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Effect of predator control at Poutiri Ao ō Tāne on Boundary Stream Mainland Island

Effect of predator control at Poutiri Ao ō Tāne on Boundary Stream Mainland Island

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Contents

Summary

Project and client

- The Department of Conservation (DOC) has trapped mammalian predators in Boundary Stream Mainland Island (BSMI) since 2006. In mid-2011 Hawke's Bay Regional Council commenced wide-scale predator trapping in adjacent Poutiri Ao ō Tāne. This report used trapping data provided by DOC to determine if predator abundance indices at BSMI have changed over the period 2006–2017, especially as a result of the predator control at Poutiri Ao ō Tāne. The report was completed by Landcare Research, Lincoln, for Hawke's Bay Regional Council during December 2016 and June 2017.

Objective

- To analyse the benefits to BSMI in terms of predator abundance indices resulting from predator control at Poutiri Ao ō Tāne. Of primary interest were the mustelid guild and cats; however, we subsequently included possums, rodents, and hedgehogs in our analyses.

Methods

- We stratified BSMI into northern, central and southern areas. This was done because Poutiri Ao ō Tāne is south of BSMI, and so trapping effort in that area could have had a variable spatial effect on BSMI.
- We used DOC trapping data to compare predator abundance indices in each of the strata before and after mid-2011 (i.e. after trapping began in Poutiri Ao ō Tāne). Our prediction was that if trapping at Poutiri Ao ō Tāne had reduced the number of predators migrating into BSMI, trapping indices should be lower there after mid-2011, and the proportional reduction should be greatest in the southern portion of BSMI immediately adjacent to Poutiri Ao ō Tāne.
- We corrected for trapping effort in two ways. First, we assumed that bait applied at traps remained attractive for 5 days and that traps would not catch anything after this period. If a trap did catch a predator, we assumed it was caught at 2.5 days. Second, we used the total number of times a trap was checked per year as a correction.
- We assessed all mustelids combined, stoats separately, hedgehogs, all species combined, and all species excluding rodents. We included data from cats trapped in mustelid traps; however, because the necessary data were missing from the cat trap diary, we did not have sufficient data to assess cats separately.
- The report explores trends in the trapping data from DOC. Initially we were interested in determining if there were any clear patterns that warranted further assessment. Because no clear patterns that could be attributed to predator trapping at Poutiri Ao ō Tāne were apparent, no formal statistical tests were done.

Results

- Based on uncorrected raw data, the numbers of stoats, ferrets, cats and hedgehogs trapped were generally lower after trapping began in Poutiri Ao ō Tāne. Weasels and mice appear to have increased, whereas possums were at low numbers throughout the study and showed no discernible pattern. Rats were the most commonly trapped predator (n = 4,348), and they were trapped most often after mid-2011, particularly from mid-2012 to mid-2015.
- After correcting for trapping effort, reductions in the number of predators trapped (excluding rodents) in the northern portion of BSMI were apparent, but there was no evidence of an effect of Poutiri Ao ō Tāne on the central part of BSMI. The results from the southern part of BSMI, immediately adjacent to the highest trapping effort from Poutiri Ao ō Tāne, suggest no effect or a small increase in the number of predators (excluding rodents) trapped.

Conclusions

- The results from the DOC database were equivocal, and so it is not possible to say with certainty whether trapping at Poutiri Ao ō Tāne has reduced the number of predators trapped at BSMI.
- Although we predicted that, proportionally, the numbers of predators trapped after mid-2011 should be lowest in the southern portion of BSMI, immediately adjacent to Poutiri Ao ō Tāne, we found the opposite: the greatest proportional reduction of predators (excluding rodents) tended to be in the northern area of BSMI.
- Including rodents in analyses, we found that predator indices have increased in all BSMI strata after trapping began at Poutiri Ao ō Tāne. This may be a result of top predators being removed, or an increase in food availability from mid-2013 to mid-2016.
- Our results may be sensitive to the low number of predators (excluding rats) trapped annually. However, there were consistent temporal trends across species and species groups, indicating a consistent effect in the data that was not attributable to trapping in Poutiri Ao ō Tāne.

Recommendations

- This analysis demonstrates the need to design data collection carefully to answer the question of how predator control in one area also benefits adjacent areas. In the current instance it is unclear whether no observed effect was due to there being no actual effect or insufficient/inappropriate data collection.
- Entering the required data into the trap database from the cat trap diary will enable cat data to be analysed separately. Based on raw data, there were fewer cats trapped at BSMI after trapping at Poutiri Ao ō Tāne began. Consequently, it may be worthwhile assessing this relationship after correcting for trapping effort.
- Within BSMI and Poutiri Ao ō Tāne there have been spatial and temporal differences in trap type used, whether they were double or single sets, and bait type used. We did

not assess these factors. However, the results from our analysis suggest that including this additional intensive data manipulation exercise is probably not warranted and would be unlikely to change the general conclusions in this report.

- We discuss the pros and cons of alternative survey designs to answer the question posed in this report.

1 Introduction

The Department of Conservation (DOC) has trapped mammalian predators in Boundary Stream Mainland Island (BSMI) since 2006. In mid-2011 Hawke's Bay Regional Council commenced wide-scale predator trapping in adjacent Poutiri Ao ō Tāne. This report used trapping data provided by DOC to determine if predator abundance indices at BSMI have changed over the period 2006–2017, especially as a result of the predator control at Poutiri Ao ō Tāne. The report was completed by Landcare Research, Lincoln, for Hawke's Bay Regional Council during December 2016 and June 2017.

2 Objective

- To analyse the benefits to BSMI in terms of predator abundance indices resulting from predator control at Poutiri Ao ō Tāne (see Figure 1 for locations of traplines). Of primary interest were the mustelid guild and cats; however, we subsequently included possums, rodents, and hedgehogs in our analyses.

3 Methods

We stratified BSMI into northern (or 'north'), central and southern (or 'south') areas. This was done because Poutiri Ao ō Tāne is south of BSMI, and thus trapping effort in that area could have had a variable spatial effect on BSMI.

The information provided by DOC included data from traplines inside and outside of BSMI, both pre- and post-predator control at Poutiri Ao ō Tāne. We therefore analysed the data in two ways. First, we included all traps (n = 809), stratified as detailed above (see Figure 2). Second, we included only those traps for which data were available before mid-2011 and after mid-2011 (n = 586), again stratified as above (see Figure 3).

We used DOC trapping data to compare predator indices in each of the strata before and after mid-2011 (i.e. after trapping began in Poutiri Ao ō Tāne). Our prediction was that if trapping at Poutiri Ao ō Tāne was reducing the number of predators migrating into BSMI, trapping indices should be lower after mid-2011, and the proportional reduction should be greatest in the southern portion of BSMI immediately adjacent to Poutiri Ao ō Tāne.

Mustelid traps were baited with Erayz dried mustelid and rat blocks, and an egg per box trap (see Glen's [2014] preliminary unpublished mustelid report for Hawke's Bay Regional Council). Cat traps were located along mustelid traplines and were baited with Erayz dried mustelid and rat blocks and fresh rabbit meat.

Trapline set up and trap-checking schedules at BSMI were not designed to answer this question. Notably, checking schedules were highly variable, ranging from once or twice a month to once per year. Thus, if a trap caught a predator, we did not know when it was caught and thus how long the trap was actually active.

To account for this uncertainty we corrected for trapping effort in two ways. First, we assumed that bait applied at traps remained attractive for 5 days and that traps would not catch anything after this period. If a trap did catch a predator, we assumed it was caught at 2.5 days. Second, we used a simpler correction: the total number of times the trap was checked per year. In both cases the numerator was the total number of animals caught in a trap. For these exploratory analyses we did not correct for trap type, bait type, or whether they were single or double sets.

We assessed all mustelids combined, stoats separately, hedgehogs, all species combined, and all species excluding rodents. We included data from cats trapped in mustelid traps. However, because the necessary data were missing from the cat trap diary, we did not have sufficient data to assess cats separately.

The report explores trends in the trapping data from DOC. Initially we were interested in determining if there were any clear patterns that warranted further assessment. Because no clear patterns that could be attributed to predator trapping at Poutiri Ao ō Tāne were apparent, no formal statistical tests were done.

