Killer Whales: Distribution Of Orcinus Orca Around The World

Introduction

Orcinus orca, the killer whale, is widely distributed in all of the world's oceans and some of its seas (Fig.1). A member of the dolphin family, it is easily recognized based on its large size and distinctive black and white markings that set it apart from any other marine mammal on the planet. Though it has long been vilified and feared, the last few decades have helped to increase the public's understanding of these intelligent and social creatures, in part due to their, now controversial, presence in captive situations since 1964.

For many years, orcas have been studied more or less extensively based on proximity to shore. Estimates are that around 50,000 individuals live in the Oceans, but these numbers are always approximations based on sightings and those are sparse, particularly in the open ocean. Nevertheless, some populations are very closely watched, and each individual is known and monitored.

Feeding habits vary depending on available prey in a region, as well as the prey's size and abundance. Groups of orcas have specialized while others are slightly more generalized. Related, their hunting tactics also vary widely.

Populations of killer whales are divided into two general groups: residents and transients. These categories broadly describe their tendencies to either remain in one locality year-round or travel widely throughout certain ranges, respectively, but many specific characteristics have been observed that further differentiate the two groups.

Consistently, orcas have been found to be social animals and to form social units based on maternal relationships. This is called a matriline, where mothers will be seen with their descendants, often for life and possibly with multiple generations living and traveling together. As social animals, they generally stay in groups and are seldom seen alone for any significant length of time.

Pod and community are terms used to describe groups of Killer Whales that are thought to be related by a female ancestor and to include multiple matrilines travelling together, with pods being together for shorter time periods than communities. Clan is also sometimes used for sympatric pods that don't necessarily have to be related but associate regularly.

Methods of measuring their distributions are similar to those of any other cetacean. Researchers have chosen whichever methods they felt were most conducive to achieving the results they were looking for; some chose to use more than one of the following methods:

- Catalogs of photos identifying individual orcas based on markings, scars, size or other distinctive characteristics. This method is often preferred for purposes of tracking every individual known to reside in an area and is very useful when birth and death records can be maintained on a consistent basis as well, allowing for an exact local population

count.
- Mark-recapture methods are similar to photo catalogs but involve comparing photos of individuals in at least two consecutive time periods and then calculating an approximate abundance by dividing the initial number by the number that were seen again on the following occasion
- Line-transect surveys are considered quite accurate quantitatively and involve counting the number of individuals in a given area at a given time. Visibility can be difficult and must be considered carefully beforehand to get reliable results
- Non-standardized surveys result from observations made by people who were not necessarily setting out to measure population sizes. For orcas this can involve anything from whale watching vessels to research vessels to fishermen who happen to see orcas and give an account of location, number and time they were seen.
- Other observations and Anecdotal Information are given by reports of by-catch, biologists at sea for other purposes, and so forth. Not very different from the previous category, these observations can however also include not seeing orcas at various times.

Most often, even if one primary method is chosen, more than one is used to maximize accuracy. (Forney, K. and Wade, P., 2006 for methods)

Distribution

Orcas are widely distributed in the Oceans, but understandably occur more commonly in some than in others. Data compiled by Karin Forney and Paul Wade in 2006 of research done by a number of scientists in recent decades show that orcas can be considered abundant in the following regions based on observed density of greater than 0.4 animals per 100 square kilometers:

- the Norwegian Sea and northern Norway (Olen, 1990; Simila, et al., 1996)
- Various areas of the Southern Ocean as measured by Hammond between the years of 1978 and 1982 and published in 1984; also south of 60 degrees south (Branch and Butterworth, 2001)
- The Aleutian Islands and Gulf of Alaska (Forney, unpublished; Zerbini, et al., 2006)

They are considered common (0.20-0.40 whales per 100 square kilometers) in a number of other localities generally near their abundant zones, but also notably off the South Australian Coast (Ling, 1991) and Southern Brazil (Pinedo, et al., 2002).

