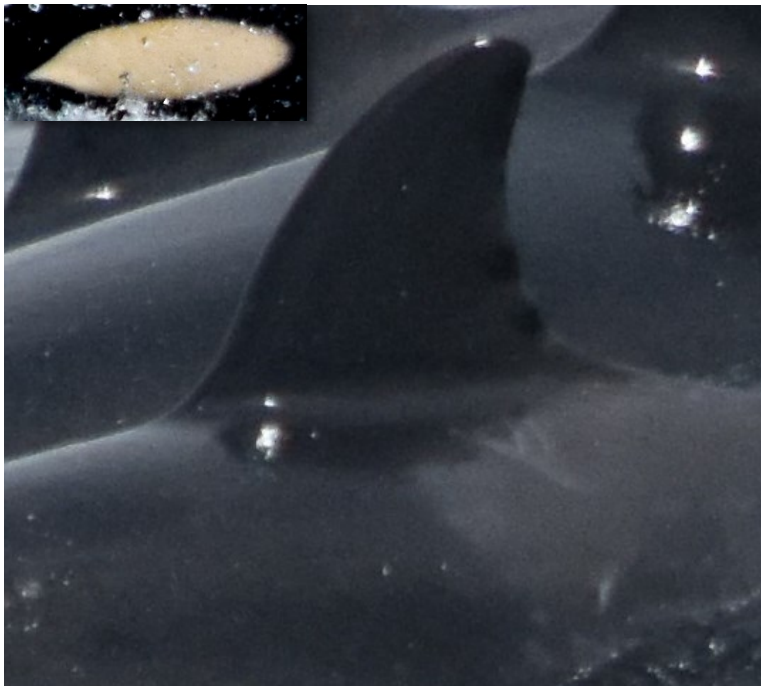
Second-born offspring of OCT030B; member of the OCT030 matriline. Regularly encountered in Monterey Bay, CA.

OCT030B3

Sex: UNK

AC: Juvenile

Third-born offspring of OCT030B; member of the OCT030 matriline. Encountered in Monterey Bay, CA.



No Image Available

OCT030C

Sex: ♂

AC: Adult male

Son of OCT030; member of the OCT030 matriline. Regularly seen in Monterey Bay, CA, but has also been documented off Vancouver Island, BC and Dana Point, CA. Often involved in gray whale predation events.

OCT030D

Sex: UNK

AC: Juvenile

Fourth-born offspring of OCT030; member of the OCT030 matriline. Regularly seen in Monterey Bay, CA. Often involved in gray whale predation events.

OCT031

Sex: ♀

AC: Adult female

Mother of OCT031B and OCT031C. Frequently seen in Monterey Bay, CA. We last encountered her in 2011; possibly deceased or dispersed.

OCT031B

Sex: ♂

AC: Adult male

Offspring of OCT031. Often encountered in Monterey Bay, CA. Tends to be a wanderer; associates with many different groups, but also travels alone.

OCT031C

Sex: ♀

AC: Adult female

Offspring of OCT031; travels frequently with the OCT044A matriline. Occasionally sighted in Monterey Bay, CA. Mother of OCT031C1 (born 2019, not present in this catalog).

OCT032

Sex: ♀

AC: Adult female

Poorly known individual. Occasionally encountered in Monterey Bay, CA.

OCT033

Sex: ♂

AC: Adult male

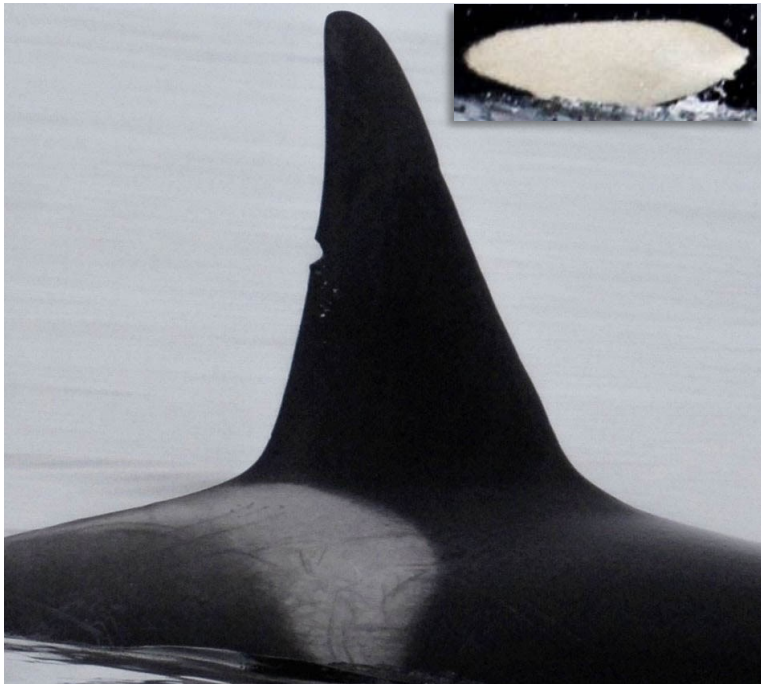
Rarely seen individual. Occasionally encountered in Monterey Bay, CA.

OCT034

Sex: ♂

AC: Adult male

Infrequently encountered individual; documented a handful of times in Monterey Bay, CA. Seen traveling with various other groups of transients.



OCT035

Sex: ♀

AC: Adult female

Post-reproductive female; travels with various groups of transients. Often sighted in Monterey Bay, CA; has also been documented in the Farallon Islands, CA and as far north as Tofino, BC.

OCT036

Sex: ♀

AC: Adult female

Poorly known individual; infrequently encountered in Monterey Bay, CA. Mother of OCT036A.

OCT036A

Sex: UNK

AC: Juvenile

Poorly known individual; infrequently encountered in Monterey Bay, CA. Offspring of OCT036.

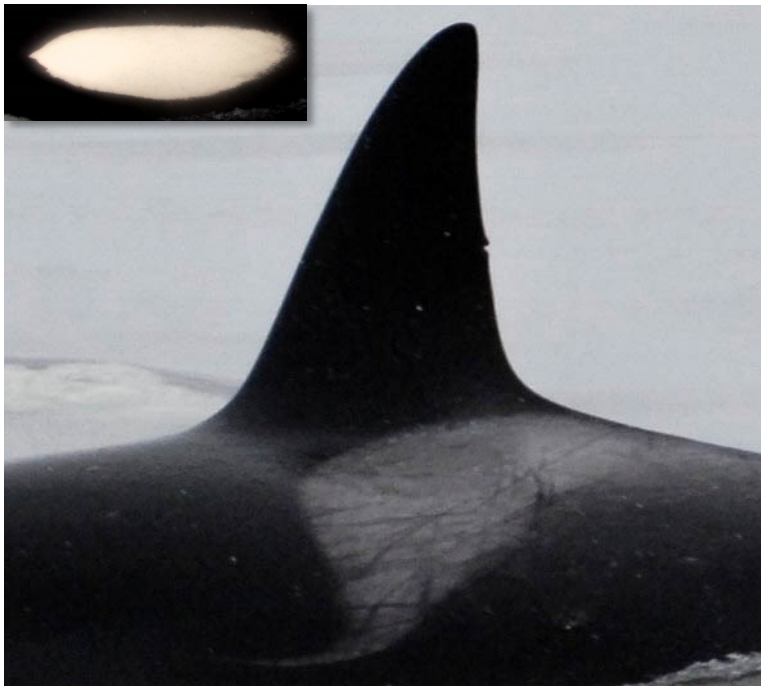
No Image Available

OCT037

Sex: ♀

AC: Adult female

Matriarch of the OCT037 matriline; travels with offspring and OCT038. Documented on several occasions in Monterey Bay, CA.

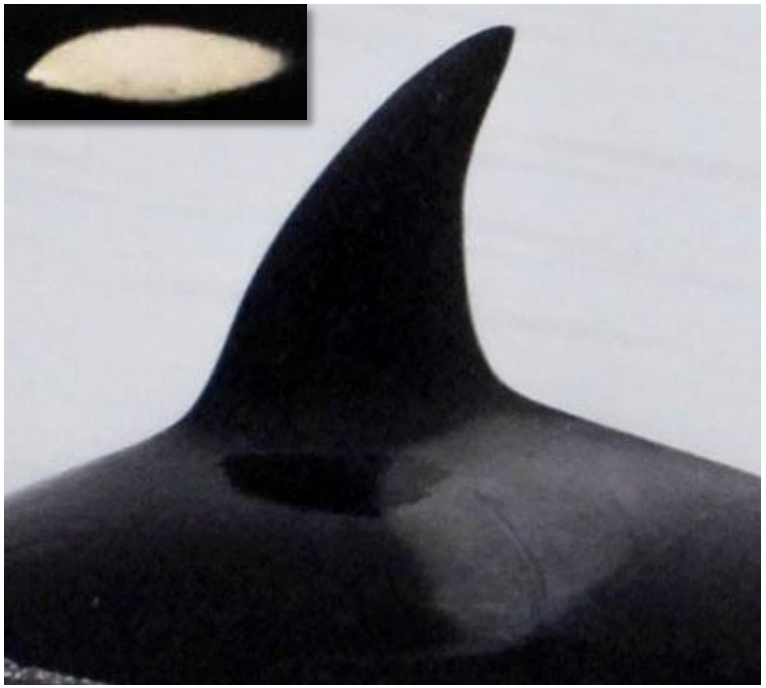


OCT037A

Sex: UNK

AC: Sub-adult

Offspring of OCT037; last documented traveling with mother and siblings in Monterey Bay, CA in 2015. Missing from subsequent encounters with this matriline; possibly deceased or dispersed.



OCT037B

Sex: UNK

AC: Juvenile

Offspring of OCT037. Documented traveling with mother and sibling OCT037C in Monterey Bay, CA.

OCT037C

Sex: UNK

AC: Juvenile

Offspring of OCT037. Documented traveling with mother and sibling OCT037B in Monterey Bay, CA.

OCT038

Sex: ♀

AC: Adult female

Mother of OCT038B. Frequently encountered in Monterey Bay, CA. Travels with known offspring, and regularly associates with the OCT037 matriline.

OCT038B

Sex: UNK

AC: Juvenile

Offspring of OCT038. Encountered in Monterey Bay, CA. Travels with mother and regularly associates with the OCT037 matriline.

OCT039

Sex: UNK

AC: Sub-adult

Poorly known individual; very seldom encountered. Sighted in Monterey Bay, CA. Possibly deceased or dispersed.