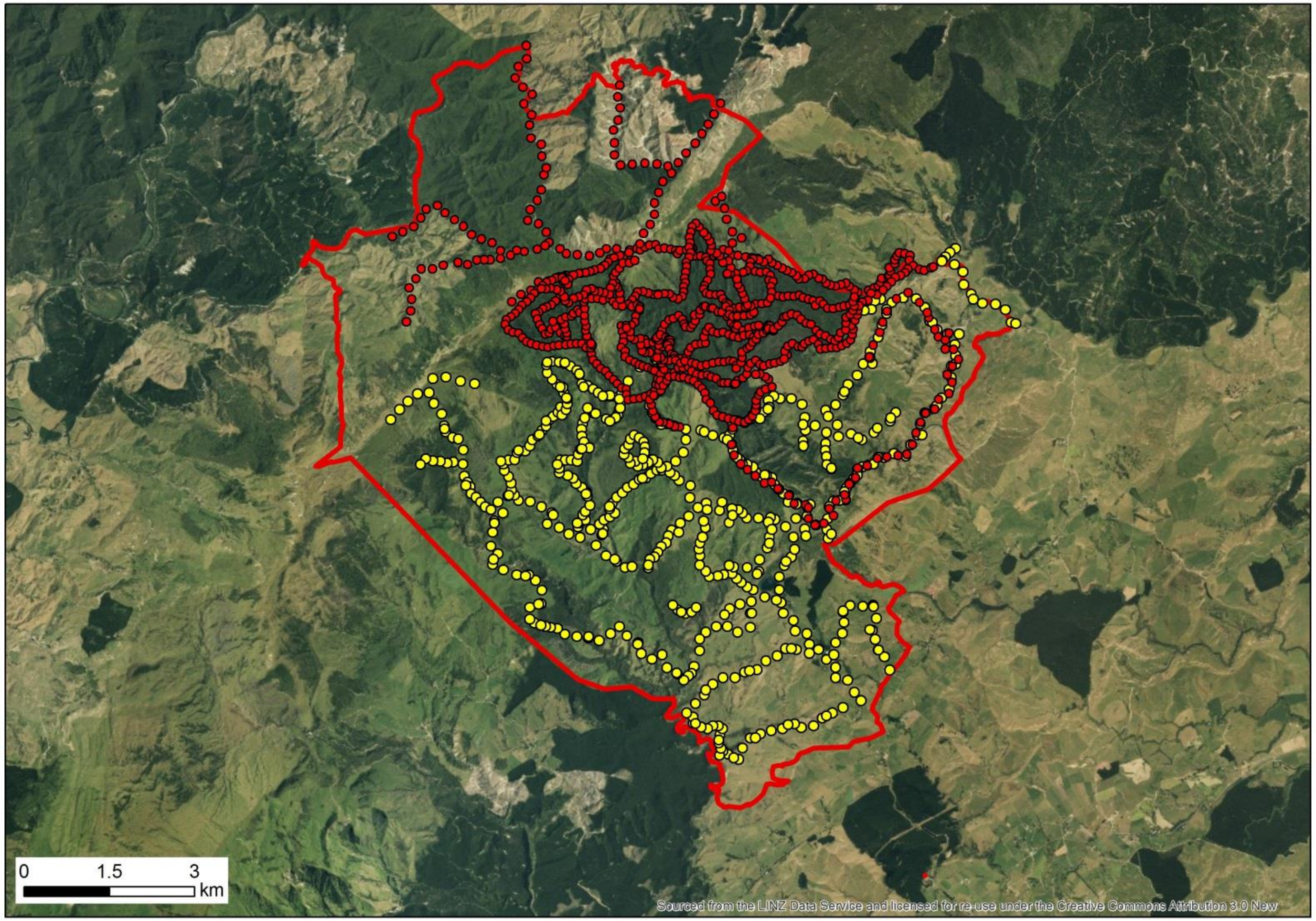


Figure 1 Locations of traplines within BSMI and Poutiri Ao ō Tāne, Hawke's Bay. The red polygon encompasses both areas, the red dots indicate DOC traps (focused on BSMI, but also including a few additional traplines outside BSMI), and the yellow dots indicate traps associated with Poutiri Ao ō Tāne.

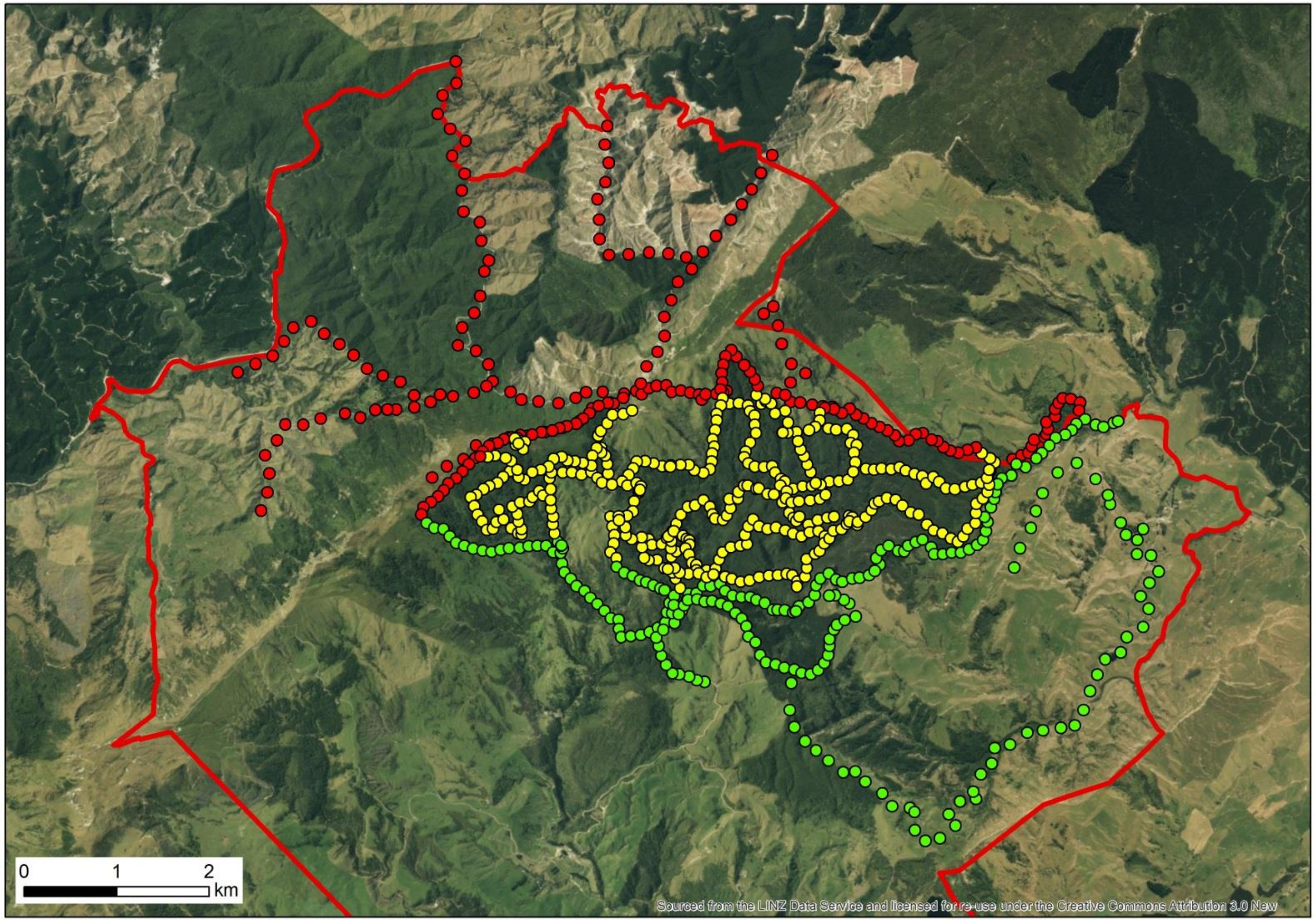


Figure 2 We analysed data from DOC traplines in BSMI in two ways. This figure represents the first approach. It includes all traps for which there were data (*n* = 809), and is stratified into northern (red dots), central (yellow dots), and southern (green dots) areas.