Though less common, they are seen in most areas of the world including the tropics, generally near productive zones and based on prey availability, but are noticeably more abundant further away from the equator. Their relatively less common occurrence in the southern hemisphere is believed to be due to limited research thus far. (Forney, K. and Wade, P. 2006)

NE Pacific populations:

Residents:

The northeast pacific population is generally divided into two groups referred to as the southern

and northern residents, which are subdivided into clans, of which the northern residents have three and the southern residents only have one, though they are said to have 3 pods within that clan. The northern residents are a larger group and were comprised of 219 individuals in 2004 when studies related to feeding events were done in great detail. The southern residents only had 87 members at the time and are now down to 75 (Center for Whale Research, 2019).

Feeding behavior among the resident populations shows that they focus primarily on salmonids found in their normal range and of the 4 types of common salmon species, they predominantly focus on Chinook salmon even when it is not the most abundant in the range. This is presumed to be due to a number of factors including, as is common with predators, availability, energy expenditure required to catch the prey and benefits derived. In the case of these orcas, catching the Chinook salmon rewards them with the largest, high-lipid meal of the available salmon species. Another possible reason might be their ability to use echolocation to locate these large fish, compared to the often much smaller sockeye and pink salmon in the region. An exception is the case of Chum salmon, which are preferentially caught by orcas in mid-October when the salmon's numbers are unusually high in the area in which the whales were observed. Chum are the next largest salmonids and may be easiest to catch at that time.

An interesting observance that was across all resident killer whales of the region was prey sharing. Males, females and juveniles all shared prey they caught with other whales, regardless of the size of their prey, however, adult males were less likely to do so with 17% while adult females and juveniles shared upwards of 80% of their catches. Often up to a half dozen whales would feed on one prey item, but hunting was mostly done alone.

Hunting behavior in these whales is generally near surface and often close to shore. The orcas can be seen moving slowly in generally the same direction but relatively far apart. When a suitable prey is located, one of the animals will alter its pattern showing increased speed, sometimes erratic or rolling maneuvers near the surface and then after no more than a few minutes, or possibly only a few seconds, wait for other orcas to approach to share the catch. In some cases, the only indication of a catch might be longer than usual dives by an individual whale or a number of animals working together close to shore. Regardless of the effort put into the catch, it is most often shared.

Currently, far less is known about feeding habits or even range during the months of November through April, but it is thought that orcas follow availability of Chinook salmon into more open waters during these months.

Transients:

Reports on transient populations are rare and generally included as comparisons and side-notes in papers reporting on resident orcas. This is likely due to their tendency to travel further distances making them more difficult to study in detail.

Nevertheless, a paper by J. Ford and G. Ellis (2005) details some of the hunting strategies employed by the northeast Pacific transient population of killer whales, specifically their attacks on minke whales documented between 1994 and 2004. In this report, 9 pursuits of individual minke whales were observed, 4 of which were successful. All of the pursuits showed the minke swimming at speeds of 15 – 30 km/h at distances of tens to hundreds of meters ahead of

pursuing orcas. There were between 2 and 13 orcas involved in the pursuits with adult females and juveniles leading the chase as well as the attack if in shallow waters. Only in deep waters did adult males get involved in the attacks, which is hypothesized to be due to their larger size and mass making prolonged high-speed chases and maneuvering in the shallows more difficult. Except for one case of a young minke whale being killed in open water, all the kills happened when the mysticetes ended up trapped in a bay or in one case attempted to hide next to a large boat. In open water on strait trajectories, the minke whales were able to outpace the orcas which gave up the chase after 30 to 60 minutes in most cases. The attacks were in every successful case lengthy, lasting up to several hours and resulted in death of the whale by repeated strikes against the belly or sides and/or by asphyxiation due to submersion when an orca would position itself on top of the minke whale covering the blow hole and pushing it under water. Killer whales are observed to limit consumption of a whale carcass to the tongue, skin and some of the blubber.