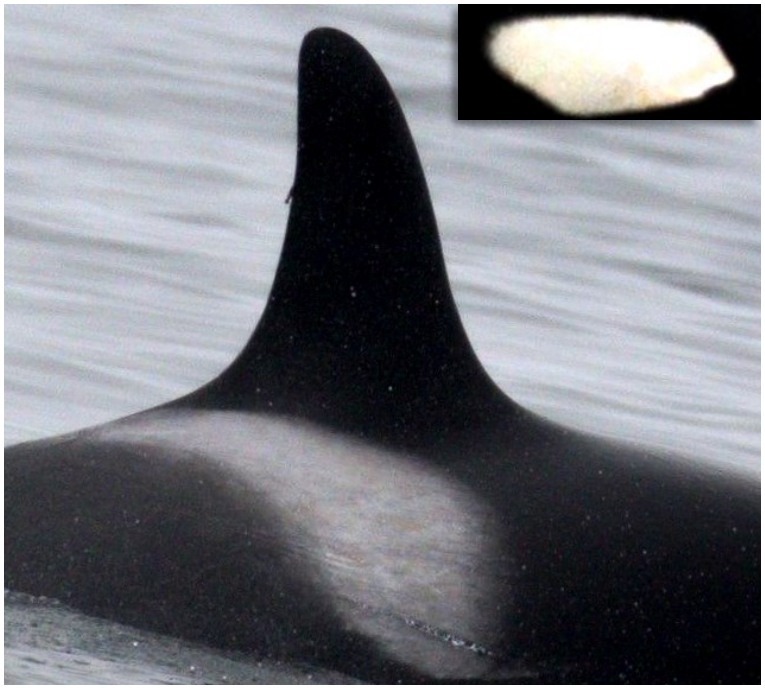
No Image Available

OCT040

Sex: ♀

AC: Adult female

Distinctive, unusually rounded dorsal fin. Occasionally encountered in Monterey Bay, CA; also sighted off northern California and as far north as Coos Bay, Oregon.



OCT041

Sex: ♀

AC: Adult female

Mother of OCT041A and OCT041B. Infrequently encountered individual; documented a handful of times in Monterey Bay, CA. Travels with offspring; sometimes seen in groups with other infrequently sighted individuals.

OCT041A

Sex: ♂

AC: Adult male

Infrequently encountered individual; documented a handful of times in Monterey Bay, CA. Son of OCT041; travels with mother and sibling OCT041B.

OCT041B

Sex: UNK

AC: Juvenile

Offspring of OCT041. Last sighted in 2008 in Monterey Bay, CA; absent from this matriline in subsequent sightings; possibly deceased or dispersed.

OCT042

Sex: ♀

AC: Adult female

Mother of OCT042A, OCT042B, and OCT042C. Frequently encountered in Monterey Bay, CA. Travels with offspring; often associates with OCT013B and the OCT044 matriline.

OCT042A

Sex: ♂

AC: Sub-adult

Son of OCT042. Frequently encountered in Monterey Bay, CA. Travels with mother and siblings OCT042B and OCT042C; often associates with OCT013B and the OCT044 matriline.

OCT042B

Sex: ♀

AC: Sub-adult

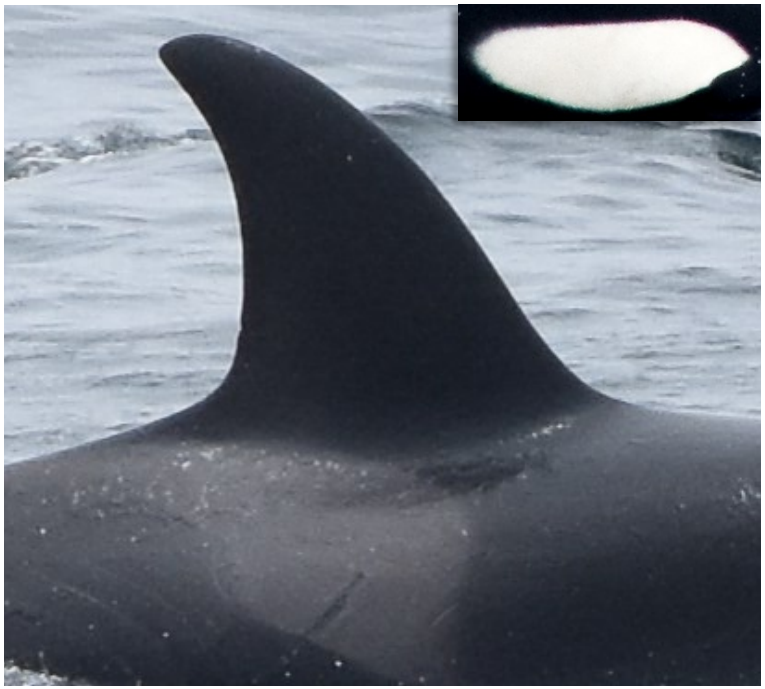
Daughter of OCT042. Frequently encountered in Monterey Bay, CA. Travels with mother and siblings OCT042B and OCT042C; often associates with OCT013B and the OCT044 matriline.

OCT042C

Sex: UNK

AC: Juvenile

Daughter of OCT042. Frequently encountered in Monterey Bay, CA; travels with mother and sibling OCT042A and OCT042B.



Members of the OCT042 matriline surfacing in front of Moss Landing, CA—photograph by Peggy West-Stap 2008 | NOAA NMFS permit 1094-1836

OCT043

Sex: ♀

AC: Adult female

Mother of OCT043A. Travels with offspring, and often associates with the OCT019 and OCT030 matrilines. Documented frequently in Monterey Bay, CA.

OCT043A

Sex: UNK

AC: Sub-adult

Offspring of OCT043. Travels with mother, and often associates with the OCT019 and OCT030 matrilines. Documented frequently in Monterey Bay, CA.

OCT044

Sex: ♀

AC: Adult female

Matriarch of the OCT044 matriline. Very commonly encountered in Southern California and Monterey Bay, CA; has also been documented off the Farallon Islands, CA. Travels with matriline; known to associate with the OCT030 and OCT044A matrilines.

OCT044A

Sex: ♀

AC: Adult female

Daughter of OCT044; matriarch of the OCT044A matriline. Very commonly encountered in Southern California and Monterey Bay, CA. Travels with offspring; known to associate with the OCT030 and OCT044 matrilines.

OCT044A2

Sex: UNK

AC: Sub-adult

Offspring of OCT044A; member of the OCT044A matriline. Very commonly encountered in Southern California and Monterey Bay, CA. Travels with family.

OCT044A3

Sex: UNK

AC: Sub-adult

Offspring of OCT044A; member of the OCT044A matriline. Very commonly encountered in Southern California and Monterey Bay, CA. Travels with family.

OCT044B

Sex: ♂

AC: Adult male

Son of OCT044; member of the OCT044 matriline. Very commonly sighted; frequently documented in Southern California and Monterey Bay, CA. Known to associate with the OCT030 and OCT044A matrilines.

OCT044C

Sex: ♂

AC: Adult male

Son of OCT044; member of the OCT044 matriline. Very commonly sighted; frequently documented in southern California and Monterey Bay, CA. Known to associate with the OCT030 and OCT044A matrilines.

OCT044D

Sex: UNK

AC: Sub-adult

Offspring of OCT044; member of the OCT044 matriline. Very commonly encountered matriline; frequently seen in Southern California and Monterey Bay, CA. Known to associate with the OCT030 and OCT044A matrilines.

OCT045

Sex: ♂

AC: Adult male

Rarely encountered individual. Has been documented in Monterey Bay, CA, the Farallon Islands, CA, and as far north as Long Beach, near Tofino, BC.

Members of the OCT044 matriline in front of Moss Landing , CA—photograph by Chelsea Mathieson 2019 | NOAA NMFS permit 20519

OCT046

Sex: ♀

AC: Adult female

Infrequently encountered individual. Occasionally sighted in Monterey Bay, CA, but has also been documented in the Channel Islands, CA.

OCT047

Sex: ♀

AC: Adult female

Poorly known individual; not commonly encountered. Occasionally sighted in Monterey Bay, CA; has been documented as far south as the Channel Islands, CA and as far north as offshore Kenny, CA.

OCT048

Sex: ♀

AC: Adult female

Poorly known individual. Encountered infrequently in Monterey Bay, CA; has also been documented as far north as Coos Bay, OR.

OCT049

Sex: UNK

AC: Sub-adult

Poorly known individual. Encountered on rare occasion in Monterey Bay, CA.

No Image Available

OCT050

Sex: ♀

AC: Adult female

Matriarch of the OCT050 matriline, mother of five. Frequently encountered in Monterey Bay, CA and the Southern California Bight. Travels with family; occasionally seen interacting with other transient groups.

OCT050A

Sex: ♀

AC: Adult female

Offspring of OCT050; member of the OCT050 matriline. Frequently sighted in Monterey Bay, CA and the Southern California Bight. Travels with family; occasionally interacts with other transient groups.

OCT050B

Sex: ♀

AC: Adult female

Very distinctive dorsal fin. Mother of OCT050B1 and OCT050B2, offspring of OCT050, and member of the OCT050 matriline. Frequently encountered in Monterey Bay, CA and Southern California Bight; travels with family.

OCT050B1

Sex: UNK

AC: Juvenile

First-born offspring of OCT050B and member of the OCT050 matriline. Documented in Monterey Bay, CA traveling with family.

OCT050B2

Sex: UNK

AC: Juvenile

Second-born offspring of OCT050B and member of the OCT050 matriline. Documented in Monterey Bay, CA traveling with family.

OCT050C

Sex: ♀

AC: Adult female

Daughter of OCT050, mother of OCT050C1, and member of the OCT050 matriline. Frequently encountered in Monterey Bay, CA; travels with family.

OCT050C1

Sex: UNK

AC: Juvenile

Rare distinctive white color morph—also recognized in one other transient killer whale (T046B1B born in 2018). Offspring of OCT050C and member of the OCT050 matriline. Travels with family.

Transient killer whale OCT050C (right) with her offspring, OCT050C1"Frostbite" (left) displaying a rare white color morph, Monterey Bay, CA—photograph by Tim Ward 2020 | NOAA NMFS permit 20519

OCT050D

Sex: UNK

AC: Sub-adult

Offspring of OCT050 and member of the OCT050 matriline. Frequently encountered in Monterey Bay, CA and the Southern California Bight. Travels with family.

OCT050E

Sex: UNK

AC: Juvenile

Offspring of OCT050 and member of the OCT050 matriline. Frequently encountered in Monterey Bay, CA and the Southern California Bight. Travels with family.

OCT055

Sex: UNK

AC: Sub-adult

Poorly known individual. Only documented on rare occasions in Monterey Bay, CA.

OCT056

Sex: UNK

AC: Sub-adult

Poorly known individual. Only documented on rare occasions in Monterey Bay, CA.

OCT058

Sex: UNK

AC: Sub-adult

Poorly known individual. Only documented on rare occasions in Monterey Bay, CA.

No Image Available

OCT059

Sex: ♂

AC: Adult male

Not commonly encountered; documented sporadically in Monterey Bay, CA. Often travels with presumed mother OCT009.

OCT060

Sex: ♂

AC: Adult male

Distinctive black line through right eye patch. Member of the OCT030 matriline; presumed brother of OCT030 and presumed son of OCT014. Regularly encountered in Monterey Bay, CA.

OCT062

Sex: ♂

AC: Adult male

Poorly known individual. Documented on occasion in Monterey Bay, CA traveling with an assemblage of other rarely sighted transient killer whales. Possibly deceased or dispersed.

OCT063

Sex: ♀

AC: Adult female

Poorly known individual. Only documented on rare occasions in Monterey Bay, CA traveling with an assemblage of other rarely sighted transient killer whales. Possibly deceased or dispersed.