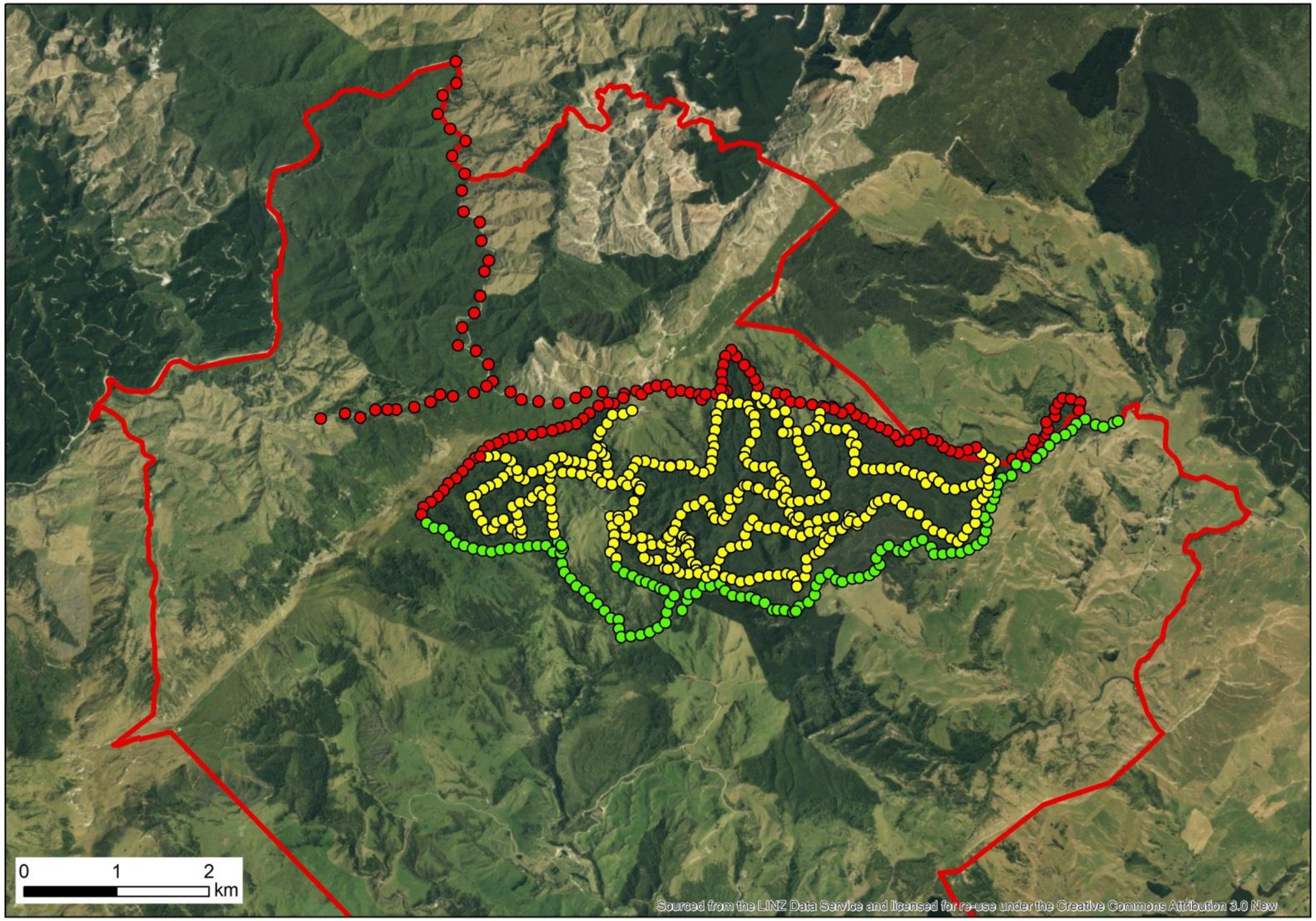


Figure 3 We analysed data from DOC traplines in BSMI in two ways. This figure represents the second approach. It includes only those traps for which there were data both before and after mid-2011 (n = 586), and is stratified into northern (red dots), central (yellow dots), and southern (green dots) areas.

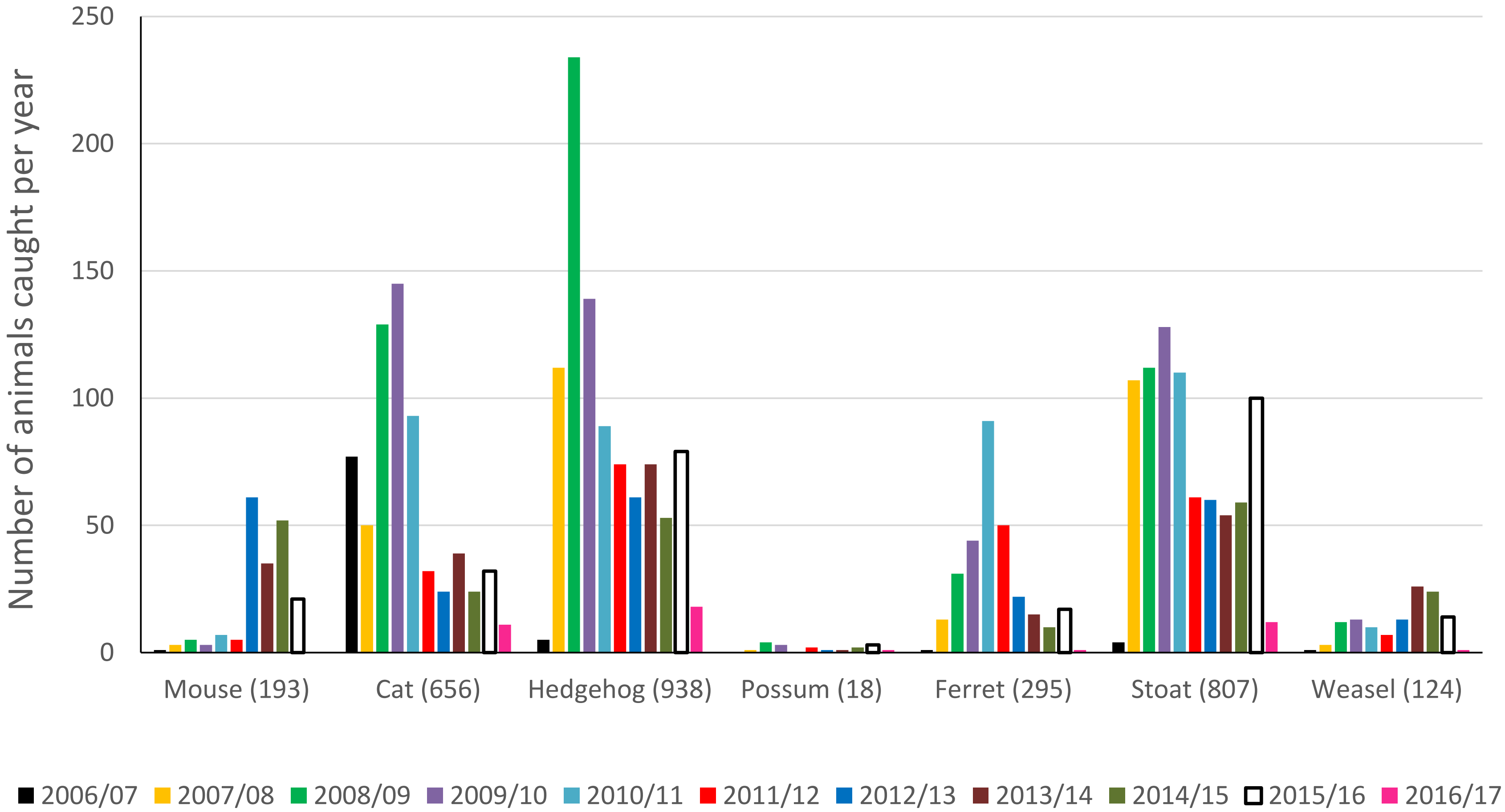


Figure 4 The annual trends in the numbers of predators, by species (but not including rats), trapped by DOC at BSMI from 2006 to early 2017 (total numbers of each species trapped during the study are shown in parentheses). The red bar (2011/12) represents the period when trapping at adjacent Poutiri Ao ō Tāne started. (See text in Results for rats.)

