

Killer Whales

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What are killer whales?

Killer whales are the largest members of the dolphin family, with males reaching up to 9m long and can weigh well over 6 tons. Killer whales are easily identifiable by their striking black and white coloration, with a white underside and “eye patch” marking above the eyes and a grey “saddle patch” behind the dorsal fin (Fig 1). Males are considerably larger than females, and have exaggerated extremities, including a tall, straight dorsal fin, large pectoral flippers, and curved flukes. Genetic analyses suggest that killer whales are basal to the delphinid family, without any close living relatives among the other dolphin species.

How did killer whales get their name? The origin of the name “killer whale” seems to refer to observations by early whalers, who observed killer whales killing and feeding on other species of whales and referred to them as “killers”. The Latin name for killer whales, *Orcinus orca*, reflects how they were once feared in Western societies. *Orcinus* is derived from the Latin *Orcus*, who was a Roman god of the underworld. *Orcinus* translates to belonging to *Orcus* and thus belonging to the realms of the dead. Even well into the 20th century, killer whales were depicted as “extremely ferocious”. In Western society, our understanding of killer whales has been transformed thanks to long-term individual-based studies of killer whales over the last five decades, which have given incredible insight into the behaviour and ecology of killer whales, and they are no longer feared as they once were. However, the term “killer whale” is still more commonly used in the scientific literature.

Where do killer whales live?

Outside of humans, killer whales are the most widely naturally distributed mammal on the planet, and they can be found in all of the world’s oceans. Killer whales tend to occur in greater densities in colder, more productive waters. Particular hotspots include the Pacific northwest of the United States and Canada, the north Atlantic waters off Scandinavia, and the waters of Antarctica. There are, however, several populations of killer whales known to inhabit areas closer to the equator, including the Gulf of Mexico and the Bahamas, as well as the Indian Ocean. Most of what we know about killer whales comes from longterm studies of coastal, accessible populations, especially the killer whales in the northeastern Pacific. Photo identification methods were developed by scientists working on the northeastern Pacific

populations in the 1970s, which allow individuals to be identified by their unique markings (e.g. the shape of the saddle patch) and for some populations, all individuals are known, and all births and deaths have been recorded for nearly half a century. In recent years, long-term studies of other populations around the world have revealed much more about the diversity of killer whale ecology and behavior.

What do killer whales eat?

Killer whales are the ocean's apex predator, with no natural predators of their own. Killer whales are the only marine mammal that regularly feed on other marine mammals and killer whale groups have been observed attacking and eating the world's largest animal, the blue whale, as well as other top predators like white sharks. Different populations of killer whales have very different diets. Some specialise on fish, while some prefer mammal prey, and yet other populations appear to be generalist hunters. Even killer whales living in the same areas may differ in their dietary specialisations. The classic example of this can be found in the northeast Pacific, where there are three different "ecotypes" of killer whales with different diets: the salmon-eating "resident" killer whales, the mammal-eating "Bigg's" killer whales, and the shark-eating "offshore" killer whales. The differences in these ecotypes' diets are accompanied by differences in behaviour, genetics, and even physical appearance. Around the world, there are at least ten different killer whale ecotypes, each with their own diet, geographical range, behavioural repertoire and physical appearance (Fig 1).

What kind of societies do killer whales live in?

Killer whales are highly social, almost always travelling in groups. These groups are often highly stable and strongly bonded. Killer whales will engage in affiliative social contacts, rubbing and pushing against each other, often with individuals of similar age and the same sex (Fig 1). These social relationships are important for the whales. Killer whales will often hunt cooperatively, share the food they catch with their social group, and even learn where and how to get food from one another. In many populations, social groups are made up of females and their offspring and grandoffspring of both sexes. These groups, referred to as matriline, may be part of higher-level social groups. In resident killer whales, matriline are part of "acoustic clans", sets of matriline with overlapping vocal repertoires. In some populations, there is a middle level of social structure, referred to as pods, representing sets of related, closely associated matriline. Mothers and grandmothers are especially central to killer whale societies. Females use the knowledge they gain throughout their lives to help their offspring and grandoffspring find food, boosting the survival of their sons and grandchildren.

These benefits that females can provide their kin, together with the benefits of avoiding reproducing at the same time as their adult daughters, have led female killer whales to evolve a prolonged post-reproductive lifespan, a phenomenon that is extremely rare in mammals and outside of humans menopause has only evolved in a small number of toothed whales.

What threats do killer whales face?