OCT064

Sex: ♀

AC: Adult female

Matriarch of the OCT064 matriline. Commonly sighted in Monterey Bay, CA; has also been documented offshore of Kenny, CA and as far north as Glacier Bay, AK.

OCT064A

Sex: ♀

AC: Adult female

Daughter of OCT064 and member of the OCT064 matriline. Frequently sighted in Monterey Bay, CA; has also been documented far offshore of Kenny, CA.

OCT064B

Sex: ♀

AC: Adult female

Daughter of OCT064 and member of the OCT064 matriline. Frequently sighted in Monterey Bay, CA; has also been documented far offshore of Kenny, CA.

OCT064B1

Sex: UNK

AC: Juvenile

Offspring of OCT064B and member of the OCT064 matriline. Frequently sighted in Monterey Bay, CA traveling with family.

OCT064C

Sex: ♂

AC: Adult male

Son of OCT064 and member of the OCT064 matriline. Frequently sighted in Monterey Bay, CA; has also been documented far offshore of Kenny, CA.

OCT064D

Sex: ♀

AC: Adult female

Offspring of OCT064 and member of the OCT064 matriline. Frequently sighted in Monterey Bay, CA; has also been documented far offshore of Kenny, CA.

OCT064E

Sex: UNK

AC: Juvenile

Offspring of OCT064 and member of the OCT064 matriline. Frequently sighted in Monterey Bay, CA; has also been documented far offshore of Kenny, CA.

OCT070

Sex: ♂

AC: Adult male

Poorly known individual; has been seen associating with OCT071 and OCT072 in Monterey Bay, CA. Documented as far north as Race Rocks, BC associating with local coastal transients (the T037A matriline).

OCT071

Sex: UNK

AC: Sub-adult

Rarely encountered. Has been seen associating with OCT070 and OCT072 in Monterey Bay, CA.

OCT072

Sex: ♀

AC: Adult female

Mother of OCT072A; rarely encountered. Travels with offspring; has been seen associating with OCT070 and OCT071 in Monterey Bay, CA.

OCT072A

Sex: UNK

AC: Juvenile

Offspring of OCT072; rarely encountered. Documented in Monterey Bay, CA traveling with mother.

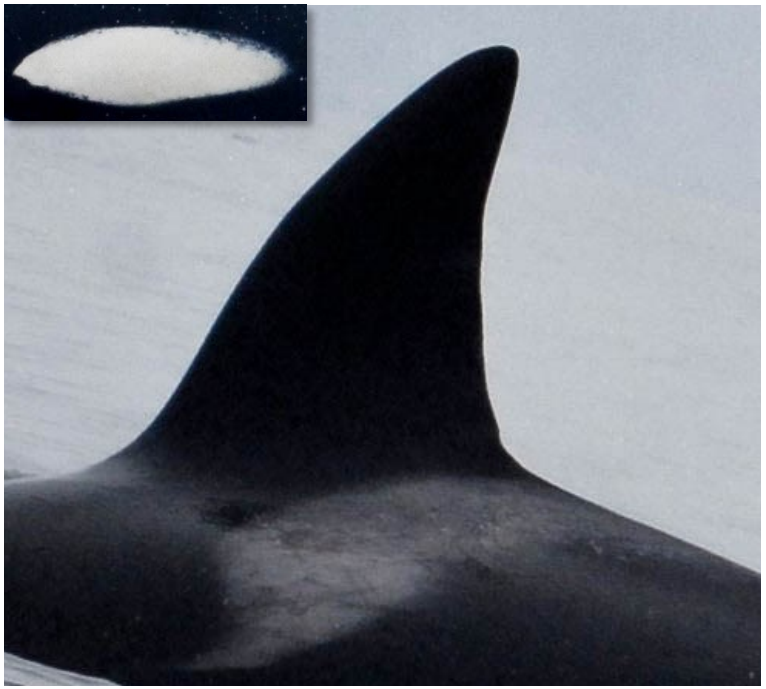
No Image Available

OCT073

Sex: ♀

AC: Adult female

Distinctive wide dorsal fin. Sporadically sighted in Monterey Bay, CA. Has been documented associating with a number of different transient groups.

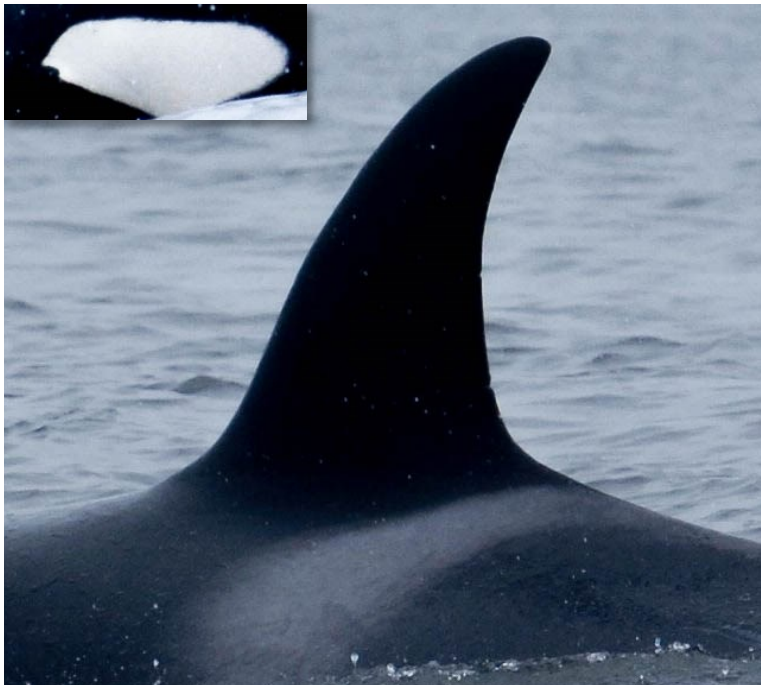


OCT074

Sex: UNK

AC: Sub-adult

Poorly known individual; sighted infrequently in Monterey Bay, CA. Identified associating with the OCT075 matriline and OCT076.

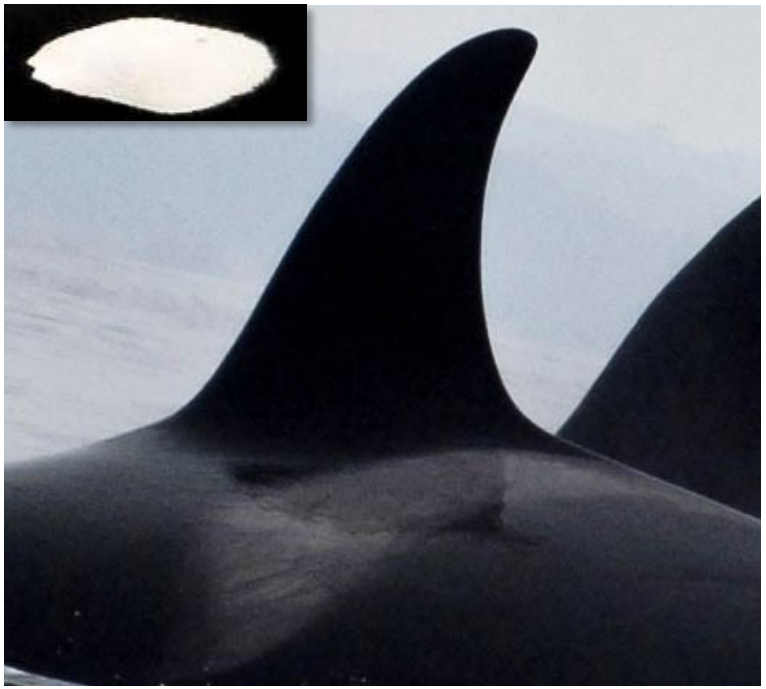


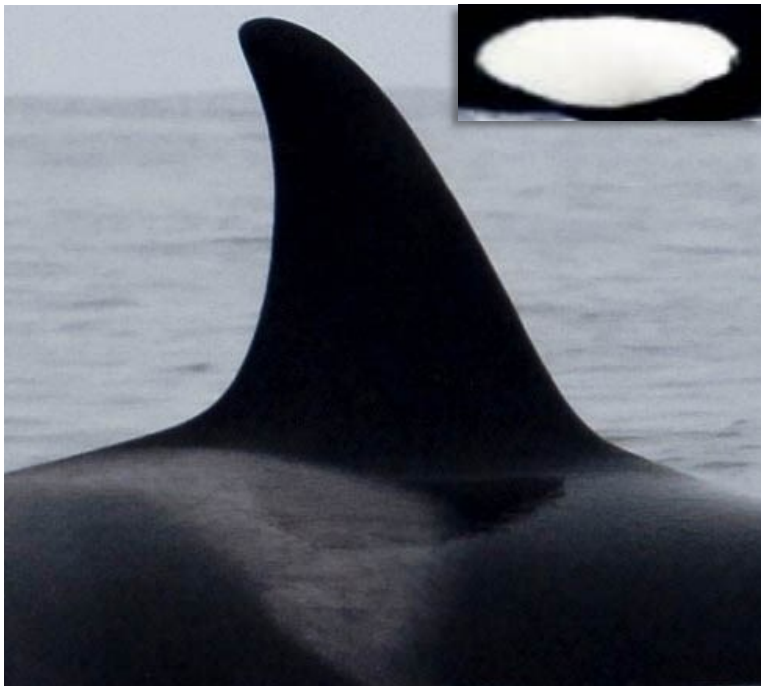
OCT075

Sex: ♀

AC: Adult female

Mother of OCT075B. Infrequently encountered; documented on rare occasions in Monterey Bay, CA. Travels with offspring and has been seen in association with OCT074 and OCT076.





OCT075B

Sex: UNK

AC: Juvenile

Offspring of OCT075. Travels with mother; documented in Monterey Bay, CA.

No Image Available

OCT076

Sex: UNK

AC: Sub-adult

Poorly known individual. Only sighted sporadically on rare occasions in Monterey Bay, CA. Identified associating with OCT074 and the OCT075 matriline.

OCT077

Sex: ♀

AC: Adult female

Mother of OCT077A and OCT077B; matriarch of the OCT077 matriline. Sighted on occasion in Monterey Bay, CA; has been documented as far south as Santa Barbara, CA. Frequently associates with the OCT078 matriline.

OCT077A

Sex: UNK

AC: Sub-adult

Offspring of OCT077 and member of the OCT077 matriline. Sighted on occasion in Monterey Bay, CA; travels with family.

No Image Available

OCT077B

Sex: UNK

AC: Juvenile

Offspring of OCT077 and member of the OCT077 matriline. Sighted on occasion in Monterey Bay, CA; travels with family.

No Image Available

OCT078

Sex: ♀

AC: Adult female

Mother of OCT078A; occasionally sighted in Monterey Bay, CA. Travels with offspring; frequently associates with the OCT077 matriline.

OCT078A

Sex: UNK

AC: Juvenile

Offspring of OCT078; travels with mother. Occasionally sighted in Monterey Bay, CA.

OCT079

Sex: UNK

AC: Sub-adult

Poorly known individual. Only documented on rare occasions in Monterey Bay, CA.