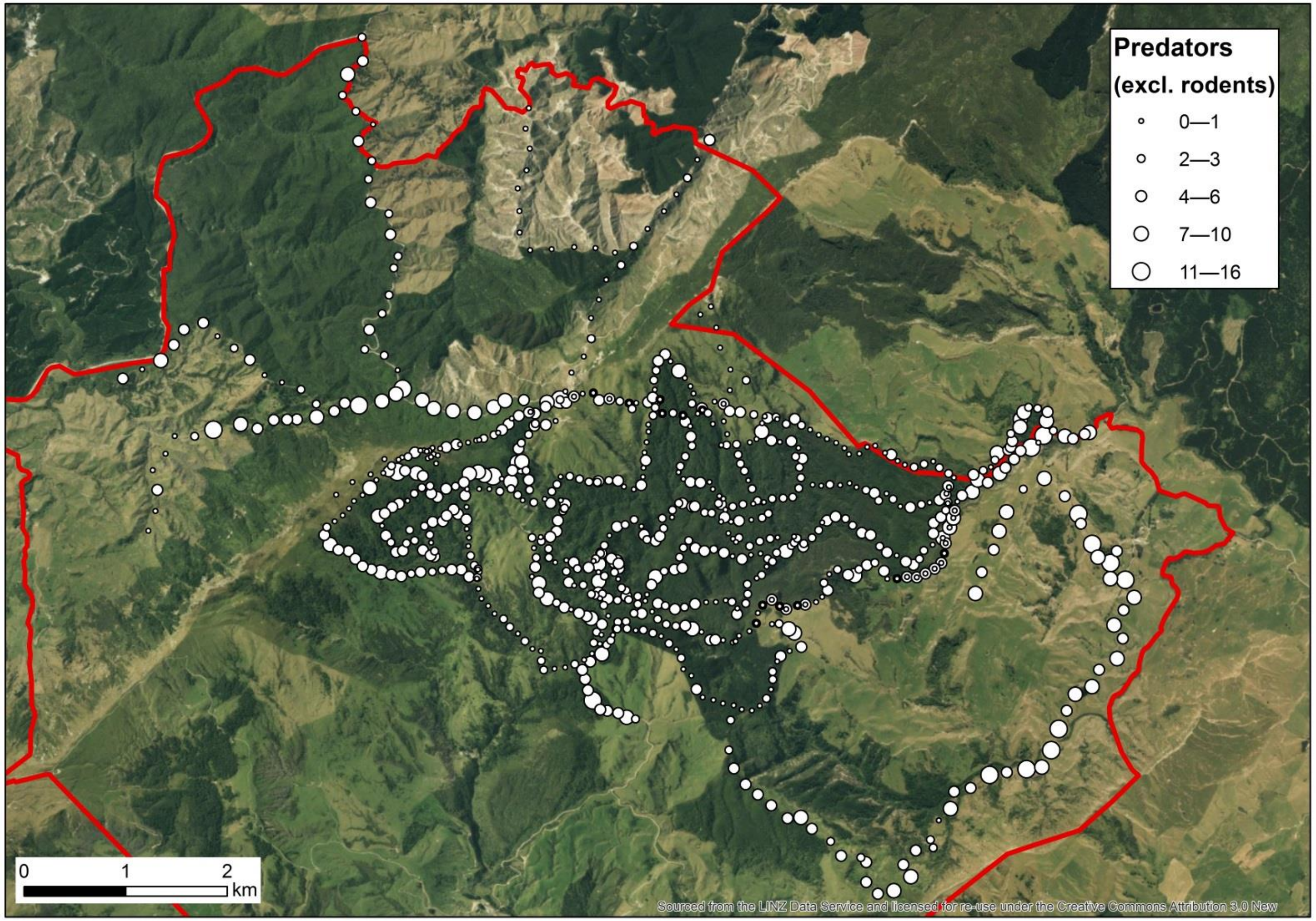


Figure 5 Spatial distribution of predators (excluding rodents) trapped on DOC traplines in and around BSMI from 2006 to early 2017. The figure shows that captures were not evenly distributed across the landscape.

4 Results: DOC data analyses

The annual trends in the number of predators trapped (but not including rats) are shown in Figure 4. In brief, the numbers of stoats, ferrets, cats and hedgehogs were generally lower after trapping began in Poutiri Ao ō Tāne. Mice and weasels appear to have increased, whereas possums were at low numbers throughout the study and showed no discernible pattern. Rats were the most commonly trapped predator (*n* = 4,348) and were trapped most often after mid-2011, particularly from mid-2012 to mid-2015.

The spatial distribution of predators trapped (excluding rodents) is shown in Figure 5. The figure shows that traps in a few areas, particularly along the eastern boundary, caught comparatively high numbers of predators, whereas traps across much of BSMI caught few predators.

The method used to correct for trapping effort did not have an effect on before/after patterns of predator abundance indices (see Figure 6A, B, which uses information from all 809 traps for mustelids). Consequently, we do not present graphs for both correction methods, but rather show only the five-night trap attractiveness method.

The patterns derived from using information from all 809 DOC traps versus only those traps for which before mid-2011 and after mid-2011 data were available (*n* = 586) differed, particularly in the south of BSMI (Figure 7A, B). In the example of all mustelids combined, the pattern resulting from all 809 DOC traps suggests a decline in the number of mustelids trapped in the south of BSMI after mid-2011 (Figure 7A), whereas this pattern is not evident in the other analysis (Figure 7B). Thus we show patterns from both of these methods for all predator analyses for 2006 to mid-2011 (before Poutiri Ao ō Tāne) and mid-2011 to early 2017 (after Poutiri Ao ō Tāne). However, because the patterns are not as discernible for annual trends in predator abundance indices (see Figure 8), we only show results for those traps for which before mid-2011 and after mid-2011 data were available.

Annual trends suggest that the numbers of mustelids trapped after mid-2011 tended to be lower from mid-2011 to mid-2014, before increasing from mid-2014 to mid-2016, and dropping again in 2016/17 (Figure 8).

Stoats, the most commonly trapped species of mustelid, showed similar patterns to the analyses for all mustelids combined (see Figures 9A, B and Figure 10). Conversely, the pattern for hedgehogs was reversed in the south of BSMI, with data from all 809 DOC traps suggesting fewer hedgehogs were trapped after Poutiri Ao ō Tāne trapping began, and data from those traps for which before/after information was available suggesting that more hedgehogs were trapped after Poutiri Ao ō Tāne (Figure 11A, B). This anomaly may have been driven by the massive spike in the number of hedgehogs trapped in the south of BSMI in 2015/16 (Figure 12).

The analyses of all predators combined consistently showed that more predators have been trapped after Poutiri Ao ō Tāne, particularly between mid-2013 and mid-2016 (Figure 13A, B and Figure 14). However, this pattern was driven by the inclusion of rodents, particularly rats, in the analysis. If rodents are removed, the patterns tend to be reversed, with no difference between the number of predators trapped in the central and southern strata before versus after Poutiri Ao ō Tāne, and a reduction in the northern stratum (Figure 15A, B and Figure 16).

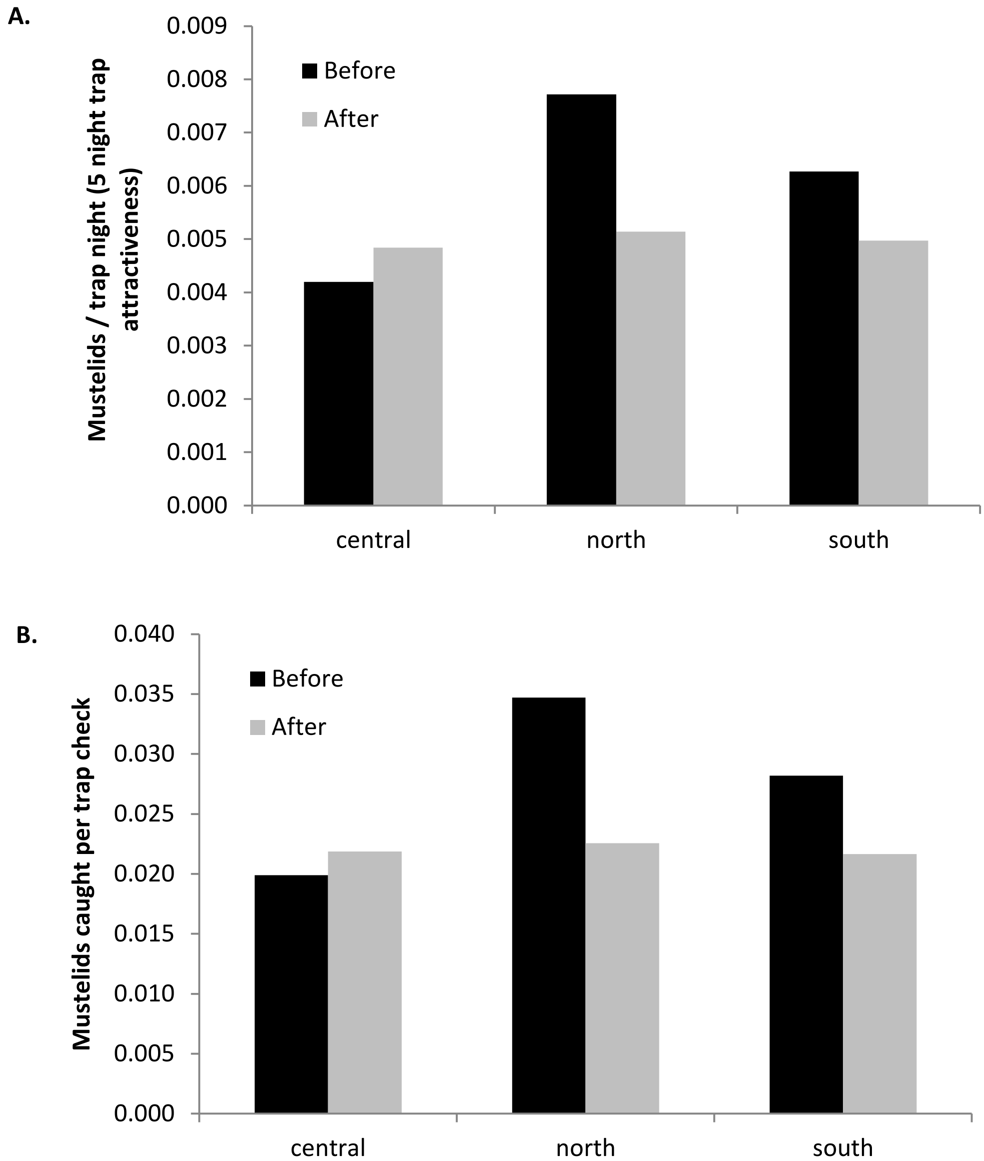


Figure 6 Patterns in the number of mustelids (all species combined) trapped by DOC before (black bars) and after (grey bars) mid-2011 in BSMI (see Figures 2 and 3 for details on strata). This figure compares the two methods of correcting for trapping effort (using data from all 809 traps); A shows the results assuming that bait applied at traps remained attractive for 5 days, and B shows the results using the number of times a trap was checked per year. Both graphs show similar patterns in mustelid abundance indices: no (or little) effect in the centre, and a decrease in the northern and southern areas of BSMI after mid-2011. Given that both methods of correcting for trapping effort show near identical patterns for mustelids (and all other species or groups assessed), we only report the five-night trap attractiveness method hereafter.

