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Impacts of a coastal State Highway on a recovering pinniped population

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Alasdair Hall was a winner of the 2022 NZCS Student Research MSc Scholarship, and this article draws on his project research. His profile was published in Coastal News 79 (November 2022).

Introduction

At just after midnight on November 14th, 2016, a magnitude 7.8 earthquake struck the Kaikōura region of South Island. This event had dramatic impacts on the terrestrial and marine environment of the area, and on the people and wildlife living there.

The earthquake triggered numerous landslips along the coastline, caused significant coastal uplift and instigated a substantial flushing event in the Kaikōura marine canyon, with noticeable impacts on marine food chains (Guerra et al., 2020).

One of the most enduring impacts from a human perspective was the damage to State Highway 1 (SH 1), New Zealand's most significant road. In places, the road was destroyed, necessitating a lengthy reconstruction project to reconnect Kaikōura to the rest of New Zealand.

The road reconstruction was not only significant to humans, but also to several colonies of New Zealand fur seal (*Arctocephalus forsteri*: NZFS) that haul-out and breed very close to it. The occurrence of a protected pinniped species next to a major transport route is rare and provides opportunities to study the relationship between the animals and the road. Further, the post-earthquake reconstruction of SH1 provided a chance to understand how changes to human infrastructure can influence coastal species.

Past research showed that SH1 does impact Kaikōura's NZFS. Between 1996 and 2005, 120 NZFS (an average of 12 per year) were recorded on SH1 (Boren et al., 2008). Of these seals, 40% died due to vehicle collisions, and 61% of all mortalities were pups. At the time, it was predicted that the problem would worsen due to growth in the local NZFS population (Boren et al., 2008).

Given the substantial post-earthquake modifications to SH1, and suspected changes to the abundance and distribution of local NZFS, our research sought to establish the current impacts of the road on NZFS colonies. As well as drawing comparisons with previous research, we sought to identify the hotspots for NZFS 'incidents' (records of live or dead NZFS on the road), establish the factors that might make a certain part of the road more likely to experience incidents, determine whether the hotspot locations have changed through time, and whether certain environmental or temporal factors affect the timing of these incidents.

Methodology

This research used data collected by the New Zealand Transport Authority (NZTA) on NZFS incidents on SH1 between May 2012 and April 2022. NZTA is permitted by DOC to remove NZFS carcasses or herd live NZFS from the road, typically in response to callouts from members of the public or during road maintenance work.

There are some gaps in this record, most notably the time from the earthquake through to the re-opening of the road (November 2016 - June 2018). During this time, the road was either closed or operating at a much-reduced capacity due to the ongoing reconstruction.

Kernel density estimation plus (KDE+) (Bíl et al., 2013, 2016, 2019), was used to identify hotspots of NZFS incidents with traffic along 90 km of SH1 between Oaro and the border between the Canterbury and Marlborough regions. To ensure that our results reflected the current distribution of hotspots, we limited the NZFS incident data set to January 2021 to April 2022, leaving 91 incidents available for analysis.

To determine spatial features of the road where NZFS incidents occur, SH1 was divided into 250-metre segments. For each segment, a yes or no (binary) response variable was created indicating whether or not it contained at least one NZFS incident. Twenty-six segments contained at least one incident, and, to permit spatial variable modelling, 52 incident-free segments were also randomly selected for comparison. For each segment, we analysed variables to assess their impacts on whether NZFS incidents occurred, and these included: the presence or absence of various guard rails and other road barrier

Like all youngsters, seal pups can sometimes be found in unexpected, and possibly hazardous, places (Photo: Alasdair Hall).

types, the road width, the road height from sea level, the distance to the nearest stream or culvert, the distance to the nearest bend, the distance to the coast, the percentage coverage of roadside vegetation, the coastal substrate type, the location of the road relative to the railway line, and whether or not the road abutted an area of NZFS breeding.

To analyse whether the locations of NZFS hotspots had persisted through time, NZFS incidents between May 2012 and April 2022 were aggregated into kilometre segments. The incidents' spatial distribution was then compared with what would be expected in a random situation, where the probability of incidents in a given segment should follow a Poisson distribution.

A Poisson regression model was used to determine the impacts of environmental (temperature, rain, wind and wave and tide height) and temporal (traffic volume) drivers on the timing of NZFS incidents. An additional season variable was also created to determine whether the season impacted NZFS incidents.

Results and implications

A total of 393 dead and 57 live NZFS were recorded on SH1 within the study area between May 2012 and April 2022. For 'complete years' (those with a full 12 months' worth of data) there were an annual average of 59 (±17 s.d.) NZFS incidents. There was an average of 49 (±9 s.d.) dead and 9 (±10 s.d.) live NZFS recorded each year on SH1. Where an indication of an individual NZFS' age was recorded, pups accounted for 88% of road mortality.