OCT080

Sex: ♀

AC: Adult female

Poorly known individual. Only documented on rare occasions in Monterey Bay, CA; has also been documented in the Farallon Islands, CA.

OCT081

Sex: ♀

AC: Adult female

Mother of OCT081A; not commonly sighted. Documented infrequently in Monterey Bay, CA; tends to travel in large groups of transients.

OCT081A

Sex: UNK

AC: Juvenile

Offspring of OCT081; not commonly sighted. Documented infrequently in Monterey Bay, CA traveling with mother.

OCT082

Sex: UNK

AC: Sub-adult

Poorly known individual; documented infrequently in Monterey Bay, CA.

OCT083

Sex: UNK

AC: Sub-adult

Poorly known individual; sighted on occasion in Monterey Bay, CA.

OCT084

Sex: ♂

AC: Adult male

Poorly known individual; encountered on rare occasions in Monterey Bay, CA.

OCT085

Sex: ♀

AC: Adult female

Rarely sighted individual; encountered on a handful of occasions in Monterey Bay, CA. Often travels with presumed son, OCT086.

OCT086

Sex: ♂

AC: Adult male

Rarely sighted individual; encountered on a handful of occasions in Monterey Bay, CA. Often travels with presumed mother, OCT085.

OCT087

Sex: ♀

AC: Adult female

Poorly known individual. Sighted sporadically in Monterey Bay, CA.

No Image Available

OCT088

Sex: ♀

AC: Adult female

Poorly known individual; documented on rare occasions in Monterey Bay, CA. Travels with offspring, OCT088A.

OCT088A

Sex: UNK

AC: Juvenile

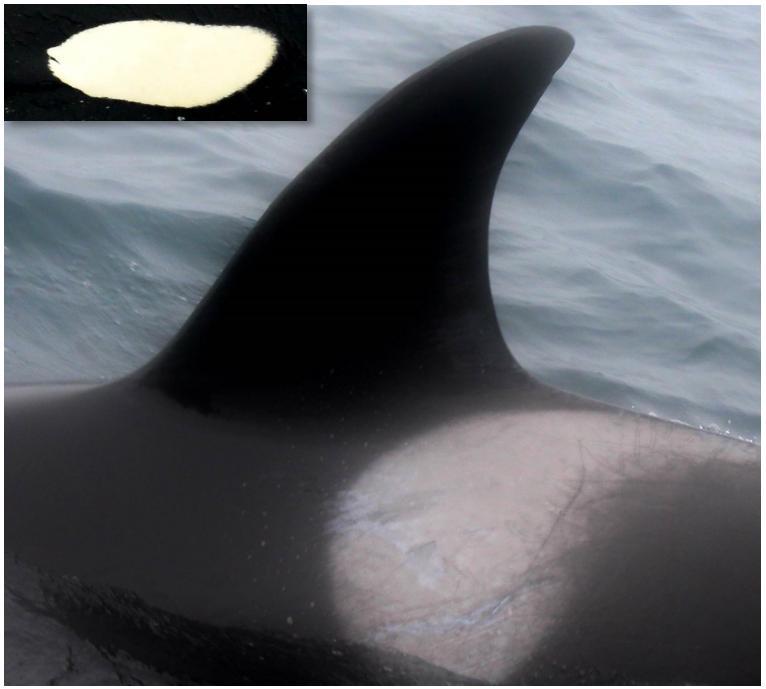
Poorly known individual; documented on rare occasions in Monterey Bay, CA. Travels with mother, OCT088.

OCT089

Sex: ♀

AC: Adult female

Poorly known individual; documented on rare occasions in Monterey Bay, CA. Travels with offspring, OCT089A.



OCT089A

Sex: UNK

AC: Juvenile

Poorly known individual; documented on rare occasions in Monterey Bay, CA. Travels with mother, OCT089.

No Image Available

OCT090

Sex: ♂

AC: Adult male

Poorly known individual; documented in Monterey Bay, CA and far offshore of Kenny, CA.

OCT091

Sex: UNK

AC: Sub-adult

Poorly known individual. Documented on rare occasions in Monterey Bay, CA.

No Image Available

OCT092

Sex: ♀

AC: Adult female

Poorly known individual. Seen on occasion in Monterey Bay, CA; has also been documented off Northern California.

OCT093

Sex: UNK

AC: Sub-adult

Poorly known individual; documented in 2018 in Monterey Bay, CA.

A Blue-Water Encounter

In June 2015, while transporting our new research vessel from Bellingham, Washington to Moss Landing, California, we encountered an interesting assemblage: a large group of transient killer whales about 20 km offshore of Kenny, California just south of Shelter Cove. The group consisted of 36 different whales spread out over multiple subgroups. From photographs, using published catalogs, we were able to identify 33 of these whales, some of which had been documented previously off the central coast of California, and others in the coastal waters of the Pacific Northwest. Interestingly, the remaining three whales did not appear to exist in any published catalogs. We have since assigned these whales new identifications: OCT500, OCT501, and OCT502.

During this encounter, the whales exhibited an array of social activity including breaches, tail slaps, and upside-down pectoral slaps. There were three distinct subgroups that were primarily traveling slowly, but then would mill around to socialize. The groups came together several times throughout the encounter. At one point, an individual made a surface vocalization while others were tail slapping around the vessel. One male surfaced near the boat as we floated closer to the group of young calves. The young whales gradually approached us, where we saw one very young calf with the characteristic orange coloration on the eye patch and underside of the rostrum.

The most notable behavior that we documented was an interaction between two of the unidentified males. They swam abreast, just far enough apart so they could slap their dorsal fins on the surface towards each other without hitting one another. They continued to do this multiple times. This was the first time we have seen behavior of this sort. As we continue to explore offshore areas outside Monterey Bay, it is likely we will continue to identify new whales and witness new behaviors.

Transient killer whales off northern California—photographs by Anna Hunter 2015

Transient killer whales diving into the deep blue waters off northern California—photograph by Anna Hunter 2015

The following transient killer whales have not been identified in Monterey Bay, CA. For that reason, each whale is given an OCT5XX designation.

OCT500

Sex: ♂

AC: Adult male

Poorly known individual. Identified far offshore of Kenny, CA.

OCT501

Sex: ♂

AC: Adult male

Poorly known individual. Identified far offshore of Kenny, CA.

OCT502

Sex: ♂

AC: Adult male

Poorly known individual. Identified far offshore of Kenny, CA.

No Image Available

OCT503

Sex: ♂

AC: Adult male

Poorly known individual. Documented off the Farallon Islands, CA in association with OCT027.

Group of transient killer whales in Monterey Bay, CA—photograph by Winnie Mulé 2017 | NOAA NMFS permit 20519

Matrilineal Groups

The basic social unit of transient killer whales is the matrilineal group, which comprises of a mother and her offspring. The social organization of transient killer whales is fluid, with members of the group frequently dispersing and associating with other groups. For this reason, long term observational studies are required for understanding the relatedness of individuals. The following pages display the matrilineal relationships based on observed association of known groups that have been encountered on multiple occasions, and in part on common knowledge that has accrued among the whale -watch community for decades. Sex is included, when known.

Key

OCT789	Known individual
OCT789	Deceased individual
———	Known relationship
.....	Presumed relationship
♂	Male
♀	Female