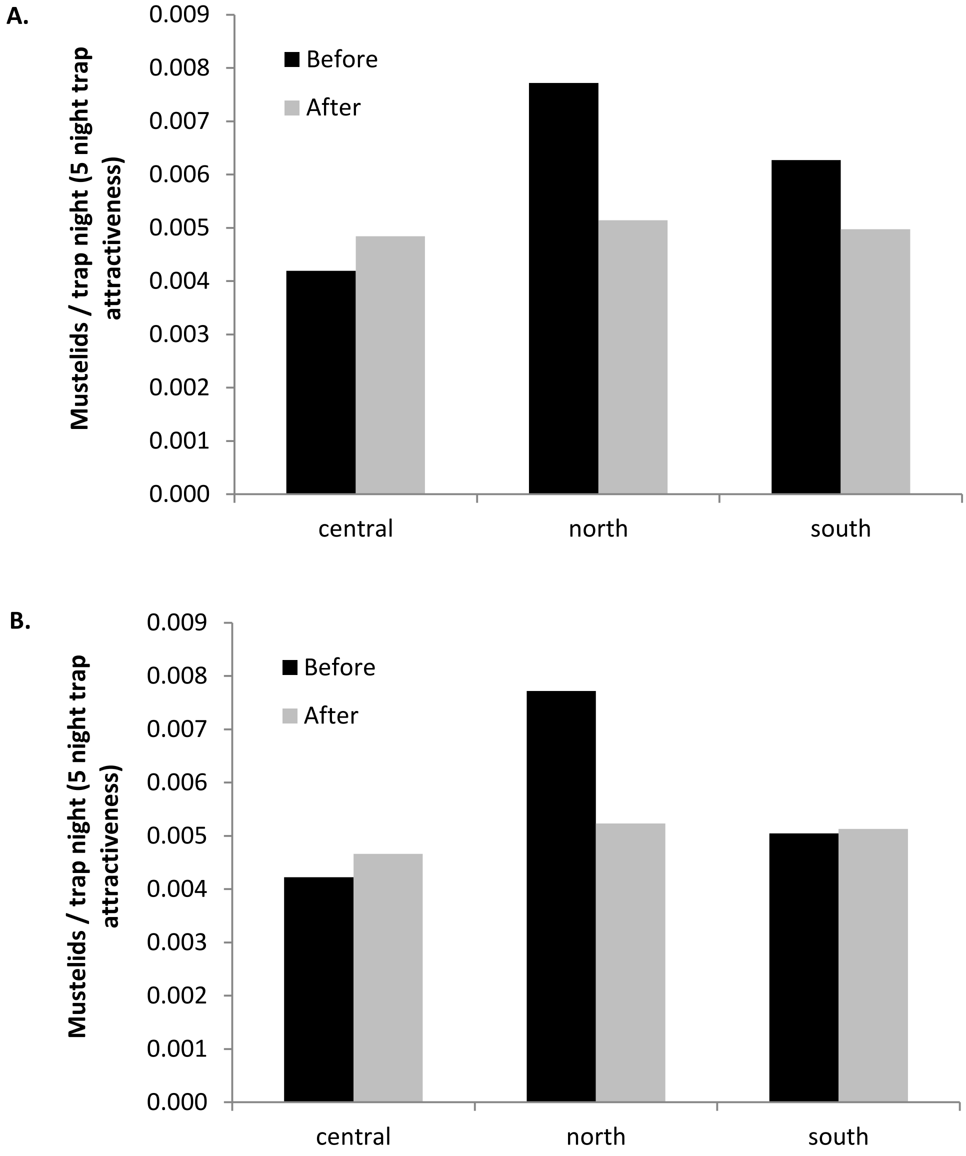


Figure 7 Patterns in the number of mustelids (all species combined) trapped by DOC before (black bars) and after (grey bars) mid-2011 in BSMI (see Figures 2 and 3 for details on strata). This figure shows the patterns derived from using A, information from all 809 DOC traps (identical to Figure 6A), versus B, only those traps for which before mid-2011 and after mid-2011 data were available (*n* = 586). In contrast to the comparative approach in Figure 6, this comparison shows that the number of traps used in analyses does have an effect on predator abundance indices before and after mid-2011. In this case, B shows that there was no effect of Poutiri Ao ō Tāne on BSMI; thus, for all analyses we show graphs using all 809 DOC traps and the 586 traps for which we have before/after data.

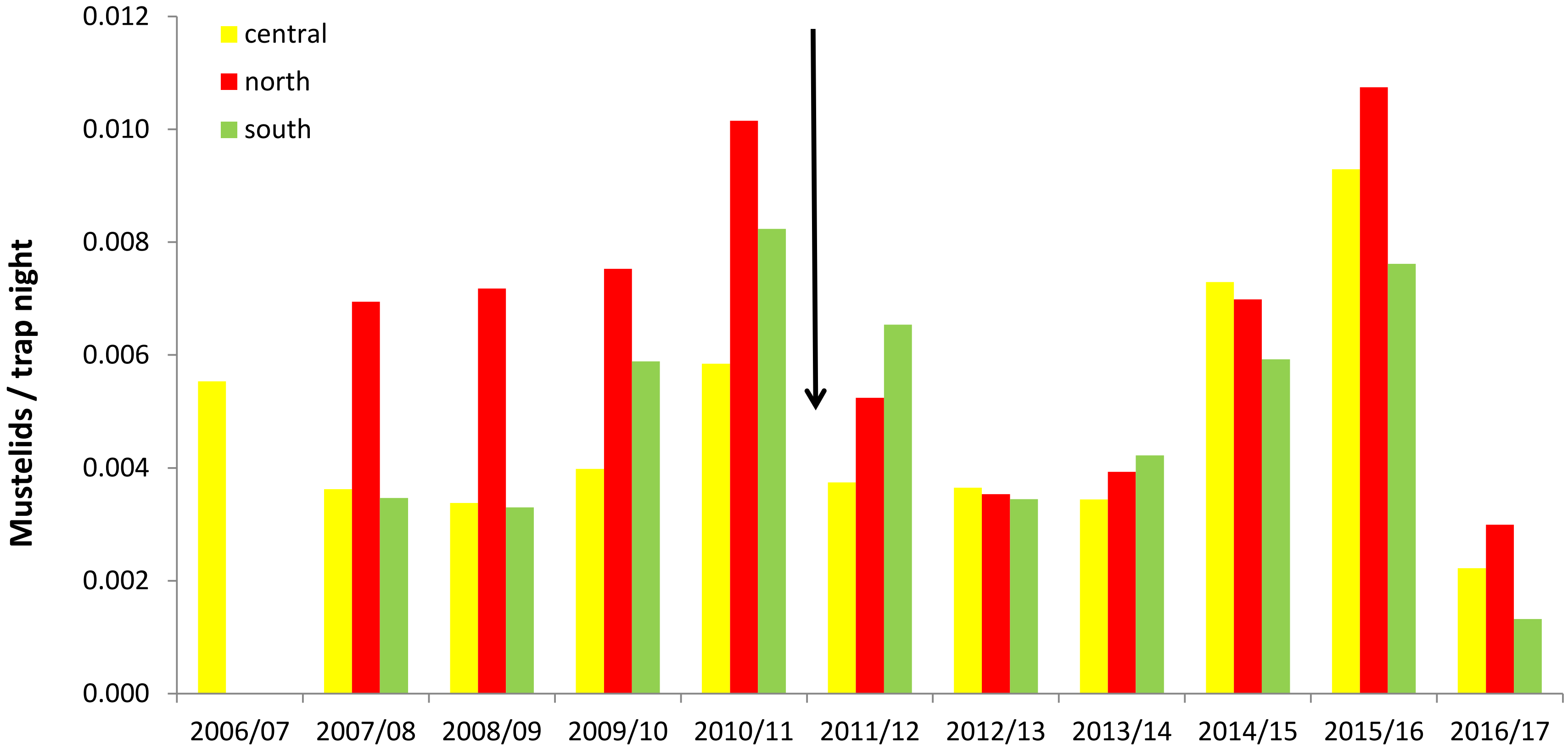
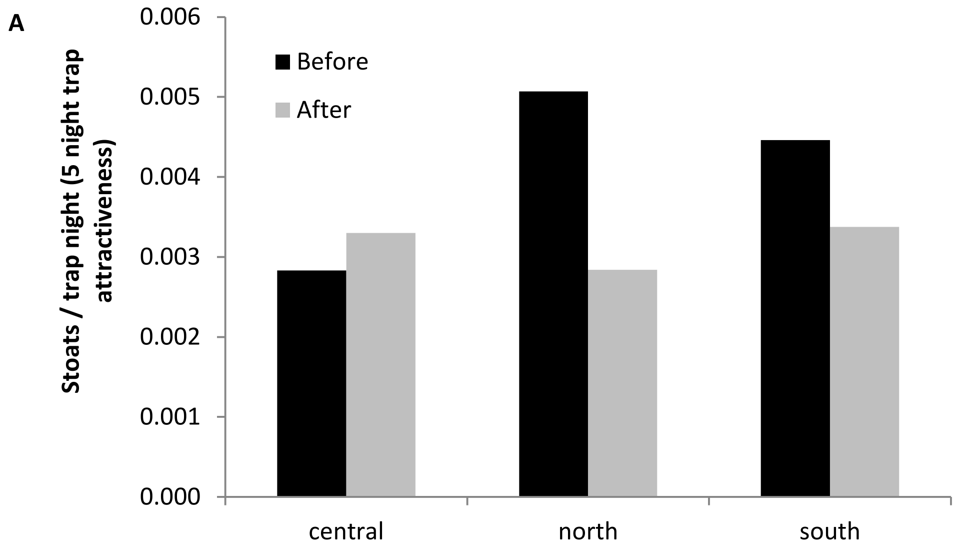


Figure 8 Annual trends in the number of mustelids (all species combined) trapped by DOC in BSMI (see Figures 2 and 3 for details on strata). The results show that after trapping began in Poutiri Ao ō Tāne in mid-2011 (see black arrow) there was an initial drop in mustelids trapped in BSMI from mid-2011 to mid-2014, before increasing from mid-2014 to mid-2016, and dropping again in 2016/17.



