

Staqeya: the lone wolf at the edge of its ecological niche

In May 2012, a lone wolf (*Canis lupus*) appeared in Victoria, British Columbia (BC), Canada, a metropolitan area on the southern tip of Vancouver Island with a population of 365,000 (Fig. 1A, B). After sightings in backyards over a few days, the wolf settled in the adjacent Chatham and Discovery Islands. This wolf traveled a minimum of ~40 km from the nearest known wolf distribution, and through at least ~20 km of suburbia before swimming 1.5 km to the islands. The island chain comprises only 1.9 km² of terrestrial area, with 1.2 km² owned by the Songhees First Nation, while a portion of Discovery Island and islets occurs within provincial protected areas (Gomes 2013).

These islands, known as *Tl'Chés* in the Lekwungen language of the Songhees Nation, contain a diverse array of terrestrial habitats including Garry oak (*Quercus garryana*) meadows, arbutus (*Arbutus menziesii*) woodlands, coastal Douglas-fir (*Pseudotsuga menziesii*) forest, and vernal

wetlands. Adjacent and productive marine habitats include tidal lagoons, eelgrass (*Zostera* spp.) meadows, rocky reefs, bull kelp (*Nereocystis luetkana*) forests, and extensive intertidal habitats.

The political context in which the wolf exists is complex. Initial efforts by provincial authorities to capture and relocate the animal failed (Wilson 2016). Subsequently, the Songhees Nation named the wolf Staqeya (Fig. 1A), and assumed stewardship of him, noting that his arrival coincided with the passing of Chief Robert Sam, a member of the wolf clan who was instrumental in protecting the islands. To safeguard the islands and the wolf, public access is forbidden within the Songhees territory. Although prohibited by Provincial and Songhees law, domestic dogs have occasionally been brought to the islands, which have created conflict. On one occasion, Staqeya non-aggressively followed a dog and his human companions. This event elicited renewed consideration by the Province to capture Staqeya, to which the Songhees remain adamantly opposed. The British Columbia Parks Service now educates the public rather than attempting to remove the wolf.

The unique ecological and social-cultural context of Staqeya has prompted us to reconsider the spatial ecology, dietary niche, and sociality of wolves, as well as to reflect on the challenges and opportunities of coexisting with carnivores. In collaboration with the Songhees First Nation, we employed



FIG. 1. (A) Staqeya the wolf with a background of arbutus berries. (B) Staqeya looking out across the narrow channel from the Chatham Islands to the suburbs of Victoria. (C) Staqeya with a recently killed harbor seal (*Phoca vitulina*) pup. (D) Staqeya with fresh river otter (*Lontra canadensis*) kill. (Photos: Cheryl Alexander).

noninvasive research techniques to examine the range, foraging habits and social biology of the wolf. Between September and December 2016, we visited the islands on five occasions (~29 h). The trails and shorelines of the islands were surveyed (~20 km) for sign. This circuit was completed twice over five visits to the islands. We also deployed three remote cameras (Bushnell Trophy Cam HD Essential; Bushnell Outdoor Product, Overland Park, Kansas, USA) from 21 October 21 2016 to 29 November 2016 ($n = 117$ camera nights) and collected scat and shed hair opportunistically.

Our data, complemented by frequent observations by one of our team members (C. Alexander; >50) since 2014 and reports from Songhees members, indicate that Staqeya uses the full archipelago, including all main islands and smaller outcroppings. Sightings also suggest that Staqeya has left the Chatham Islands at least once. Three months after his initial arrival in 2012, Staqeya was photographed on Trial Island (M. Dickman, *unpublished data*), a minimum 5.5 km swim through some of the strongest current conditions on the BC coast. However, Staqeya was observed back in the Chatham Islands the following week. Despite his swimming ability, he does not seem to travel to adjacent Victoria, which supports hyperabundant Sitka black-tailed deer (*Odocoileus hemionus sitkensis*). Therefore, his long-term home range of 1.9 km² is an order of magnitude less than the smallest recorded home range of a wolf pack in North America (33 km² in Minnesota; Mech and Boitani 2010) and the smallest recorded on northern Vancouver Island (64 km², Scott 1979).

This wolf also diverges considerably in resource use from others of his species, which are considered obligate predators of ungulates where they coexist. Whereas other wolves in coastal areas of western North America use marine resources extensively (Darimont et al. 2004, 2009, Semmens et al. 2009), our results suggest that Staqeya consumes almost exclusively marine foods. Stable-isotope analysis on shed guard hair samples and tissue from potential prey items analyzed in MixSIAR (Stock and Semmens 2016) estimated that over 80% of his diet is comprised of marine mammals (Fig. 2A, B). Deer have no established population on the islands, but occasional migrants (the carcasses of which we have observed) contributed an estimated 6% to Staqeya's diet between the June and October hair growth periods.