OCT003s

OCT009s

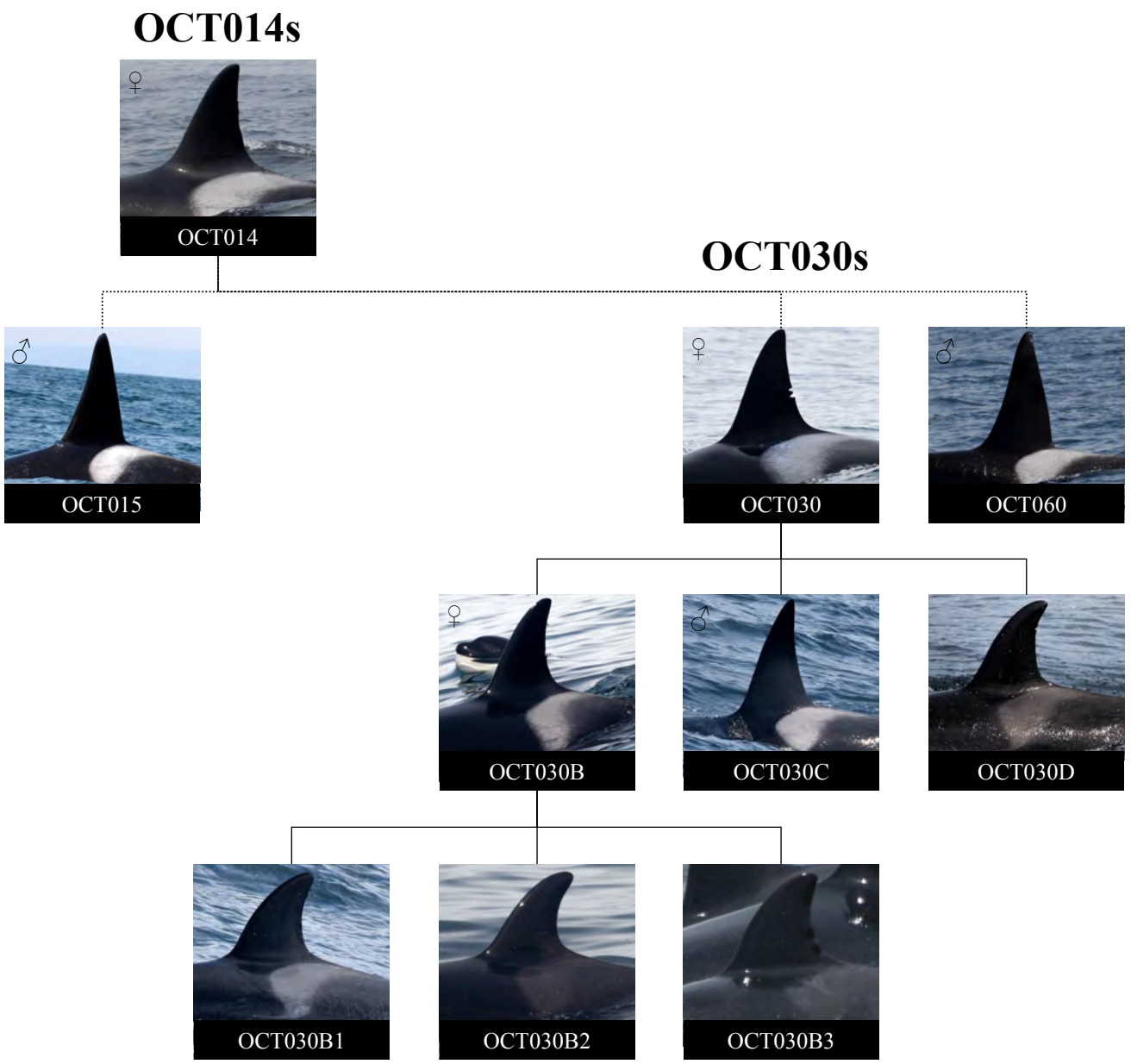
OCT010s

OCT016s

OCT019s

OCT023s

OCT028s


OCT014s
♀
OCT014
OCT030s
♂
OCT015
♀
OCT030
♂
OCT060
♀
OCT030B
♂
OCT030C
OCT030D
OCT030B1
OCT030B2
OCT030B3

OCT031s

OCT031

OCT031B

OCT031C

OCT036s

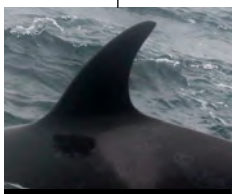
OCT036

OCT036A

OCT037s

OCT037

OCT037A

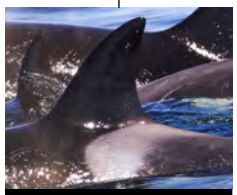


OCT037B

OCT037C

OCT038s

OCT038



OCT038B

OCT041s

OCT041

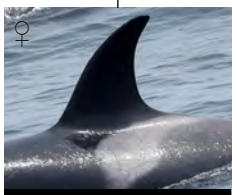
OCT041A

OCT041B

OCT042s

OCT042

OCT042A



OCT042B

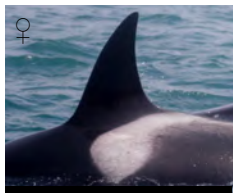
OCT042C

OCT043s

OCT043

OCT043A

OCT044s

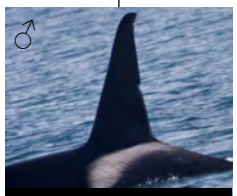


OCT044

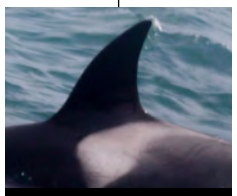
OCT044As

OCT044A

OCT044B



OCT044C



OCT044D

OCT044A2

OCT044A3

OCT050s

OCT072s

OCT064s

OCT075s

OCT077s

OCT078s

OCT081s

OCT085s

OCT088s

OCT089s

Bibliography

Baird, R.W., & Stacey, P.J. (1988). Variation in saddle patch pigmentation in populations of killer whales (*Orcinus orca*) from British Columbia, Alaska, and Washington State. *Canadian Journal of Zoology*, *66*(11), 2582-2585.

Baird, R.W. (1994). *Foraging behaviour and ecology of transient killer whales* (*Orcinus orca*) (Doctoral dissertation). Simon Fraser University, British Columbia, Canada

Baird, R.W. & Dill, L.M. (1995). Occurrence and behaviour of transient killer whales: seasonal and pod-specific variability, foraging behaviour, and prey handling. *Canadian Journal of Zoology*, *73*(7), 1300-1311.

Baird, R.W. & Dill, L.M. (1996). Ecological and social determinants of group size in transient killer whales. *Behavioral Ecology*, *7*(4), 408-416.

Baird, R.W. (2000). The killer whale. In Mann, J., Connor, R.C., Tyack, P.L., Whitehead, H. (Eds.), Cetacean societies: Field studies of dolphins and whales, 127-153.

Baird, R.W. & Whitehead, H. (2000). Social organization of mammal-eating killer whales: group stability and dispersal patterns. *Canadian Journal of Zoology*, *78*(12), 2096-2105.

Baird, R.W. (2006). *Killer whales of the world: natural history and conservation*. Voyageur Press.

Baird, R.W., McSweeney, D.J., Bane, C., Barlow, J., Salden, D.R., La'Ren, K.A., & Webster, D.L. (2006). Killer Whales in Hawaiian Waters: Information on Population Identity and Feeding Habits. *Pacific Science*, *60*(4), 523-530.

Baldridge, A. (1972). Killer whales attack and eat a gray whale. *Journal of Mammalogy*, *53*(4), 898-900.

Barrett-Lennard, L.G., Ford, J.K., & Heise, K.A. (1996). The mixed blessing of echolocation: differences in sonar use by fish-eating and mammal-eating killer whales. *Animal behaviour*, *51* (3), 553-565.

Barrett-Lennard, L.G. & Ellis, G.M. (2001). *Population structure and genetic variability in northeastern Pacific killer whales: towards an assessment of population viability* (p. 35). Canadian Science Advisory Secretariat.

Barrett-Lennard, L.G., Matkin, C.O., Durban, J.W., Saulitis, E.L., & Ellifrit, D. (2011). Predation on gray whales and prolonged feeding on submerged carcasses by transient killer whales at Unimak Island, Alaska. *Marine Ecology Progress Series*, *421*, 229-241.

Belonovich, O.A. (2011). *Northern fur seals (Callorhinus ursinus) of the Commander Islands: summer feeding trips, winter migrations and interactions with killer whales (Orcinus orca)* (Doctoral dissertation). Texas A&M University, Texas, United States.

Bigg, M.A., MacAskie, I.B., & Ellis, G.M. (1976). *Abundance and Movements of Killer Whales off Eastern and Southern Vancouver Island: With Comments on Management*. (Unpublished Report) Arctic Biological Station, Ste. Anne de Bellevue, Quebec.

Bigg, M.A. (1982). An assessment of killer whale (*Orcinus orca*) stocks off Vancouver Island, British Columbia. *Report of the International Whaling Commission*, *32*, 655-666.

Bigg, M.A., Ellis, G.M., Ford, J.K.B., & Balcomb K.C. (1987). *Killer whales: a study of their identification, genealogy, and natural history in British Columbia and Washington State*. Nanaimo, BC: Phantom Press, Nanaimo BC.

Bigg, M.A., Olesiuk, P.F., Ellis, G.M., Ford, J.K.B., & Balcomb, K.C. (1990). Social organization and genealogy of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. *Report of the International Whaling Commission*, *12*, 383-405.

Black, N.A., Schulman-Janiger, A., Ternullo, R.L., & Guerrero-Ruiz, M. (1997). *Killer whales of California and western Mexico: a catalog of photo-identified individuals*. NOAA-TM-NMFS-SWFSC-247.

Burrage, B.R. (1964). An observation regarding gray whales and killer whales. *Transactions of the Kansas Academy of Science, 1903*, *67*(3), 550-551.

Burrows, J.A., Harvey, J.T., Newton, K.M., Croll, D.A., & Benson, S.R. (2012). Marine mammal response to interannual variability in Monterey Bay, California. *Marine Ecology Progress Series*, *461*, 257-271.

Cummings, W.C. & Thompson, P.O. (1971). Gray whales, *Eschrichtius robustus*, avoid the underwater sounds of killer whales, *Orcinus orca. Fishery Bulletin*, *69*(3), 525-530.

Dahlheim, M.E. (1997). *A photographic catalog of killer whales, Orcinus orca, from the central Gulf of Alaska to the southeastern Bering Sea*. NOAA-TR-NMFS-131.

Dahlheim, M.E., Ellifrit, D.K., & Swenson, J.D. (1997). *Killer whales of Southeast Alaska: a catalogue of photo-identified individuals*. Day Moon Press, Seattle, Washington, USA.

Dahlheim, M., Schulman-Janiger, A., Black, N.A., Ternullo, R., Ellifrit, D., & Balcomb, K.C. (2008). Eastern temperate north Pacific offshore killer whales (*Orcinus orca*): Occurrence, movements, and insights into feeding ecology. *Marine Mammal Science (24)*:719-729.

Dahlheim, M.E. & White, P.A. (2010). Ecological aspects of transient killer whales *Orcinus orca* as predators in Southeastern Alaska. *Wildlife Biology*, *16*(3), 308-323.

Deecke, V.B. (2003). *The Vocal Behaviour of Transient Killer Whales, (Orcinus Orca): Communicating with Costly Calls* (Doctoral dissertation) University of St Andrews, Scotland.

Deecke, V.B., Ford, J.K., & Slater, P.J. (2005). The vocal behaviour of mammal-eating killer whales: communicating with costly calls. *Animal Behaviour*, *69*(2), 395-405.

Dwyer, S.L. & Visser, I.N. (2011). Cookie cutter shark (*Isistius* sp.) bites on cetaceans, with particular reference to killer whales (*Orcinus orca*). *Aquatic Mammals*, *37*(2), 111-138.

Ford, J.K.B., Ellis, G.M., & Nichol, L.M.. (1992). *Killer whales of the Queen Charlotte Islands: A preliminary study of the abundance, distribution and population identity of Orcinus orca in the waters of Haida Gwaii*. Prepared for South Moresby/Gwaii Haanas National Park Reserve, Canadian Parks Service, by the Vancouver Aquarium.

Ford, J.K.B. & Ellis, G.M. (1999). *Transients. Mammal-hunting killer whales. UBC Press*.

Ford, J.K.B., Ellis, G.M., & Balcomb, K.C. (2000). *Killer Whales: The Natural History and Genealogy of Orcinus orca in British Columbia and Washington State*, (2nd ed). *UBC Press.*

Ford, J.K., Ellis, G.M., Matkin, D.R., Balcomb, K.C., Briggs, D., & Morton, A.B. (2005). Killer whale attacks on minke whales: prey capture and antipredator tactics. *Marine mammal science*, *21*(4), 603-618.

Ford, J.K. & Ellis, G.M. (2006). Selective foraging by fish-eating killer whales Orcinus orca in British Columbia. *Marine Ecology Progress Series*, *316*, 185-199.

Ford, J.K., Ellis, G.M., & Durban, J.W. (2007). *An assessment of the potential for recovery of west coast transient killer whales using coastal waters of British Columbia.* DFO Canadian Scientific Advisory. Sec. Res. Doc. 2007/088.

Ford, J.K.B., Stredulinsky, E.H., Towers , J.R., & G.M. Ellis. (2013). *Information in support of the identification of critical habitat for Transient killer whales (Orcinus orca) off the west coast of Canada*. DFO Canadian Scientific Advisory. Sec. Res. Doc. 2012/155. Iv + 46p.

Ford, J.K.B., Stredulinsky, E.H., Ellis, G.M., Durban, J.W., & Pilkington, J.F. (2014). *Offshore Killer Whales in Canadian Pacific Waters: Distribution, Seasonality, Foraging Ecology, Population Status and Potential for Recovery*. DFO Canadian Scientific Advisory Sec. Res. Doc. 2014/088. Vii + 55p.

Ford, J.K. (2014). *Marine Mammals of British Columbia*. Victoria, British Columbia: Royal BC Museum.

Forney, K.A. & Wade, P. (2007). Worldwide distribution and abundance of killer whales. In: *Whales, Whaling and Ecosystem* (ed. Estes J), pp. 145–162. University of California Press, Berkeley, CA.

Gemmell, G.L., McInnes, J.D., Heinrichs, S.J., & de Silva Wijeyeratne, G. (2015). Killer whale (*Orcinus orca*) predation on whales in Sri Lankan waters. *Aquatic Mammals*, *41*(3), 265.

Goley, P.D. & Straley, J.M. (1994). Attack on gray whales (*Eschrichtius robustus*) in Monterey Bay, California, by killer whales (*Orcinus orca*) previously identified in Glacier Bay, Alaska. *Canadian Journal of Zoology*, *72*(8), 1528-1530.

Green, G.A., Brueggeman, J.J., Grotefendt, R.A., Bowlby, C.E., Bonnell, M.L., & Balcomb K.C. (1992). Cetacean distribution and abundance off Oregon and Washington, 1989-1990. In: Brueggeman JJ (ed) Oregon and Washington marine mammal and seabird surveys. Ebasco Environmental Bellevue, WA, p 1-100.