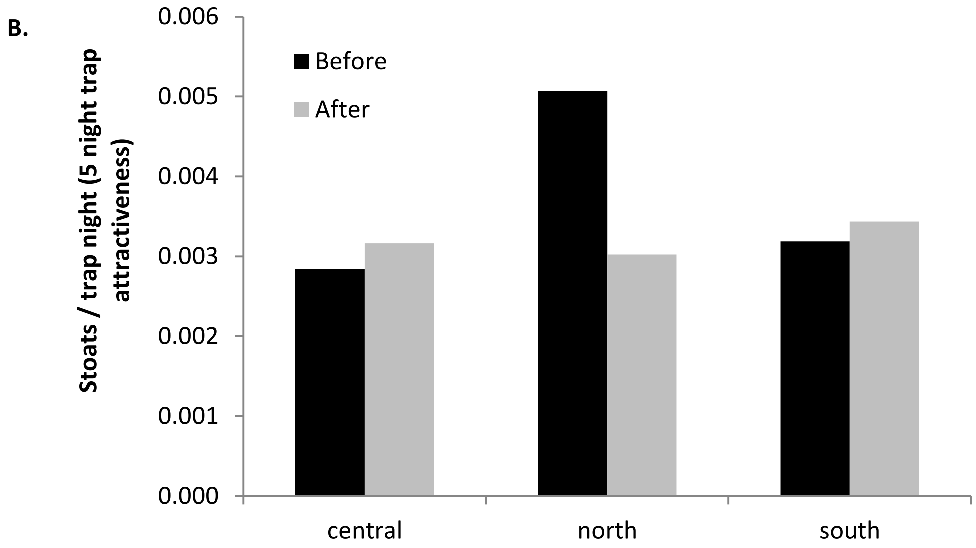


Figure 9 Patterns in the number of stoats trapped by DOC before (black bars) and after (grey bars) mid-2011 in BSMI (see Figures 2 and 3 for details on strata). Similar to the analysis for all mustelid species combined (Figure 7), patterns derived from using A, information from all 809 DOC traps, versus B, only those traps for which before mid-2011 and after mid-2011 data were available (n = 586), were similar for central (no effect) and northern strata (decline after mid-2011), but not for the southern stratum (A = decline after mid-2011; B = no effect).

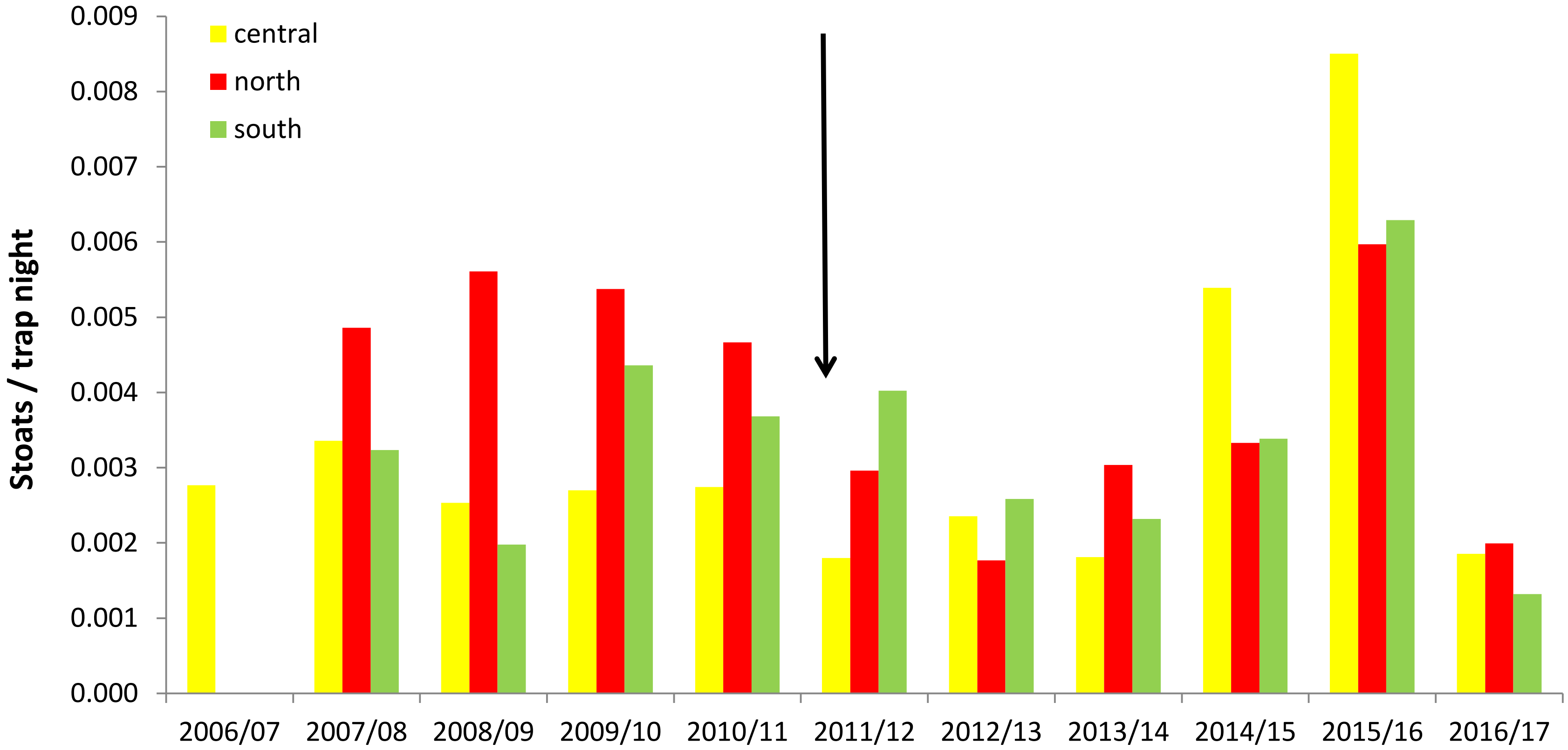
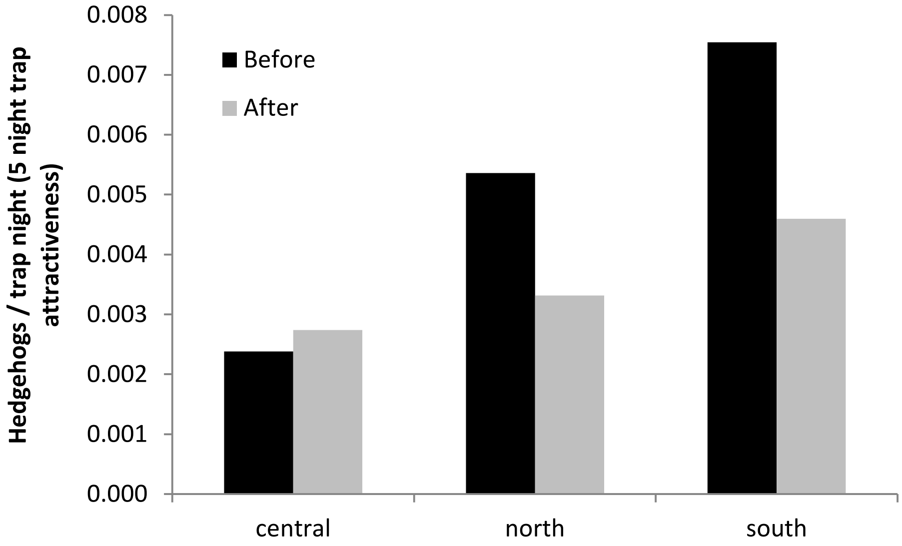


Figure 10 Annual trends in the number of stoats trapped by DOC in BSMI (see Figures 2 and 3 for details on strata). The results show that after trapping began in Poutiri Ao ō Tāne in mid-2011 (see black arrow) there was on average an initial drop in stoats trapped in BSMI from mid-2011 to mid-2014, before increasing from mid-2014 to mid-2016, and dropping again in 2016/17.

A.



B.