Furthermore, transients are believed to hunt in silence, so they are not detected by prey and they have been observed to feed primarily on seals, walruses and smaller odontocetes. Evasive behaviors of other whale species have been reported, such as swimming near to shore. A trend has been noted in numerous papers listed by Ford and Ellis (2005) that the faster mysticetes show no defensive maneuvers once caught, while the slower baleen whales resort to thrashing around and slapping the water and the orcas with their flukes in efforts to defend themselves. As expected, the diet of transient killer whales appears to consist of whichever prey are most energetically favorable at any given time (Ford and Ellis, 2005).

Norwegian populations:

Off the coasts of northern Norway, scientists have observed over 500 individual Orcas belonging to 31 different pods. These killer whales feed primarily on Herring which gather in three fjords, the Tysfjord, Ofotfjord and Vestfjords in large quantities of up to 10 million tons of biomass for spawning and overwintering. Due to their type and size of prey, the Orcas have developed a method of hunt and capture which scientists now call ‘carousel method’. Their tactics were named ‘carousel method’ by Bel’kovich et al. (1991), when applied by a species of dolphins (Kuningas, S. et al., 2012). In this hunting style, the orcas herd a large number of Herring into a ball by vocalizations, flashing the white underside of their bodies towards the fish and blowing large bubbles around the perimeter. The fish are sensitive to sight and sound, so they, possibly in a defensive maneuver, gather into a ball giving them a better chance at survival in normal situations. However, in the case of an orca hunt, this strategy the fish employ is a disadvantage, because the killer whales use their tail flukes to slap the surface of the water or at the ball of fish underwater, which stuns the fish. Individual killer whales then gather up the stunned, floating fish and eat them. It is unknown at this time, whether the fish are stunned due to pressure, direct contact or the loud sound that accompanies the whale’s behavior, but the method is very effective for the orcas. Scientists have further observed, that only some of the orcas will gather up fish at any one time, while the rest continue to swim in tight circles around the ball of Herring. Occasionally, the ball of fish will attempt to escape by going down towards the bottom of the fjord. This tactic can work sometimes, and the orcas are observed to then move on to a new group of Herring. At other times one or more of the whales will swim below the Herring flashing their white undersides and scaring them back up towards the surface. This strategy employed by up to 9 orcas at a time results in a fairly easy to observe hunt because the Herring will be seen splashing and jumping at the surface of the water surrounded by orcas. In

all of the observed hunts the orcas never once came close to eating the entire group of fish but always moved on to a new ball of fish or ceased hunting for a time. The scientists also observed that approach of scuba divers would often distract the killer whales and they were therefore forced to use manned or unmanned inflatables with cameras attached and a nearly silent outboard motor to capture video and audio footage of the hunts (Simila, T. and Ugarte, F., 1993).

The Norwegian populations of orcas show similar calving rates as those of the northeast Pacific with each adult female giving birth once every 3 to 14 years with a mean of approximately 5 years. Their survival rates are also similar, although unlike the northeast Pacific resident populations, the Norwegian populations are not all individually known. Photo catalogs are kept and the 2013 paper by Kuningas, S. et al. mentioned 326 individuals that were repeatedly seen in the area, as well as another 187 that were clearly identified but only seen once in the 18 years of observations that the paper covers. The same study found that the contaminant load that Norwegian orcas carry is the highest of Arctic mammals, but that this has not shown to decrease their lifespans or survival rates noticeably yet.

Southern Ocean:

Around the Prince Edward Islands in the southern Indian Ocean, a small group of 40 Orcas feed on the seals and penguins which breed on these protected islands. These killer whales have been found to remain mostly in the shallow areas near to the islands with occasional excursions to nearby seamounts thought to provide additional hunting opportunities. Some individuals have however, been photographed as far as 1000 km away at the Crozet Archipelago (Reisinger, R.R. et al., 2015).