Fifty-nine is a considerable increase on the average of 12 annual NZFS incidents by Boren et al. (2008), and the result is likely tied to local population growth. Approximately 600 pups were produced at Ohau Point in 2005 (Boren et al., 2006), but this had increased to nearly 2,500 in 2015 (Gooday, 2016). Given the proximity of some of Kaikōura's NZFS colonies to SH1, it is expected that increasing NZFS abundance will lead to increasing NZFS incidents. Similarly, there has been an increase in the number of pups as a proportion of overall road mortality since the previous study. This, again, is likely tied to growth in the local breeding population of NZFS in colonies near SH1. Importantly, post-earthquake road reconstruction and COVID-19 lockdowns, which both occurred during the study period, substantially reduced traffic volumes on SH1, meaning the incident total would likely have been higher without these events. Without mitigation we might, therefore, expect the problem to worsen as tourism continues to recover.

The hotspot analysis identified 10 clusters of NZFS incidents. Together, these clusters accounted for 89% of the NZFS incidents, and represented only 2.75 km of road. This suggests that, if it is possible to prevent NZFS from accessing these limited stretches of road, the scale of the problem should be substantially reduced.

The hotspot persistence analysis showed a clear shift in the focal area of NZFS hotspots. Prior to the earthquake, 70% of the significant road segments were north of Kaikōura, whereas, post-earthquake, 63% were south of Kaikōura. Considering the south coast of Kaikōura in isolation, it is likely that the growth in incidents here is the result of local population growth. Pre-earthquake, the only recorded breeding in this area was on an nearshore islet, whereas, today, several breeding sites exist along the mainland coastline. However, there are still substantially more pups produced to the north of Kaikōura than to the south. Thus, in the absence of other factors, it would be expected that the north coast would continue to experience the bulk of NZFS incident hotspots.

Seal pup and mother resting next to State Highway 1 (left), and a new pup at home among the rocks (right) (Photos: Alasdair Hall).

The best explanation for these changes is the post-earthquake modifications to SH1. The most obvious of these is the construction of 2.5 km of non-contiguous seawall north of Kaikōura, with the majority situated around the established Ohau Point NZFS colony. In segments of SH1 now abutting the sea wall, the number of NZFS incidents have noticeably reduced since its construction, suggesting that it effectively excludes NZFS from the road. In addition, some sections of road north of Kaikōura where motorcycle protection railing (MPR; double guard rail) has replaced single guard rail, these sections have also seen reductions in NZFS incidents. This makes sense, particularly as pups make up the bulk of NZFS incidents and these smaller animals could easily fit under barriers that do not reach the road surface, such as single guard rails, but would not be able to get under MPR. By contrast, there have been increases in NZFS incident numbers in sections of road, particularly south of Kaikōura, where additional single guard rails and plastic mesh safety fencing have been installed. This suggests that these barrier types do not effectively exclude NZFS from the road.

Of the temporal and environmental variables, season had the greatest effect on NZFS incidents, with autumn experiencing substantially more incidents than any other season. This is likely tied to pup development as, during autumn, NZFS pups are still largely confined to land, but are mobile, inquisitive and feeding less frequently than in summer. Together, this means pups have the ability and time to explore their terrestrial environment. If the colony is close to SH1, this may lead them to access the road. Greater traffic volumes and higher wind speeds were also significantly associated with more NZFS incidents. It is unsurprising that months with heavier traffic volumes experience more NZFS incidents, and the relationship between windspeeds and NZFS incidents may be tied to animals escaping windy conditions on the coast by moving inland and thus onto roads. By contrast, higher temperatures and heavier rainfall were significantly associated with fewer NZFS incidents. In both cases, the relationship is likely associated with NZFS seeking shelter from high temperatures or prolonged/heavy rain. Pups are vulnerable to both over-heating and soaking to the skin, as their juvenile coats are not waterproof, and therefore are likely to escape to verges and onto roads during these conditions.

The analysis of spatial features showed that the presence of road abutting NZFS breeding sites was so predictive of NZFS incidents that a full logistic regression was not required. This finding fits with our other results indicating the prevalence of pups in NZFS mortalities, and is logical, as breeding colonies contain the greatest year-round densities of NZFS. There are, however, important management implications of this finding, as it suggests that breeding sites should be prioritised when it comes to road protection mitigation, even if, as in Kaikōura, a coastline also features non-breeding aggregations of NZFS.

Overall, these results indicate that SH1 can be a threat to Kaikōura's NZFS, and one that has worsened in recent years. However, it appears that, if appropriate mitigation measures are taken at the identified areas where incidents occur, it may be possible to significantly reduce the number of NZFS deaths. Although our study did not explicitly test different barrier type efficacy, it appears that the most effective long-term solution would be the addition of more motorcycle protection railing at the identified hotspots. As autumn is the worst time of year, and high winds and increased traffic volumes also lead to increased NZFS incidents, a next-best solution would be temporary mitigation measures during such periods – for example, autumn holidays such as Easter and ANZAC day, or when storms are forecast.

It is also worth considering that continued growth of the nationwide NZFS population, combined with sea level rise and the predicted increased intensity and regularity of storms, which will likely drive coastal species further inland, may mean that this problem becomes replicated elsewhere. As such, proactive response planning is needed to minimise the risks to both wildlife and humans.

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