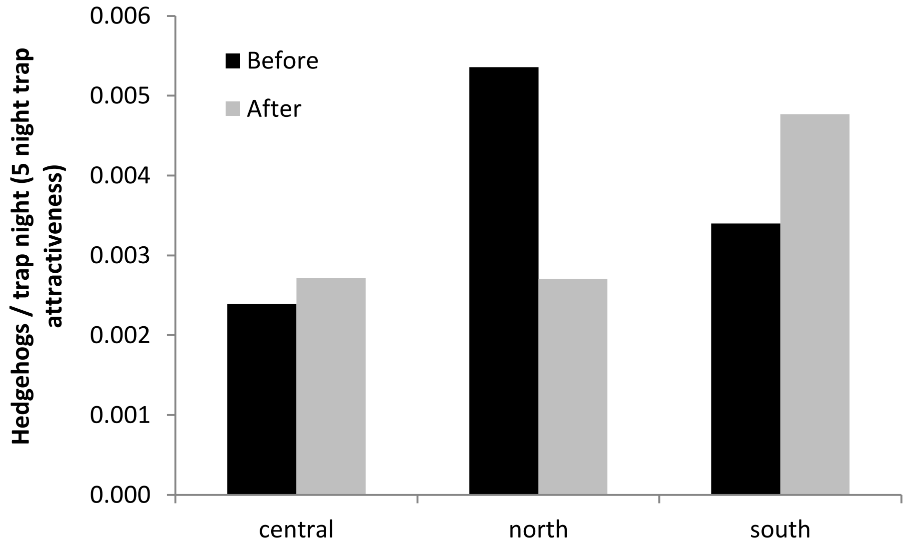


Figure 11 Patterns in the number of hedgehogs trapped by DOC before (black bars) and after (grey bars) mid-2011 in BSMI (see Figures 2 and 3 for details on strata). The patterns derived from using A, information from all 809 DOC traps, and B, only those traps for which before mid-2011 and after mid-2011 data were available (*n* = 586), were similar for central (no effect) and northern strata (decline after mid-2011), but not for the southern stratum (A = decline after mid-2011; B = increase after mid-2011).

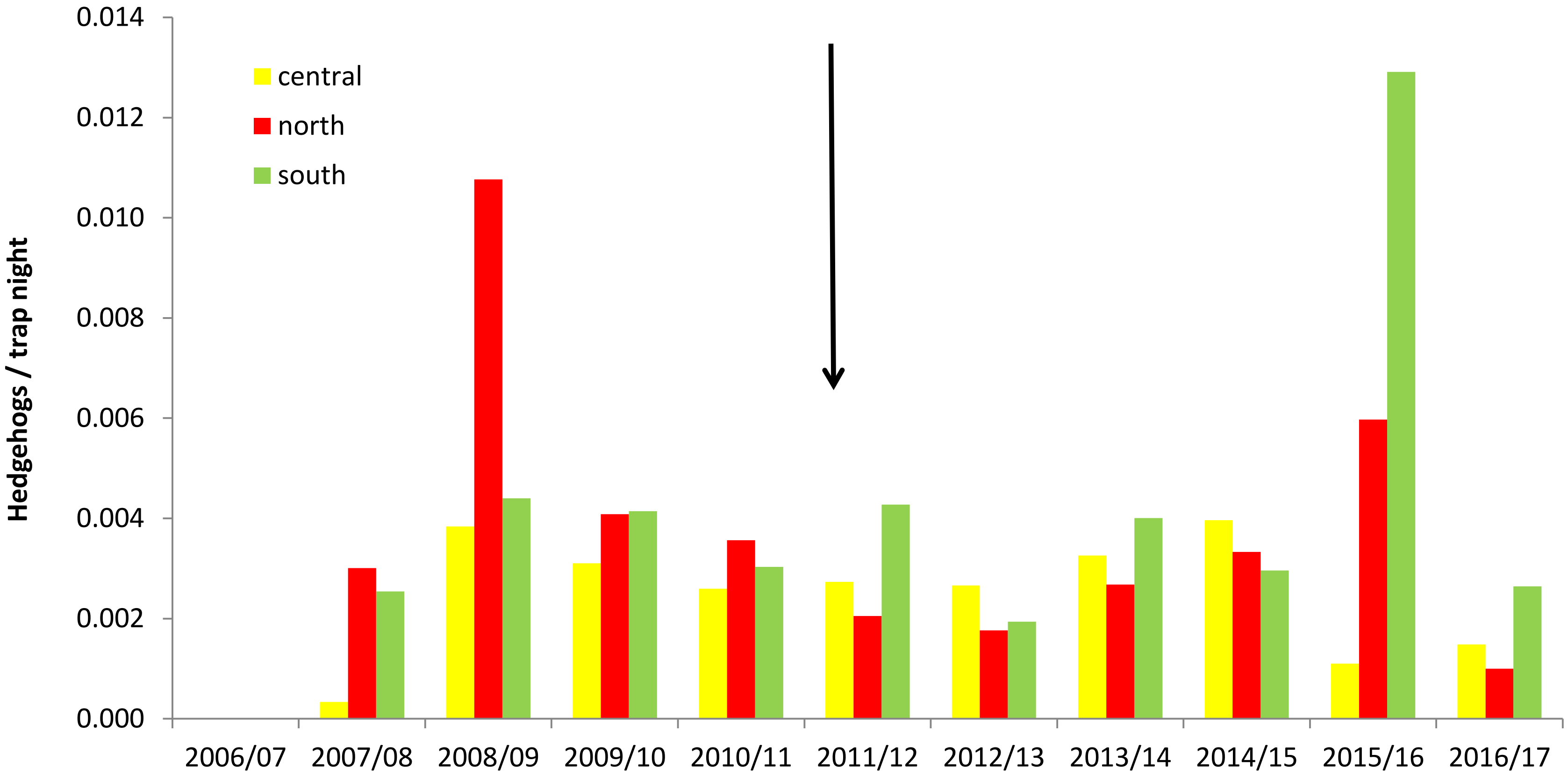
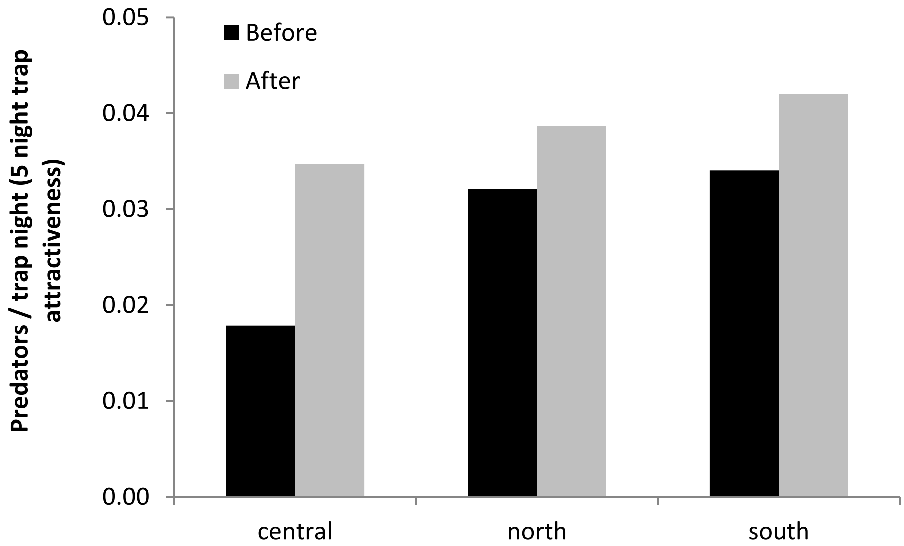


Figure 12 Annual trends in the numbers of hedgehogs trapped by DOC in BSMI (see Figures 2 and 3 for details on strata). The results show that after trapping began in Poutiri Ao ō Tāne in mid-2011 (see black arrow) the number of hedgehogs trapped in BSMI was comparable from mid-2009 to mid-2015, before increasing in the northern stratum and especially the southern stratum during mid-2015 to mid-2016, before dropping again in 2016/17.

A.



B.

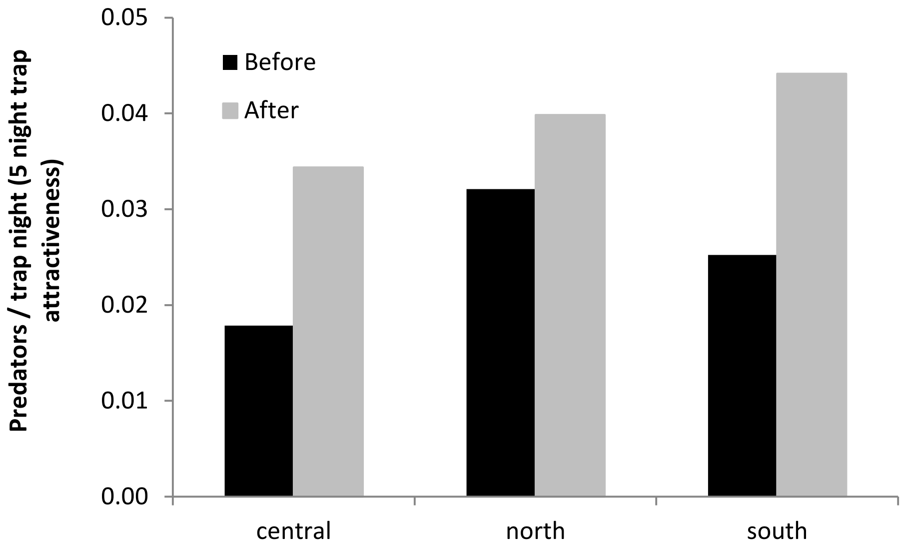


Figure 13 Patterns in the number of predators (all species combined, including rodents) trapped by DOC before (black bars) and after (grey bars) mid-2011 in BSMI (see Figures 2 and 3 for details on strata). The patterns derived from using A, information from all 809 DOC traps, and B, only those traps for which before mid-2011 and after mid-2011 data were available (*n* = 586), were similar for all three strata. The number of predators trapped increased after trapping began in Poutiri Ao ō Tāne in mid-2011, particularly in the central and southern strata (Figure 13B).