Data from scats and observations provided complementary insight. From October to November 2016, 16 scats were collected, which also showed that marine-oriented prey dominated his diet. Marine mammals (harbor seal, river otter, mink [*Neovision vison*], and Steller sea lion [*Eumetopias jubatus*]) occurred in 100% of the collected scats and compromised 89% of the identified prey remains; deer was absent (Fig. 2C). Numerous personal and remote camera observations have shown Staqeya capturing live mustelids and raiding geese nests, as well as carrying and feeding on freshly killed seals (Fig. 1C, D). Although not detected in scats, we have observed Staqeya foraging for gunnel fish (*Pholis* spp.) during low tides.

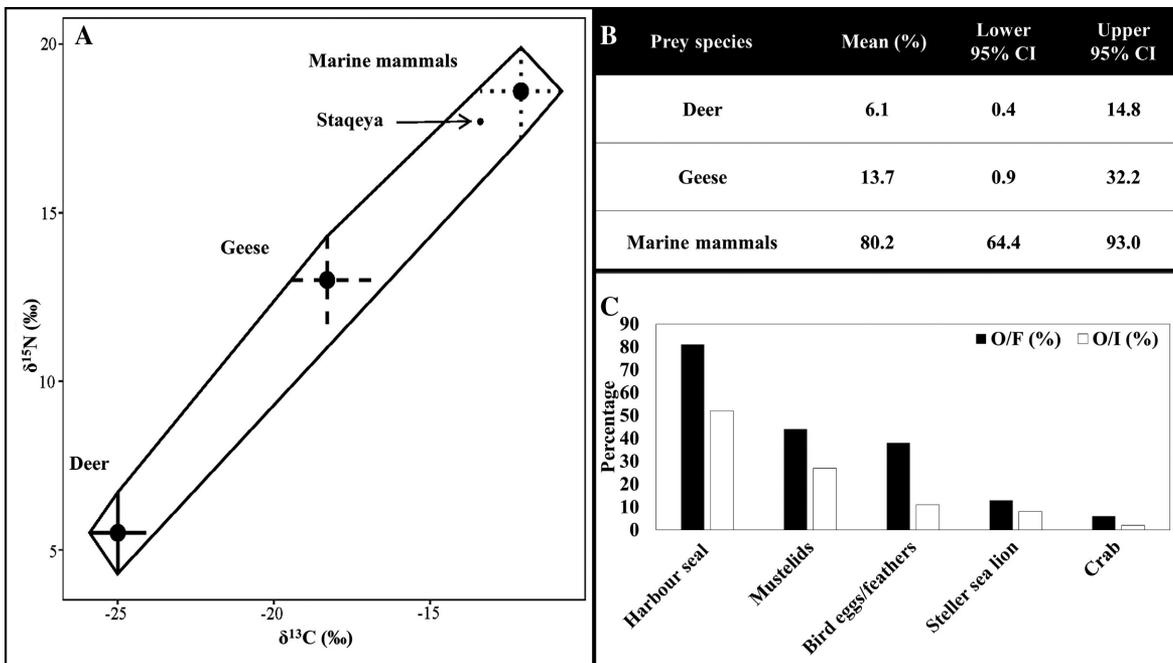


FIG. 2. (A) "Mixing space" (polygon), mean (points), and standard deviations (lines) of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ in deer, geese, and marine mammal (harbor seal, mink, river otter) prey and Staqeya the wolf used as inputs into MixSIAR. Stable-isotope signatures for geese (*Branta bernicla*) from Inger et al. (2006), signatures for marine mammals and black-tailed deer (*Odocoileus hemionus sitkensis*) from Darimont et al. (2009). (B) Mean and 95% confidence interval of prey composition in the diet of Staqeya as estimated by MixSIAR. (C) Prey species composition as occurrence per feces (O/F; percentage of feces that contain a given prey item) and as the occurrence per item (O/I; number of identified items of one species divided by the total number of identified items). The mustelid grouping is a combination of mink and river otter.

No perennial freshwater source exists in the Chatham Islands, posing challenges for this wolf. Vernal wetlands and rocky pools fill with rainwater, but often dry out in the summer months. During these times, Staqeya has dug wells throughout the vernal wetlands in an attempt to obtain water. We have found seven of these dig sites, with the largest dig approximately 1.8 m long × 0.4 m wide × 1.2 m deep. While coyotes (*Canis latrans*) in desert ecosystems have been found to excavate similar wells (Miller and Stebbins 1964), this behavior does not appear to have been documented in wolves.

