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The combined use of visual and acoustic data collection techniques for winter killer whale (*Orcinus orca*) observations

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ABSTRACT

Observations of cetaceans during the winter are difficult, if not impossible in some locations, yet their presence, habitat use, and behaviour during this period are important for conservation and management. Typically, observations come from vessel surveys, with citizen science networks increasingly adding significant sighting data. In compliment to this, acoustic data collection systems can be deployed to collect information remotely over long periods, and in almost any conditions. Here we describe how the combination of these data collection techniques works to fill knowledge gaps, with data from a well-established citizen science network, and a single passive acoustic monitoring (PAM) recorder integrated to identify killer whale presence during winter months in Clayoquot Sound, on the west coast of Vancouver Island.

Together these data show the overwinter use of Clayoquot Sound by killer whales is greater than previously thought. During the study period, February 21 to April 25, 2015, the citizen science network noted 14 visual encounters ranging from Amphitrite Point to Hot Spring Cove, Vancouver Island. The PAM recorded 17 acoustic encounters within the 10 km detection radius of the recorder, deployed off Siwash Point, Flores Island. This included 15 encounters not recorded by the visual network. Both resident and Bigg's (transient) transient whale groups were recorded, although analysis of vocalizations determined that the majority of the encounters recorded acoustically were of northern resident killer whales. This may be a function of life history, with Bigg's killer whales typically noted to be less acoustically active, or could represent greater site use by this group. This first use of acoustic monitoring over the winter, complemented with visual data, can establish a better understanding of year-round use of this area by killer whales and has broader application to other sites.

1. Introduction

Data on species distribution over long time periods or great spatial extents is difficult to collect in the marine environment. Observations of free-ranging cetaceans are hampered by high costs of field research, weather, and limited data collection periods, for example to daylight hours. Field research is more difficult, if not impossible, during the winter in many locations.

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Typically, observations come from dedicated vessel-based surveys, with citizen science networks increasingly used to add significant to sightings data. These networks potentially have a wide spatial extent, but are dependent on the chance encounters of whales, and normal activities of vessels in any given area. Night or inclement weather observations are uncommon. Data, if garnered by an experienced observer may, however, provide more information than simple presence, such as group size, individual identity, or behavioural context.

Remote data collection devices, such as passive acoustic monitors (PAM) are being used to collect marine data over long periods, in areas and at times it might otherwise be problematic to survey. Once deployed, they can record data continuously without regard to sea-state or visibility, but are spatially restricted to a defined detection radius from its location. In the case of acoustically sensitive species, PAM may also offer a less intrusive alternative to vessel-based surveying.

Here we assess the input of the more traditional against the more technological data collection method to knowledge of whale presence, habitat use, and behaviour. Opportunistic visual observations from a well-established citizen science network are compared to underwater acoustic recordings to analyse the winter presence of killer whales (*Orcinus orca*) in Clayoquot Sound on the west coast of Vancouver Island, Canada. Together they form a novel examination of whales' use of the area, particularly adding knowledge during a time period where data collection is problematic.

Killer whales are common year-round inhabitants of coastal waters in the northeastern Pacific (Ford, 2014). In the near shore waters of British Columbia three sympatric and genetically distinct ecotypes have been described: resident, Bigg's (transient), and offshore (Ford et al., 2000). They differ in morphology, social structure, diet and foraging behaviour, and acoustic behaviour (Bigg et al., 1987; Ford, 1987; Baird and Stacey, 1988; Ford and Ellis, 1999; Ford et al., 2014). The resident killer whale ecotype is distinguished into a northern and southern cohort, with a number of pods or clans arranged into each. Each pod shares an acoustic dialect, with pods with similar calls collectively referred to as clans. Residents often utilize echolocation and communicate within and between hunting groups, with the seasonal presence of their salmonid prey strongly influencing the distribution of resident groups throughout their range (Nichol and Shackleton, 1996; Baird et al., 2005). A pod can have a repertoire of 7–17 discrete calls, whose use varies depending on the group dialect (Ford, 1987, Ford, 1991; Ford and Ellis, 1999). In contrast, Bigg's killer whales are mammal hunters, with much of their time devoted to foraging, markedly more than resident groups (Heimlich-Boran, 1988; Ford and Ellis, 1999). They tend to travel in smaller groups of 2–6 individuals, with a very dynamic social order (Ford and Ellis, 1999). Bigg's killer whales are believed to vocalize significantly less than residents, with calling predominantly limited to surface-active and post-feeding behaviours (Ford 1984; Morton, 1990; Guinet, 1992; Barrett-Lennard et al., 1996; Deecke, 2003; Deecke et al., 2005). Deecke et al. (2005) suggests that they remain silent as a strategy, so as to not incur extra cost to foraging from being heard by their prey on approach. Stealth and surprise are important elements of foraging success; therefore both vocalizing and echolocating are limited (Barrett-Lennard et al., 1996; Ford and Ellis, 1999; Deecke et al., 2002). When vocalizing they use a smaller repertoire of calls (4–6), demonstrating some regional distinction in use, but less distinctive dialect identity than residents (Ford and Ellis, 1999). The offshore killer whale ecotype are estimated to have diverged from the resident killer whale lineage approximately 200,000 years ago, and feed on fish, specializing on shark prey (Herman et al., 2005; Ford et al., 2011, 2014). Offshore groups have been noted in inside waters around Vancouver Island infrequently (Ford et al., 2014), and are predominantly sighted in waters off the coast between California and south-east Alaska (Herman et al., 2005). As such this group will not be considered further in this study.

Despite efforts to map abundance, distribution, and life histories of these groups spanning more than 40 years (Bigg et al., unpublished, 1990; Ford et al., 1998), questions still remain. For example, although the distribution and use of inshore waters around Vancouver Island by killer whales has been studied intensely, little is known about movement patterns outside of these areas and during winter months (Ford et al., 1998; Krahn et al., 2002, 2004; Ford, 2006; Riera et al., 2013). Similarly, their use of space and behaviour through the night remains poorly known. Previous studies have used passive acoustic monitoring for killer whale presence in the northern Pacific (e.g. Newman and Springer, 2008; Oleson et al., 2009; Širovičet al., 2011; Riera et al., 2013 and Hanson et al., 2013); in this study, we amalgamate visual and acoustic data sets to try to describe killer whale use of Clayoquot Sound during the winter. The data from a long-term citizen science network of observers provides the visual data. We compare this to a 64-day deployment of a bottom mounted acoustic recorder, as an assessment of passive acoustic monitoring for presence that may otherwise be impossible. Although the quantity and scale of data collected by each method differs, together these databases fill gaps in our knowledge of coastal killer whale habitat use, which is vital to species management plans.

2. Methods

2.1. Visual data set

Strawberry Isle Marine Research Society (SIMRS) and their reporting network recorded visual sightings of killer whales in Clayoquot Sound. The range of reporting for SIMRS between February and May 2015 extended from Amphitrite Point, Ucluelet, to Sharp Point/Hot Springs Cove, Vancouver Island. The daily sighting records are summarized into hourly reports, with observations of presence and behaviour of killer whales reported from an extensive network. They trace movements of whale groups through the network area for as long as possible, with observational data provided by private and recreational boaters, commercial vessels such as the whale-watching fleet and fishermen, as well as SIMRS scientists. Opportunistic photographs taken during a sighting are used to determine group size and identity, residency time and return rate.