Hanson, M.B. & Walker, W.A. (2014). Trans-Pacific Consumption of Cephalopods by North Pacific Killer Whales (*Orcinus orca*). *Aquatic Mammals*, *40* (3).

Heise, K., Ellis, G., and Matkin, C. 1992. *A catalogue of the killer whales of Prince William Sound.* North Gulf Oceanic Society, Homer, Alaska.

Henkel, L.A. & Harvey, J.T. (2008). Abundance and distribution of marine mammals in nearshore waters of Monterey Bay, California. *California Fish and Game*, *94*(1), 1.

Herman, D.P., Burrows, D.G., Wade, P.R., Durban, J.W., Matkin, C.O., LeDuc, R.G., & Krahn, M.M. (2005). Feeding ecology of eastern North Pacific killer whales Orcinus orca from fatty acid, stable isotope, and organochlorine analyses of blubber biopsies. *Marine Ecology Progress Series*, *302*, 275-291.

Heyning, J.E. & Dahlheim, M.E. (1988). *Orcinus orca*. *Mammalian Species*, (304), 1-9.

Houghton, J., Baird, R.W., Emmons, C.K., & Hanson, M.B. (2015). Changes in the occurrence and behavior of Mammal-eating Killer Whales in Southern British Columbia and Washington State, 1987–2010. *Northwest Science*, *89*(2), 154-170.

Hoyt, E. (2013). *Orca: the whale called killer*. Firefly Books.

Jefferson, T.A., Stacey, P.J., & Baird, R.W. (1991). A review of killer whale interactions with other marine mammals: predation to co-existence. *Mammal review*, *21*(4), 151-180.

Jones, I.M. (2006). A northeast Pacific offshore killer whale (*Orcinus orca*) feeding on a Pacific halibut (*Hippoglossus stenolepis*). *Marine Mammal Science*, *22*(1), 198-200.

Krahn, M.M., Herman, D.P., Matkin, C.O., Durban, J.W., Barrett-Lennard, L., Burrows, D.G., Dahlheim, M.E., Black, N., Leduc, R.G., & Wade, P.R. (2007). Use of chemical tracers in assessing the diet and foraging regions of eastern North Pacific killer whales. *Marine Environmental Research*, *63*(2), 91-114.

Maniscalco, J.M., Matkin, C.O., Maldini, D., Calkins, D.G., & Atkinson, S. (2007). Assessing killer whale predation on Steller sea lions from field observations in Kenai Fjords, Alaska. *Marine Mammal Science*, *23*(2), 306-321.

Matkin, C., Ellis, G., Saulitis, E., Barrett-Lennard, L., & Matkin, D. (1999). *Killer whales of southern Alaska*. North Gulf Oceanic Society, Homer, Alaska, 1-96.

Matkin, C.O., Barrett-Lennard, L.G., Yurk, H., Ellifrit, D., & Trites, A.W. (2007). Ecotypic variation and predatory behavior among killer whales (Orcinus orca) off the eastern Aleutian Islands, Alaska. *Fishery Bulletin*, *105*(1), 74-88.

Matkin, C., & Durban, J. (2011). Killer whales in Alaskan waters. *Journal of the American Cetacean Society*, *40*, 24-29.

Matkin, C.O., Durban, J.W., Saulitis, E.L., Andrews, R.D., Straley, J.M., Matkin, D.R., & Ellis, G.M. (2012). Contrasting abundance and residency patterns of two sympatric populations of transient killer whales (*Orcinus orca*) in the northern Gulf of Alaska. *Fishery Bulletin*, *110*(2), 143-155.

McInnes, J.D., Templeman, N.M. (2016). *Commonly identified transient killer whales off Vancouver Island, British Columbia.* Transient Killer Whale Research Project.

McInnes, J.D., Mathieson, R., Templeman, N.M., Marcos, S.L., Cullen, K.D., Wade, V.L., West-Stap, P.J. (2018). Ocean chronicles, it's a Bigg's sea, part 2: outer coast transient killer whales. Kiki's communications. *Compass Magazine Vancouver Island, 19*, 8-9.

McInnes, J.D. (2019). Into the kill: a deeper look into Bigg's orcas. Nature aware media. *Nature Aware Magazine, 1,* 18-22.

McInnes, J.D., Buckmaster, J.N., Cullen, K.D., Mathieson, C.M., & Tawse, J.P. (2020a). Intentional stranding by mammal-hunting killer whales (*Orcinus orca*) in the Salish Sea. *Aquatic Mammals, 46*(6), 556-560.

McInnes, J.D., Mathieson, C.R., West-Stap, P.J., Marcos, Wade, V.L., Moore, J.E., & Olson, P.A. (2020b). *Recent trends in the ecology of transient killer whales in Monterey Bay, California 2006-2018* [Conference poster]. CalCOFI Conference 2020: Understanding Unprecedented Changes in California's Marine and Coastal Environment; online.

McInnes, J.D., Mathieson, C.R., West-Stap, P.J., Marcos, S.L., Wade, V.L., Olson, P.A., & Trites, A.W. (2021). *Transient killer whales of central and northern California and Oregon: A catalog of photo-identified individuals.* U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-644. https://doi.org/10.25923/60y3-5m49

Morejohn, G.V. (1968). A Killer Whale: Gray Whale Encounter. *Journal of Mammalogy*, *49*(2), 327-328.

Morgan, L.E. (2005). *Marine priority conservation areas: Baja California to the Bering Sea*. Commission for Environmental Cooperation of North America.

Morin, P.A., Archer, F.I., Foote, A.D., Vilstrup, J., Allen, E.E., Wade, P., Durban, J., Parsons, K., Pitman, R., Li, L., Bouffard, P., Abel Nielsen, S.C., Rasmussen, M., Willerslev, E., Gilbert, M.T.P., Harkins, T. (2010). Complete mitochondrial genome phylogeographic analysis of killer whales (*Orcinus orca*) indicates multiple species. *Genome research*, *20*(7), 908-916.

Newman, K. & Springer, A.M. (2008). Nocturnal activity by mammal-eating killer whales at a predation hot spot in the Bering Sea. *Marine mammal science*, *24*(4), 990.

Newsome, S.D., Etnier, M.A., Monson, D.H., & Fogel, M.L. (2009). Retrospective characterization of ontogenetic shifts in killer whale diets via δ13C and δ15N analysis of teeth. *Marine Ecology Progress Series*, *374*, 229-242.

Parsons, K.M., Durban, J.W., Burdin, A.M., Burkanov, V.N., Pitman, R.L., Barlow, J., Barrett-Lennard, L.G., LeDuc, R.G., Robertson, K.M., Matkin, C.O. and Wade, P.R. (2013). Geographic patterns of genetic differentiation among killer whales in the northern North Pacific. *Journal of Heredity*, *104*(6), pp.737-754.

Pitman, R.L., Ballance, L.T., Mesnick, S.I., & Chivers, S.J. (2001). Killer whale predation on sperm whales: observations and implications. *Marine mammal science*, *17*(3), 494-507.

Poole, M.M. (1984) Migration corridors of gray whales along the central California coast, 1980-1982. In: The Gray Whale (*Eschrichtius robustus*) (ed. by M. L. Jones, S. L. Swartz, and S. Leatherwood), pp. 389-407. Academic Press, London

Rice, D.W. & Wolman, A.A. (1971). *The life history and ecology of the gray whale (Eschrichtius robustus)* (No. 599.5 RIC).

Rice, A., Deecke, V.B., Ford, J.K., Pilkington, J.F., Oleson, E.M., & Hildebrand, J.A. (2017). Spatial and temporal occurrence of killer whale ecotypes off the outer coast of Washington State, USA. *Marine Ecology Progress Series*, *572*, 255-268.

Riesch, R., Barrett-Lennard, L.G., Ellis, G.M., Ford, J.K., & Deecke, V.B. (2012). Cultural traditions and the evolution of reproductive isolation: ecological speciation in killer whales? *Biological Journal of the Linnean Society*, *106*(1), 1-17.

Sakamoto, K.Q., Takahashi, A., Iwata, T., & Trathan, P.N. (2009). From the eye of the albatrosses: a bird-borne camera shows an association between albatrosses and a killer whale in the Southern Ocean. *PLoS One*, *4*(10).

Saulitis, E.L., Matkin, C.O., & Fay, F.H. (2005). Vocal repertoire and acoustic behavior of the isolated AT1 killer whale subpopulation in southern Alaska. *Canadian Journal of Zoology*, *83*(8), 1015-1029.

Saulitis, E. (2013). *Into Great Silence: A Memoir of Discovery and Loss among Vanishing Orcas*. Beacon Press.

Sharpe, D.L., Castellote, M., Wade, P.R., & Cornick, L.A. (2019). Call types of Bigg's killer whales (*Orcinus orca*) in western Alaska: Using vocal dialects to assess population structure. *Bioacoustics*, *28*(1), 74-99.

Stacey, P.J., Baird, R.W., & Hubbard-Morton, A.B. (1990). Transient killer whale (*Orcinus orca*) harassment, predation, and "surplus killing" of marine birds in British Columbia. *Pacific Seabird Group Bulletin*, *17*(1), 38.

Sumich, J.L. & Harvey, J.T. (1986). Juvenile mortality in gray whales (*Eschrichtius robustus*). *Journal of Mammalogy*, *67* (1), 179-182.

Towers, J.R., Sutton, G.J., Shaw, T.J.H., Malleson, M., Matkin, D., Gisborne, B., Forde, J., Ellifrit, D., Ellis, G.M., Ford, J.K.B., and Doniol-Valcroze, T. (2019). Photo-identification Catalogue, Population Status, and Distribution of Bigg's Killer Whales known from Coastal Waters of British Columbia, Canada. Canadian Technical Report Fisheries Aquatic Science. 3311: vi +299 p.

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

Vos, D.J., Quakenbush, L.T., & Mahoney, B.A. (2006). Documentation of sea otters and birds as prey for killer whales. *Marine Mammal Science*, *22* (1), 201-205.

Wright, B.M., Ford, J.K., Ellis, G.M., Deecke, V.B., Shapiro, A.D., Battaile, B.C., & Trites, A.W. (2017). Fine-scale foraging movements by fish-eating killer whales (*Orcinus orca*) relate to the vertical distributions and escape responses of salmonid prey (*Oncorhynchus* spp.). *Movement ecology*, *5*(1), 3.

Young, B., Higdon, J., & Ferguson, S. (2011). Killer whale (*Orcinus orca*) photo-identification in the eastern Canadian Arctic. *Polar Research*, *30* (1), 7203.

Zerbini, A.N., Waite, J.M., Durban, J.W., LeDuc, R., Dahlheim, M.E., & Wade, P.R. (2007). Estimating abundance of killer whales in the nearshore waters of the Gulf of Alaska and Aleutian Islands using line-transect sampling. *Marine Biology*, *150*(5), 1033-1045.