It was observed that most of the diving by these whales is shallow and near shore, thought to be primarily related to hunting and socializing which is commonly seen in Orcas around the world. In the Prince Edward Islands region, the killer whales are known to take fish from longlines, target primarily the larger elephant seals and king penguins and also dive to catch cephalopods which rise from great depths following their prey. This would also correspond to the difference of dive depths noticed between day and nighttime dives, because zooplankton and their predators come up to 300 to 400 meters during the day and less than 100 meters at night and killer whales follow that general pattern in their dive-depths. The researchers used satellite tags to track movements of some of the orcas and found that two individuals in particular, dove to greater depths than previously recorded, going up to 500 meters and one of them to more than 750 meters in depth. It appears that orcas are capable of traveling long distances and to great depths, but as expected limit their movements to energetically favorable patterns. This is why scientists indicated that their close proximity to shore gave the orcas an advantage over their prey of penguins and seals because it limited the maneuverability of the prey in such as way as to make capture easier for the whales (Reisinger, R.R., et al., 2015).

[bookmark: _Hlk7296030]Other information gained by satellite tagging is that orcas travel at slower speeds when hunting and socializing than when traveling. Studies done by Durban and Pitman (2012) at the Antarctic Peninsula and these orcas around Marion Island (one of the two Islands comprising the Prince Edward Islands), show that the animals travel at around 5 km/h on average, going slower when perceived to be hunting down to less than 3 km/h at which time they also show altered diving and directional patterns. When traveling longer distances they will

go up to 12.13 km/h as recorded for Antarctic Peninsula whales that move slightly faster in transit than the Marion Island whales. Orcas in the Ross Sea travel around 20 km/day while those of the Prince Edward Islands travel over 80 km/day (Reisinger, R.R., et al., 2015).

Hunting behavior seen in Antarctic waters east of Adelaide Island by the type B ecotype of killer whales is unique. Pitman and Durban (2012) followed three groups of these whales through ice floes and glacial ice in 2009 and observed their hunting behavior. While the animals stayed close together in open waters, they would immediately separate when entering areas with ice. They could then be seen spy-hopping, including mothers with their calves at their side, raising their heads out of the water next to ice and apparently looking for seals. When seals were spotted, the whales showed discrimination based on type of ice, size of ice, and species of seal. When a seal was on glacial ice, or if it was a leopard seal, the orcas generally moved on to the next piece of ice, presumably because the type of prey or ice made it too difficult to hunt successfully. If the ice was flat, however, and most often if the seal was a Weddell seal, the whales would submerge under water, presumably to vocalize to the rest of the group, and the entire group would then appear and spy-hop next to the ice within about one minute. If the ice was young and relatively thin, the whales would swim up to 50 meters away, turn towards the ice, swim side-by-side just below the surface while pumping their flukes vigorously and create two sets of waves, one just by their heads the other behind a trough near their tails. They would then dive under the ice just before hitting it and turn to their sides to avoid ramming it with their dorsal fins. The waves would wash over the ice floes and the orcas would be seen on the other side of the ice spy-hopping to determine what happened to the seal. This procedure would be repeated an average of 4 times, as necessary to wash the seal off the ice. Most of the time, this maneuver was successful, and the whales very carefully worked to exhaust the defensive seal by surrounding it in the water, blowing bubbles around it and grabbing it by the tail flukes and pulling it under water.

In some cases, the whales could be seen pushing the ice out into open water to reduce the possibility of the seal escaping to glacial ice which was more difficult to get it off of.

When the ice was older and therefore thicker, the whales employed a slightly different tactic, in which they also created a wave while swimming towards the ice, but then dove under it continuing to pump their flukes and used the wave to break apart the ice, causing the seal to fall into the water or be forced onto a smaller more manageable piece of ice.

Conclusion

Overall consistencies in orca behavior and physical characteristics globally lesson the potential negative effects of having only a limited number of researchers working on individual populations. Observations contributed by the general public as well as fisheries and other researchers coincide with those given by the groups of scientists studying these animals and add bits of knowledge that might otherwise be unavailable. One of the most interesting things about orca research is that unlike most species in the wild, the commitment of some scientists to study these animals for decades, combined with the limited number of individuals in resident populations and their large size allows us to have an increasingly detailed and comprehensive understanding of them.