Over more than 6 yr, Staqeya has never been observed with a conspecific on the islands, suggesting an atypical solitary existence. Although often alone during dispersal, it is extremely rare for a wolf to remain solitary for its entire life; typically, wolf packs are composed of 5–11 individuals (Mech and Boitani 2010). Despite being the only wolf within ~40 or more kilometers, Staqeya is exceptionally vocal, with his howls often audible in adjacent Victoria (C. Alexander, *personal observations*). Some of these howls likely to represent hormonally induced mate searching in the early winter.

Staqeya's highly unusual existence highlights several ecological and social-cultural implications for wolves, other carnivores, and coexistence with humans. First, our observations support the hypothesis that inter- and intraspecific competition might exert strong influence on territory size relative to prey biomass. In relation to coastal wolves, shoreline perimeter and intertidal area might be a better predictor of suitable habitat than island area; although the Chatham Islands only have an area of 1.9 km², there is approximately 40 km of shoreline along which interactions with marine-oriented prey can occur (see also Merriam 1964, Darimont and Paquet 2002, Darimont et al. 2009). Second, that a typically widely roaming and highly social top carnivore can apparently thrive physiologically while alone on a small archipelago off a marine dominated diet suggests significant plasticity in life history in wolves. Most ecological studies report population averages, not divergent behavior of individuals. Such information can give us insight into evolutionary plasticity (past and present) as well as behavioral resilience in the face of environmental change. Finally, the Songhees Nation are working toward ensuring the continued protection of Staqeya and his home on *Tl'Chés*, which will require cooperation from the Province. As of August 2018, Staqeya continues to thrive in this unique landscape. Minimally intrusive management that reduces the probability of conflict with humans offers this wolf an opportunity to live out his exceptional life with respect.

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LITERATURE CITED

- Darimont, C. T., and P. C. Paquet. 2002. The gray wolves, *Canis lupus*, of British Columbia's central and north coast: distribution and conservation assessment. *Canadian Field-Naturalist* 116:416–422.
- Darimont, C. T., M. H. H. Price, N. N. Winchester, J. Gordon-Walker, and P. C. Paquet. 2004. Predators in natural fragments: foraging ecology of wolves in British Columbia's central and north coast archipelago. *Journal of Biogeography* 31:1867–1877.
- Darimont, C. T., P. C. Paquet, and T. E. Reimchen. 2009. Landscape heterogeneity and marine subsidy generate extensive intrapopulation niche diversity in a large terrestrial vertebrate. *Journal of Animal Ecology* 78:126–133.
- Gomes, T. C. 2013. Novel ecosystems in the restoration of cultural landscapes of Tl'chés, West Chatham Island, British Columbia, Canada. *Ecological Processes* 2:15.
- Inger, R., G. D. Ruxton, J. Newton, K. Colhoun, J. A. Robinson, A. L. Jackson, and S. Bearhop. 2006. Temporal and intrapopulation variation in prey choice of wintering geese determined by stable isotope analysis. *Journal of Animal Ecology* 75:1190–1200.
- Mech L. D., and L. Boitani. editors. 2010. *Wolves: behavior, ecology, and conservation*. University of Chicago Press, Chicago, Illinois, USA.
- Merriam, H. 1964. The wolves of Coronation Island. *Science in Alaska* 15, 27–32.
- Miller, A. H., and R. C. Stebbins. 1964. *The lives of desert animals in the Joshua Tree National Monument*. University of California Press, Berkeley, California, USA.
- Scott, B. M. V. 1979. *The Vancouver Island wolf (Canis lupus crassodon): an initial study of food habits and social organization*. Dissertation. University of British Columbia, Vancouver, British Columbia, Canada.
- Semmens, B. X., E. J. Ward, J. W. Moore, and C. T. Darimont. 2009. Quantifying inter- and intra-population niche variability using hierarchical Bayesian stable isotope mixing models. *PLoS ONE* 4:e6187.
- Stock, B. C., and B. X. Semmens 2016. *MixSIAR GUI User Manual*. Version 3.1. <https://github.com/brianstock/MixSIAR>. <https://doi.org/10.5281/zenodo.56159>
- Wilson, D. 2016. Encounter with Discovery Island's lone wolf sees island closed to tourists. *CBC News British Columbia*. <http://www.cbc.ca/news/canada/british-columbia/discovery-island-wolf-1.3769858>

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