Appendix

Table 1. Identified transient (Bigg's) killer whales of Monterey Bay and the Montereyan Pacific Transition Ecoregion 2006 to 2020: whale identification code, sex, age class, California designation (CA ID, where applicable), British Columbia designation (BC ID, where applicable), Alaska designation (AK ID, where applicable), and photographers' names and dates for photographs used in the identification catalog.

						Photographers (year)			
ID	**Sex**	**Age class**	**CA ID**	**BC ID**	**AK ID**	**Left dorsal**	**Right dorsal**	**Left eye patch**	**Right eye patch**
OCT001	M	Adult male	CA60			Josh McInnes (2009)	Peter Schultz (2008)	n/a	n/a
OCT002	M	Adult male	CA20	T132	AO10	Peggy West-Stap (2016)	Victoria Wade (2017)	Peggy West-Stap (2016)	Victoria Wade (2017)
OCT003	F	Adult female	CA180			Peggy West-Stap (2012)	Peggy West-Stap (2011)	Peggy West-Stap (2012)	n/a
OCT004	M	Adult male	CA24			Peggy West-Stap (2012)	Peggy West-Stap (2012)	Peggy West-Stap (2012)	Peggy West-Stap (2011)
OCT005	M	Adult male	N25			Peggy West-Stap (2010)	Peggy West-Stap (2011)	n/a	Peggy West-Stap (2011)
OCT008	F	Adult female	CA26			April Silbar (2018)	April Silbar (2018)	April Silbar (2018)	n/a
OCT009	F	Adult female	CA45			Doug Croft (2016)	Peggy West-Stap (2012)	Doug Croft (2016)	Peggy West-Stap (2012)
OCT009C	UNK	Juvenile				Doug Croft (2016)	Stephanie Marcos (2016)	n/a	n/a
OCT010	F	Adult female	CA46			Peggy West-Stap (2012)	n/a	Peggy West-Stap (2012)	n/a
OCT010C	UNK	Juvenile				Peggy West-Stap (2012)	Peggy West-Stap (2012)	Peggy West-Stap (2012)	Peggy West-Stap (2012)
OCT012	M	Adult male	CA43			Peggy West-Stap (2008)	Mike Johns (2006)	n/a	Peggy West-Stap (2006)
OCT013B	M	Adult male	CA171B*			Peggy West-Stap (2015)	Peggy West-Stap (2015)	Peggy West-Stap (2014)	Peggy West-Stap (2008)
OCT014	F	Adult female	CA40			Alicia Beverage (2014)	Winnie Mulé (2017)	Alicia Beverage (2014)	Maya Hoffman (2017)
OCT015	M	Adult male	CA137			Peggy West-Stap (2008)	Stephanie Marcos (2017)	Peggy West-Stap (2016)	Doug Croft (2016)
OCT016	F	Adult female	CA50			Peggy West-Stap (2013)	Peggy West-Stap (2013)	n/a	Peggy West-Stap (2013)
OCT016B	M	Adult male	CA50B*			Kate Cummings (2017)	Kate Cummings (2017)	Peggy West-Stap (2009)	Peggy West-Stap (2013)
OCT017	F	Adult female	CA111			n/a	Peggy West-Stap (2006)	n/a	Peggy West-Stap (2006)
OCT018	M	Adult male	CA28	T160		Peggy West-Stap (2008)	Peggy West-Stap (2011)	Peggy West-Stap (2008)	Peggy West-Stap (2014)
OCT019	F	Adult female	CA39			Peggy West-Stap (2012)	Hayley Newell (2014)	Maya Hoffman (2017)	Peggy West-Stap (2014)
OCT019C	UNK	Juvenile				Hayley Newell (2014)	Hayley Newell (2014)	Peggy West-Stap (2014)	Peggy West-Stap (2014)
OCT020	F	Adult female				Peggy West-Stap (2012)	Hayley Newell (2014)	Peggy West-Stap (2012)	n/a
OCT021	M	Adult male	CA166	T251/U033		Alethea Leddy (2017)	Josh McInnes (2011)	Alethea Leddy (2017)	n/a
OCT022	F	Adult female	CA172	T250/U034		Alethea Leddy (2017)	Josh McInnes (2011)	Alethea Leddy (2017)	n/a
OCT022C	UNK	Juvenile		T250C/U034C		Alethea Leddy (2017)	n/a	Alethea Leddy (2017)	n/a
OCT023	F	Adult female	CA173	T252/U031		Alethea Leddy (2017)	Alethea Leddy (2016)	Alethea Leddy (2016)	Alethea Leddy (2016)
OCT024	F	Adult female		T253/U052		Alethea Leddy (2016)	Josh McInnes (2011)	n/a	n/a
OCT025	M	Adult male	CA165			Peggy West-Stap (2012)	Peggy West-Stap (2012)	Peggy West-Stap (2013)	Peggy West-Stap (2013)
OCT027	M	Adult male	CA165			April Silbar (2017)	Winnie Mulé (2017)	n/a	n/a

Table 1. Continued

						Photographers (year)			
ID	**Sex**	**Age class**	**CA ID**	**BC ID**	**AK ID**	**Left dorsal**	**Right dorsal**	**Left eye patch**	**Right eye patch**
OCT028	F	Adult female	CA54	T134	AO12	Hayley Newell (2014)	Doug Croft (2017)	Victoria Wade (2017)	Hayley Newell (2014)
OCT029	F	Adult female	CA177			Michael Broome (2017)	Alicia Beverage (2014)	Peggy West-Stap (2008)	Alicia Beverage (2014)
OCT030	F	Adult female	CA140			April Silbar (2018)	Chelsea Mathieson (2019)	April Silbar (2018)	Doug Croft (2016)
OCT030B	F	Adult female	CA140B*			Josh McInnes (2019)	Chelsea Mathieson (2019)	Hayley Newell (2014)	Doug Croft (2016)
OCT030B1	UNK	Juvenile	CA140B1*			Chelsea Mathieson (2019)	Stephanie Marcos (2018)	Charles Nye (2018)	Stephanie Marcos (2018)
OCT030B2	UNK	Juvenile	CA140B2*			Chelsea Mathieson (2019)	Josh McInnes (2019)	Chelsea Mathieson (2019)	Stephanie Marcos (2018)
OCT030B3	UNK	Juvenile	CA140B3*			Victoria Wade (2020)	n/a	Victoria Wade (2020)	n/a
OCT030C	M	Adult male	CA140C*			Chelsea Mathieson (2019)	Josh McInnes (2019)	Josh McInnes (2019)	Victoria Wade (2018)
OCT030D	UNK	Juvenile	CA140D*			Josh McInnes (2019)	Stephanie Marcos (2018)	Josh McInnes (2019)	Josh McInnes (2019)
OCT031	F	Adult female	CA49			Peggy West-Stap (2008)	Peggy West-Stap (2011)	n/a	n/a
OCT031B	M	Adult male	CA49B*			Doug Croft (2017)	Victoria Wade (2017)	Doug Croft (2017)	Peggy West-Stap (2011)
OCT031C	F	Adult female	CA49C*			Hayley Newell (2014)	Victoria Wade (2017)	n/a	Victoria Wade (2017)
OCT032	F	Adult female				John Mayer (2018)	Peggy West-Stap (2011)	n/a	Peggy West-Stap (2006)
OCT033	M	Adult male				John Mayer (2018)	Lucas Corneliussen (2020)	n/a	Peggy West-Stap (2006)
OCT034	M	Adult male				Doug Croft (2018)	Peggy West-Stap (2013)	Peggy West-Stap (2013)	Peggy West-Stap (2013)
OCT035	F	Adult female	CA38	T161		Peggy West-Stap (2008)	Doug Croft (2016)	Doug Croft (2016)	Doug Croft (2016)
OCT036	F	Adult female				Peggy West-Stap (2011)	Peggy West-Stap (2011)	n/a	Peggy West-Stap (2011)
OCT036A	UNK	Juvenile				n/a	Peggy West-Stap (2011)	n/a	n/a
OCT037	F	Adult female				Peggy West-Stap (2013)	Stephanie Marcos (2016)	Stephanie Marcos (2016)	Hayley Newell (2014)
OCT037A	UNK	Sub-adult				Peggy West-Stap (2013)	Peggy West-Stap (2013)	Peggy West-Stap (2013)	Peggy West-Stap (2013)
OCT037B	UNK	Juvenile				Stephanie Marcos (2016)	Stephanie Marcos (2016)	Stephanie Marcos (2016)	Peggy West-Stap (2013)
OCT037C	UNK	Juvenile				Peggy West-Stap (2016)	Stephanie Marcos (2016)	n/a	Stephanie Marcos (2016)
OCT038	F	Adult female	CA142			Alicia Beverage (2014)	Stephanie Marcos (2016)	Peggy West-Stap (2013)	Peggy West-Stap (2013)
OCT038B	UNK	Juvenile				Eric Austin Yee (2021)	Eric Austin Yee (2021)	Stephanie Marcos (2016)	Stephanie Marcos (2016)
OCT039	UNK	Sub-adult				n/a	Peggy West-Stap (2006)	n/a	n/a
OCT040	F	Adult	CA169			Doug Croft (2016)	Stephanie Marcos (2016)	n/a	n/a
OCT041	F	Adult female				Peggy West-Stap (2008)	Doug Croft (2017)	n/a	Doug Croft (2017)
OCT041A	M	Adult male				Michael Pierson (2021)	Eric Austin Yee (2021)	Peggy West-Stap (2008)	Doug Croft (2017)
OCT041B	UNK	Juvenile				Peggy West-Stap (2008)	Peggy West-Stap (2008)	Peggy West-Stap (2008)	n/a
OCT042	F	Adult female	CA138			Peggy West-Stap (2009)	Peggy West-Stap (2008)	Peggy West-Stap (2012)	Peggy West-Stap (2008)
OCT042A	M	Sub-adult				Sarah Colosimo (2017)	Sarah Colosimo (2017)	Sarah Colosimo (2017)	Sarah Colosimo (2017)
OCT042B	F	Sub-adult				Sarah Colosimo (2017)	Peggy West-Stap (2012)	Sarah Colosimo (2017)	Sarah Colosimo (2017)
OCT042C	UNK	Juvenile				Sarah Colosimo (2017)	Sarah Colosimo (2017)	Sarah Colosimo (2017)	Sarah Colosimo (2017)