As a species, killer whales are not currently classified as endangered, although there are concerns about the accumulation of toxins that these top predators may be experiencing throughout their range, especially polychlorinated biphenyls (PCBs) and other persistent organic pollutants (POPs). In contrast to the worldwide picture, certain killer whale populations are endangered, and some face imminent extinction. The AT1 population of Bigg's killer whales in Alaska and the West Coast Community of killer whales in the British Isles are both small, isolated, and have not reproduced in several decades. In the case of the AT1s, this decline is linked to exposure to crude oil from the Exxon Valdez oil spill, while the decline of the West Coast Community is likely due to the extremely high concentration of PCBs in these animals. Both of these populations are almost certain to go extinct in the coming decades. The salmon-eating "southern resident" population inhabiting the coastal waters of the western United States and Canada was significantly effected by marine park captures in the 1950s, 60s, and 70s, and has since failed to rebound. The lack of growth in this population is tied to contaminants, noise and disturbance, and, crucially, a lack of their primary prey, Chinook salmon. Captures of wild killer whales for marine parks have occurred in recent years in other populations, it remains unclear however, what the long-term impacts of these captures will be for these populations. Other populations of killer whales may face threats from direct killings when they come into conflict with fisheries, such as killer whales that have depredated toothfish around the Crozet Islands. As with other marine predators, killer whales around the world are likely to be impacted by ecosystem collapses caused by anthropogenic climate change.

Where can I find out more?

Bigg, M.A., Olesiuk, P.F., Ellis, G.M., Ford, J.K.B. and 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, pp.383-405.

103 Brent, L.J., Franks, D.W., Foster, E.A., Balcomb, K.C., Cant, M.A. and Croft, D.P., 2015.
 104 Ecological knowledge, leadership, and the evolution of menopause in killer whales. *Curr.*
 105 *Biol.*, 25(6), pp.746-750.

106 Croft, D.P., Johnstone, R.A., Ellis, S., Natrass, S., Franks, D.W., Brent, L.J., Mazzi, S.,
 107 Balcomb, K.C., Ford, J.K. and Cant, M.A., 2017. Reproductive conflict and the evolution
 108 of menopause in killer whales. *Curr. Biol.*, 27(2), pp.298-304.

109 de Bruyn, P.N., Tosh, C.A. and Terauds, A., 2013. Killer whale ecotypes: is there a global
 110 model? *Biol. Rev.*, 88(1), pp.62-80.

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

112 Foote, A.D., Vijay, N., Ávila-Arcos, M.C., Baird, R.W., Durban, J.W., Fumagalli, M., Gibbs,
 113 R.A., Hanson, M.B., Korneliussen, T.S., Martin, M.D. and Robertson, K.M., 2016.
 114 Genome-culture coevolution promotes rapid divergence of killer whale ecotypes. *Nat.*
 115 *Commun.*, 7(1), p.11693.

116 Ford, J.K., 1991. Vocal traditions among resident killer whales (*Orcinus orca*) in coastal waters
 117 of British Columbia. *Can. J. Zool.*, 69(6), pp.1454-1483.

118 Foster, E.A., Franks, D.W., Mazzi, S., Darden, S.K., Balcomb, K.C., Ford, J.K. and Croft, D.P.,
 119 2012. Adaptive prolonged postreproductive life span in killer
 120 whales. *Science*, 337(6100), pp.1313-1313.

121 Lacy, R.C., Williams, R., Ashe, E., Balcomb III, K.C., Brent, L.J., Clark, C.W., Croft, D.P., Giles,
 122 D.A., MacDuffee, M. and Paquet, P.C., 2017. Evaluating anthropogenic threats to
 123 endangered killer whales to inform effective recovery plans. *Sci. Rep.*, 7(1), p.14119.

124 Natrass, S., Croft, D.P., Ellis, S., Cant, M.A., Weiss, M.N., Wright, B.M., Stredulinsky, E.,
 125 Doniol-Valcroze, T., Ford, J.K., Balcomb, K.C. and Franks, D.W., 2019.
 126 Postreproductive killer whale grandmothers improve the survival of their
 127 grandoffspring. *Proc. Natl. Acad. Sci. USA.*, 116(52), pp.26669-26673.

128 Olesiuk, P.F., Bigg, M.A. and Ellis, G.M., 1990. Life history and population dynamics of
 129 resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and
 130 Washington State. *Report of the International Whaling Commission, Special, 12*,
 131 pp.209-243.