Table 1. Continued

						Photographers			
ID	**Sex**	**Age class**	**CA ID**	**BC ID**	**AK ID**	**Left dorsal**	**Right dorsal**	**Left eye patch**	**Right eye patch**
OCT043	F	Adult female				Michael Broome (2017)	Michael Broome (2017)	Michael Broome (2017)	Peggy West-Stap (2012)
OCT043A	UNK	Sub-adult				Victoria Wade (2017)	Doug Croft (2017)	Victoria Wade (2017)	Michael Broome (2017)
OCT044	F	Adult female	CA51			Josh McInnes (2019)	Peggy West-Stap (2014)	Peggy West-Stap (2006)	Stephanie Marcos (2017)
OCT044A	F	Adult female	CA51A*			Peggy West-Stap (2008)	Peggy West-Stap (2011)	Peggy West-Stap (2008)	Peggy West-Stap (2014)
OCT044A2	UNK	Sub-adult	CA51A2*			Victoria Wade (2017)	Victoria Wade (2017)	Peggy West-Stap (2012)	n/a
OCT044A3	UNK	Sub-adult	CA51A3*			Lisa Schallop (2018)	Victoria Wade (2017)	Peggy West-Stap (2012)	Victoria Wade (2017)
OCT044B	M	Adult male	CA51B*			Josh McInnes (2019)	Josh McInnes (2019)	Peggy West-Stap (2008)	Josh McInnes (2019)
OCT044C	M	Adult male	CA51C*			Josh McInnes (2019)	Josh McInnes (2019)	Stephanie Marcos (2014)	Peggy West-Stap (2017)
OCT044D	UNK	Sub-adult	CA51D*			Josh McInnes (2019)	Josh McInnes (2019)	Josh McInnes (2019)	Maya Hoffman (2017)
OCT045	M	Adult male	CA10			Doug Croft (2016)	Doug Croft (2016)	n/a	n/a
OCT046	F	Adult female	CA126			Kate Cummings (2019)	Winnie Mulé (2017)	Winnie Mulé (2017)	Winnie Mulé (2017)
OCT047	F	Adult female	CA21			Peggy West-Stap (2015)	Ted Cheeseman (2019)	Peggy West-Stap (2015)	n/a
OCT048	F	Adult female	CA170			Stephanie Marcos (2016)	Victoria Wade (2016)	Doug Croft (2016)	n/a
OCT049	UNK	Sub-adult				n/a	Peggy West-Stap (2011)	n/a	n/a
OCT050	F	Adult female	CA216			Stephanie Marcos (2018)	Stephanie Marcos (2018)	Peggy West-Stap (2008)	Stephanie Marcos (2020)
OCT050A	F	Adult female	CA216A*			Peggy West-Stap (2012)	Stephanie Marcos (2018)	Peggy West-Stap (2012)	Kate Cummings (2019)
OCT050B	F	Adult female	CA216B*			Stephanie Marcos (2018)	Stephanie Marcos (2018)	Peggy West-Stap (2009)	Peggy West-Stap (2008)
OCT050B1	UNK	Juvenile	CA216B1*			Stephanie Marcos (2018)	Stephanie Marcos (2018)	Stephanie Marcos (2018)	Stephanie Marcos (2018)
OCT050B2	UNK	Juvenile	CA216B2*			Stephanie Marcos (2020)	Stephanie Marcos (2020)	Victoria Wade (2020)	Stephanie Marcos (2020)
OCT050C	F	Adult female	CA216C*			Stephanie Marcos (2018)	Stephanie Marcos (2018)	Peggy West-Stap (2008)	Stephanie Marcos (2018)
OCT050C1	UNK	Juvenile	CA216C1*			Kate Cummings (2019)	Kate Cummings (2019)	Kate Cummings (2019)	Doug Croft (2019)
OCT050D	UNK	Sub-adult	CA216D*			Stephanie Marcos (2018)	Stephanie Marcos (2018)	Stephanie Marcos (2018)	n/a
OCT050E	UNK	Juvenile	CA216E*			Stephanie Marcos (2018)	Kate Cummings (2019)	Stephanie Marcos (2018)	Stephanie Marcos (2018)
OCT055	UNK	Sub-adult				Peggy West-Stap (2012)	Peggy West-Stap (2012)	Peggy West-Stap (2012)	n/a
OCT056	UNK	Sub-adult				Peggy West-Stap (2009)	Peggy West-Stap (2008)	n/a	Peggy West-Stap (2008)
OCT058	UNK	Sub-adult				Peggy West-Stap (2008)	n/a	n/a	n/a
OCT059	M	Adult male				Peggy West-Stap (2012)	Stephanie Marcos (2016)	Peggy West-Stap (2012)	Peggy West-Stap (2012)
OCT060	M	Adult male	CA163			Josh McInnes (2019)	Chelsea Mathieson (2019)	Josh McInnes (2019)	Chelsea Mathieson (2019)
OCT062	M	Adult male				Peggy West-Stap (2008)	Peggy West-Stap (2008)	Doug Cheeseman (2009)	Peggy West-Stap (2008)
OCT063	F	Adult female				Peggy West-Stap (2008)	Peggy West-Stap (2008)	Peggy West-Stap (2008)	Peggy West-Stap (2008)
OCT064	F	Adult female	CA27	T135	AO13	Anna Hunter (2015)	Peggy West-Stap (2008)	Peggy West-Stap (2016)	Hayley Newell (2014)
OCT064A	F	Adult female				Victoria Wade (2017)	Victoria Wade (2017)	Victoria Wade (2017)	Victoria Wade (2018)
OCT064B	F	Adult female				Doug Ross (2016)	Victoria Wade (2017)	Anna Hunter (2015)	Doug Ross (2016)

Table 1. Continued

						Photographers (year)			
ID	**Sex**	**Age class**	**CA ID**	**BC ID**	**AK ID**	**Left dorsal**	**Right dorsal**	**Left eye patch**	**Right eye patch**
OCT064B1	UNK	Juvenile				Victoria Wade (2017)	Victoria Wade (2017)	Doug Croft (2016)	Victoria Wade (2017)
OCT064C	M	Adult male				Hayley Newell (2014)	Doug Ross (2016)	Anna Hunter (2015)	Doug Ross (2016)
OCT064D	F	Adult female				Victoria Wade (2017)	Stephanie Marcos (2016)	Victoria Wade (2017)	Hayley Newell (2014)
OCT064E	UNK	Juvenile				Doug Croft (2016)	Stephanie Marcos (2016)	n/a	Hayley Newell (2014)
OCT070	M	Adult male	CA79			Peggy West-Stap (2008)	Peggy West-Stap (2008)	Peggy West-Stap (2008)	Peggy West-Stap (2008)
OCT071	F	Adult female				Peggy West-Stap (2008)	Peggy West-Stap (2008)	n/a	Peggy West-Stap (2008)
OCT072	F	Adult female				Peggy West-Stap (2008)	Peggy West-Stap (2008)	n/a	Peggy West-Stap (2008)
OCT072A	UNK	Juvenile				n/a	Peggy West-Stap (2008)	n/a	Peggy West-Stap (2008)
OCT073	F	Adult female				Peggy West-Stap (2013)	Winnie Mulé (2017)	Peggy West-Stap (2013)	Doug Croft (2016)
OCT074	UNK	Sub-adult				Peggy West-Stap (2013)	Peggy West-Stap (2013)	Peggy West-Stap (2013)	n/a
OCT075	F	Adult female				Peggy West-Stap (2013)	Peggy West-Stap (2013)	Doug Croft (2018)	Peggy West-Stap (2013)
OCT075B	UNK	Juvenile				Stephanie Marcos (2018)	n/a	Stephanie Marcos (2018)	n/a
OCT076	UNK	Sub-adult				Peggy West-Stap (2013)	Stephanie Marcos (2018)	Peggy West-Stap (2013)	Doug Croft (2018)
OCT077	F	Adult female	CA23			Peggy West-Stap (2013)	Peggy West-Stap (2013)	Peggy West-Stap (2013)	Doug Croft (2016)
OCT077A	UNK	Sub-adult				Peggy West-Stap (2013)	n/a	n/a	n/a
OCT077B	UNK	Juvenile				Peggy West-Stap (2013)	n/a	Peggy West-Stap (2013)	Peggy West-Stap (2013)
OCT078	F	Adult female				Doug Croft (2016)	Doug Croft (2016)	Peggy West-Stap (2013)	Doug Croft (2016)
OCT078A	UNK	Juvenile				Doug Croft (2016)	Doug Croft (2016)	n/a	Doug Croft (2016)
OCT079	UNK	Sub-adult				Peggy West-Stap (2013)	Peggy West-Stap (2013)	Peggy West-Stap (2013)	n/a
OCT080	F	Adult female	CA155			Winnie Mulé (2017)	Winnie Mulé (2017)	Winnie Mulé (2017)	Winnie Mulé (2017)
OCT081	F	Adult female				Doug Croft (2016)	Peggy West-Stap (2013)	n/a	n/a
OCT081A	UNK	Juvenile				John Mayer (2015)	Stephanie Marcos (2017)	Marilia Olio (2018)	Marilia Olio (2018)
OCT082	UNK	Sub-adult				Marilia Olio (2018)	John Mayer (2015)	John Mayer (2015)	n/a
OCT083	UNK	Sub-adult				Stephanie Marcos (2017)	Peggy West-Stap (2013)	John Mayer (2015)	n/a
OCT084	M	Adult male				Eric Austin Yee (2021)	Eric Austin Yee (2021)	Peggy West-Stap (2012)	n/a
OCT085	F	Adult female	CA58			Winnie Mulé (2017)	Winnie Mulé (2017)	Winnie Mulé (2017)	Doug Ross (2016)
OCT086	M	Adult male				Winnie Mulé (2017)	Winnie Mulé (2017)	Winnie Mulé (2017)	Doug Ross (2016)
OCT087	F	Adult female	CA133			Peggy West-Stap (2016)	n/a	Peggy West-Stap (2016)	n/a
OCT088	F	Adult female				Peggy West-Stap (2016)	Peggy West-Stap (2016)	Peggy West-Stap (2016)	Peggy West-Stap (2016)
OCT088A	UNK	Juvenile				Peggy West-Stap (2016)	Peggy West-Stap (2016)	Peggy West-Stap (2016)	Peggy West-Stap (2016)
OCT089	F	Adult female				Stephanie Marcos (2016)	Peggy West-Stap (2016)	Peggy West-Stap (2016)	Stephanie Marcos (2016)
OCT089A	UNK	Juvenile				Peggy West-Stap (2016)	n/a	Peggy West-Stap (2016)	Stephanie Marcos (2016)
OCT090	M	Adult male				Anna Hunter (2015)	Anna Hunter (2015)	Anna Hunter (2015)	Dana Angus (2017)

Table 1. Continued

						Photographers (year)			
ID	**Sex**	**Age class**	**CA ID**	**BC ID**	**AK ID**	**Left dorsal**	**Right dorsal**	**Left eye patch**	**Right eye patch**
OCT091	UNK	Sub-adult				Dana Angus (2017)	n/a	n/a	n/a
OCT092	F	Adult female	CA36			April Silbar (2018)	April Silbar (2018)	April Silbar (2018)	April Silbar (2018)
OCT093	UNK	Sub-adult				April Silbar (2018)	April Silbar (2018)	April Silbar (2018)	April Silbar (2018)
OCT500	M	Adult male				Peggy West-Stap (2015)	Anna Hunter (2015)	Anna Hunter (2015)	Anna Hunter (2015)
OCT501	M	Adult male				Anna Hunter (2015)	Anna Hunter (2015)	Peggy West-Stap (2015)	n/a
OCT502	M	Adult male				Peggy West-Stap (2015)	n/a	Anna Hunter (2015)	n/a
OCT503	M	Adult male				Peter Winch (2017)	Peter Winch (2017)	n/a	n/a

*Unpublished California ID based on common knowledge; well known among the whale-watch community, shared via word of mouth, on social media, or through public education and outreach efforts by dedicated individuals in the community

Photograph by Peggy West-Stap 2008 | NOAA NMFS permit 1094-1836