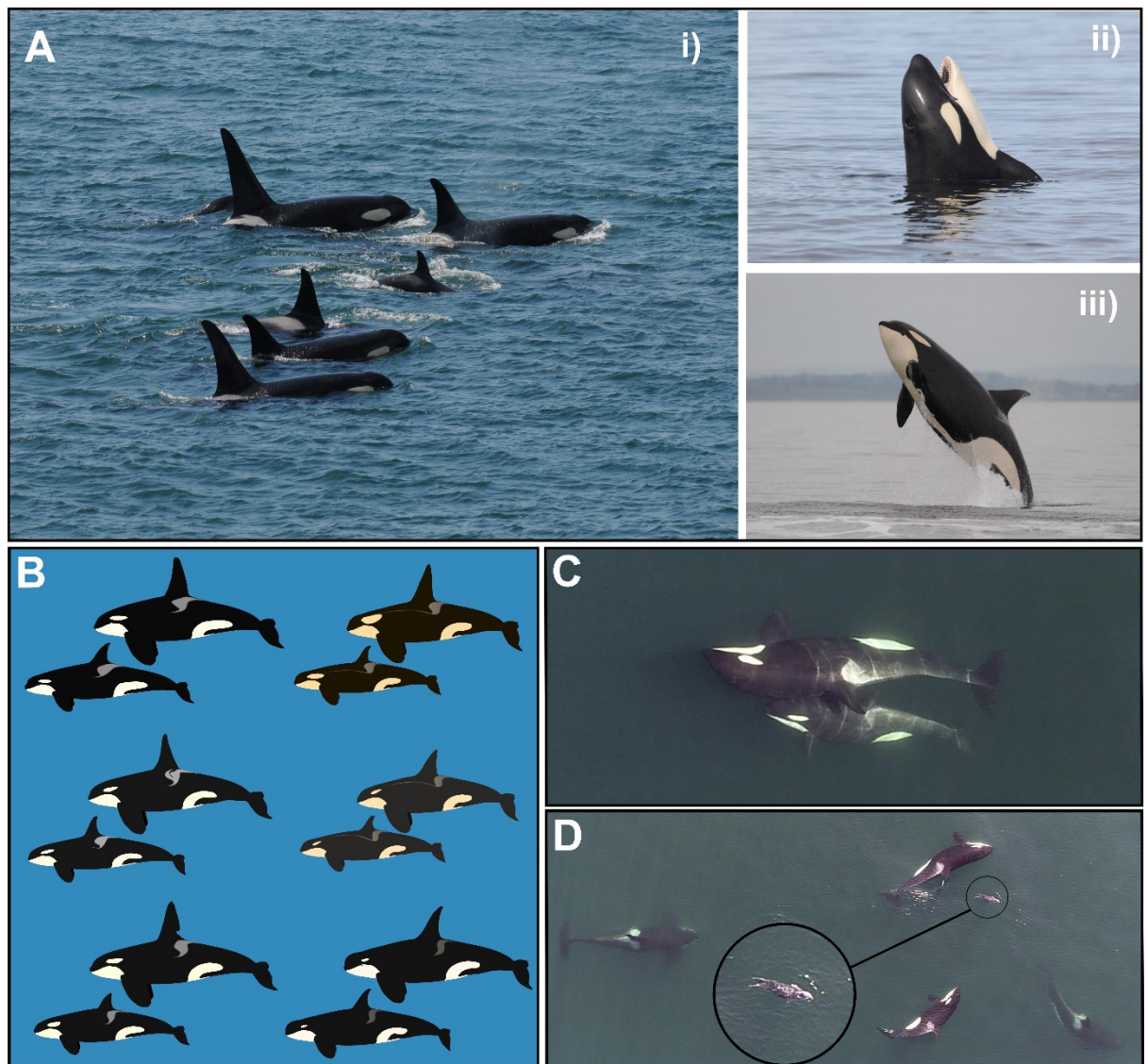
132 Weiss, M.N., Franks, D.W., Giles, D.A., Youngstrom, S., Wasser, S.K., Balcomb, K.C., Ellifrit,
 133 D.K., Domenici, P., Cant, M.A., Ellis, S. and Nielsen, M.L., 2021. Age and sex influence
 134 social interactions, but not associations, within a killer whale pod. *Proc. Roy. Soc.*
 135 *B.*, 288(1953), p.20210617.

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142 Figure 1. Killer whale diversity and behaviour. (A) Images of southern resident killer whales. i)
 143 Southern resident killer whales travel together through salmon foraging grounds credit
 144 Kenneth Balcomb/Center for Whale Research, ii) A Southern resident killer spyhopping credit
 145 Emma Foster/Center for Whale Research and iii) A Southern resident killer breaching credit
 146 Kenneth Balcomb/Center for Whale Research. (B) A selection of killer whale ecotypes from
 147 around the world. Illustrations are of male (above) and females (below). Left to right, top to
 148 bottom, Bigg's killer whales from the northeast Pacific, Antarctic Type B or Pack Ice killer
 149 whales, northeast Pacific resident killer whales, Antarctic Type C or Ross Sea killer whales,
 150 northeast Atlantic killer whales and Antarctic Type D killer whales. (C) A pair of southern
 151 resident killer whales bonding through affiliative contact. (D) A group of Bigg's killer whales
 152 works together to hunt a seal. Drone photography credit Michael Weiss/Center for Whale
 153 Research, taken under NMFS permit 21238. Killer whale illustrations by Michael Weiss,
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