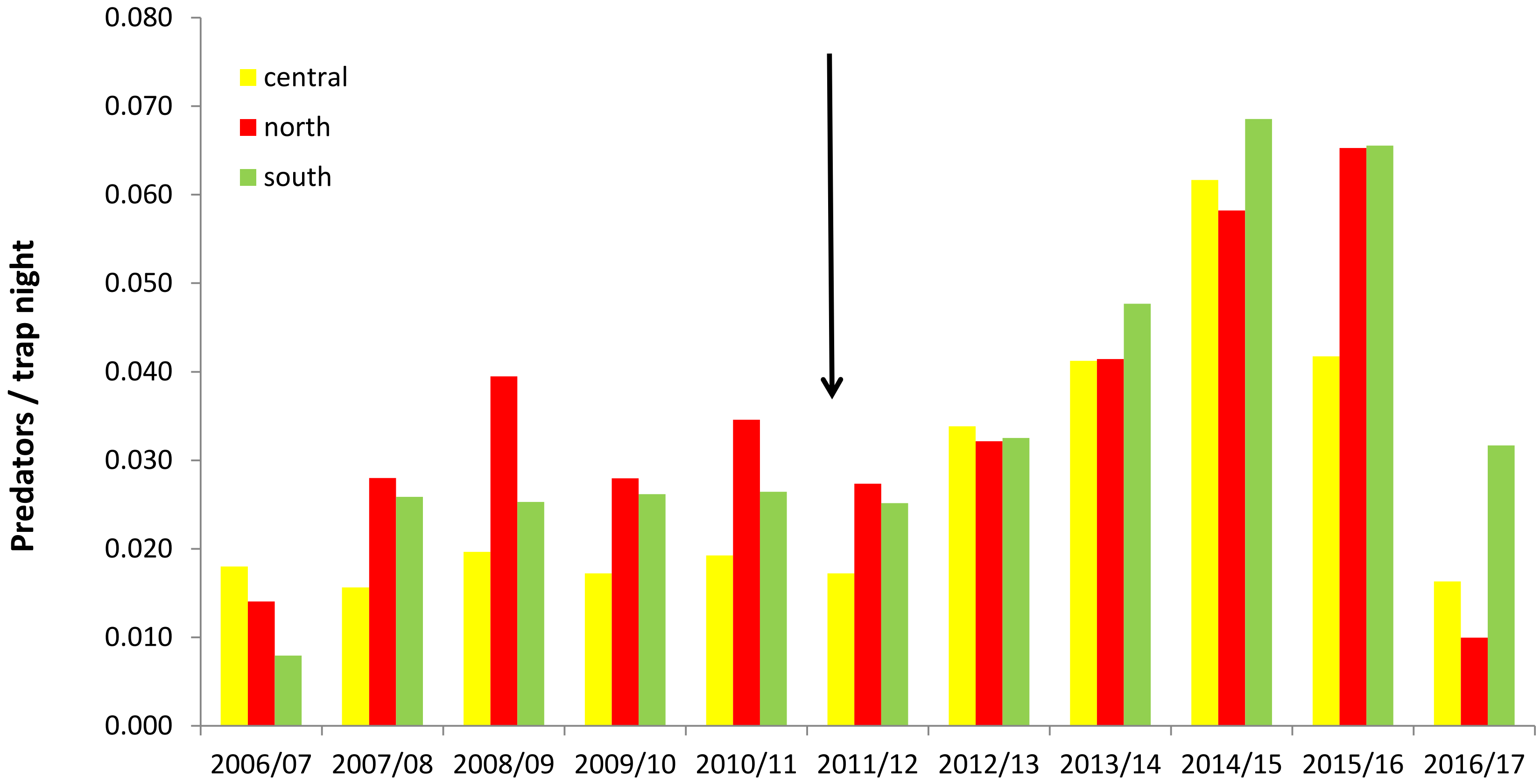
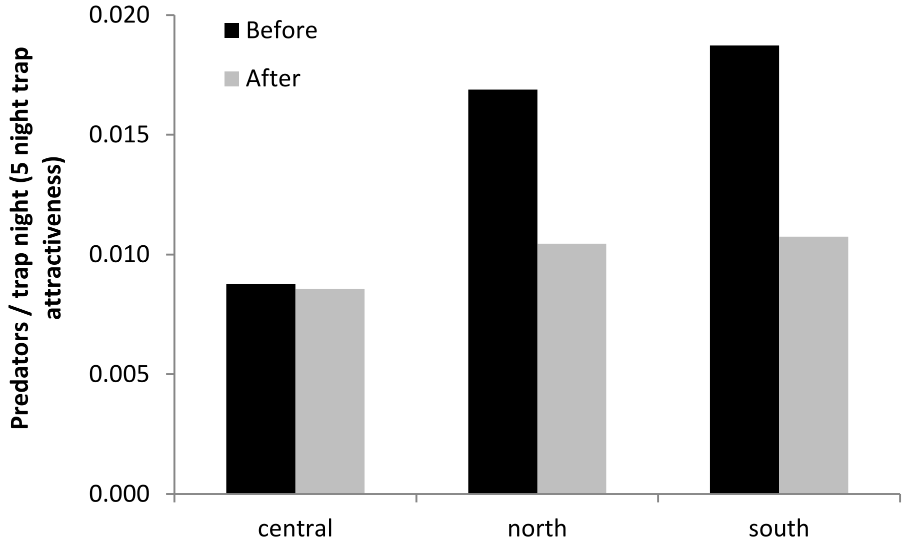


Figure 14 Annual trends in the numbers of predators (all species combined, including rodents) trapped by DOC in BSMI (see Figures 2 and 3 for details on strata). The results show that after trapping began in Poutiri Ao ō Tāne in mid-2011 (see black arrow), the number of predators trapped in BSMI increased substantially from mid-2013 to mid-2016, before dropping again in 2016/17.

A.



B.

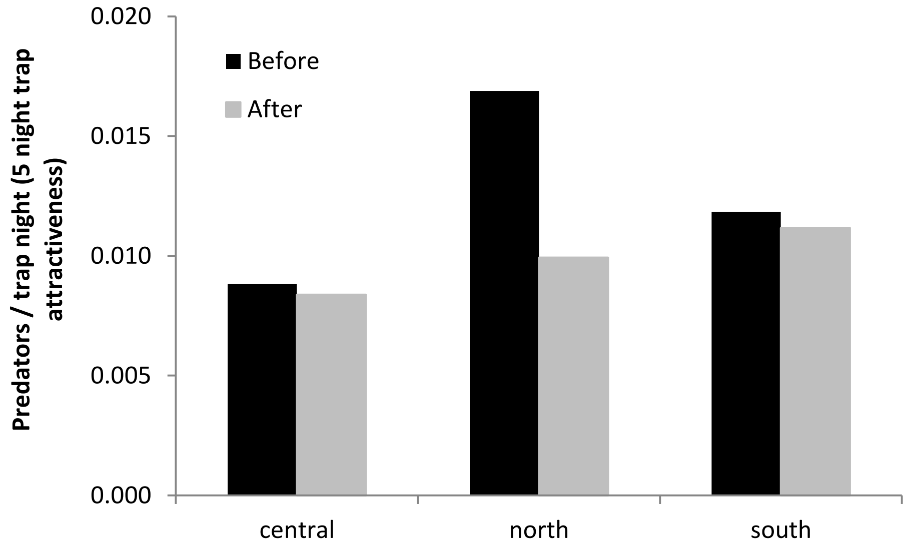


Figure 15 Patterns in the number of predators (all species combined, excluding rodents) trapped by DOC before (black bars) and after (grey bars) mid-2011 in BSMI (see Figures 2 and 3 for details on strata). The patterns derived from using A, information from all 809 DOC traps, and B, only those traps for which before mid-2011 and after mid-2011 data were available (*n* = 586), were in stark contrast to Figure 13A and B, which included rodents. Instead of an increase in the number of predators trapped in BSMI, removing rodents from the analysis resulted in no effect in the centre, a decrease in the northern stratum, and equivocal results in the southern stratum (compare 'south' Figure 15A versus B).

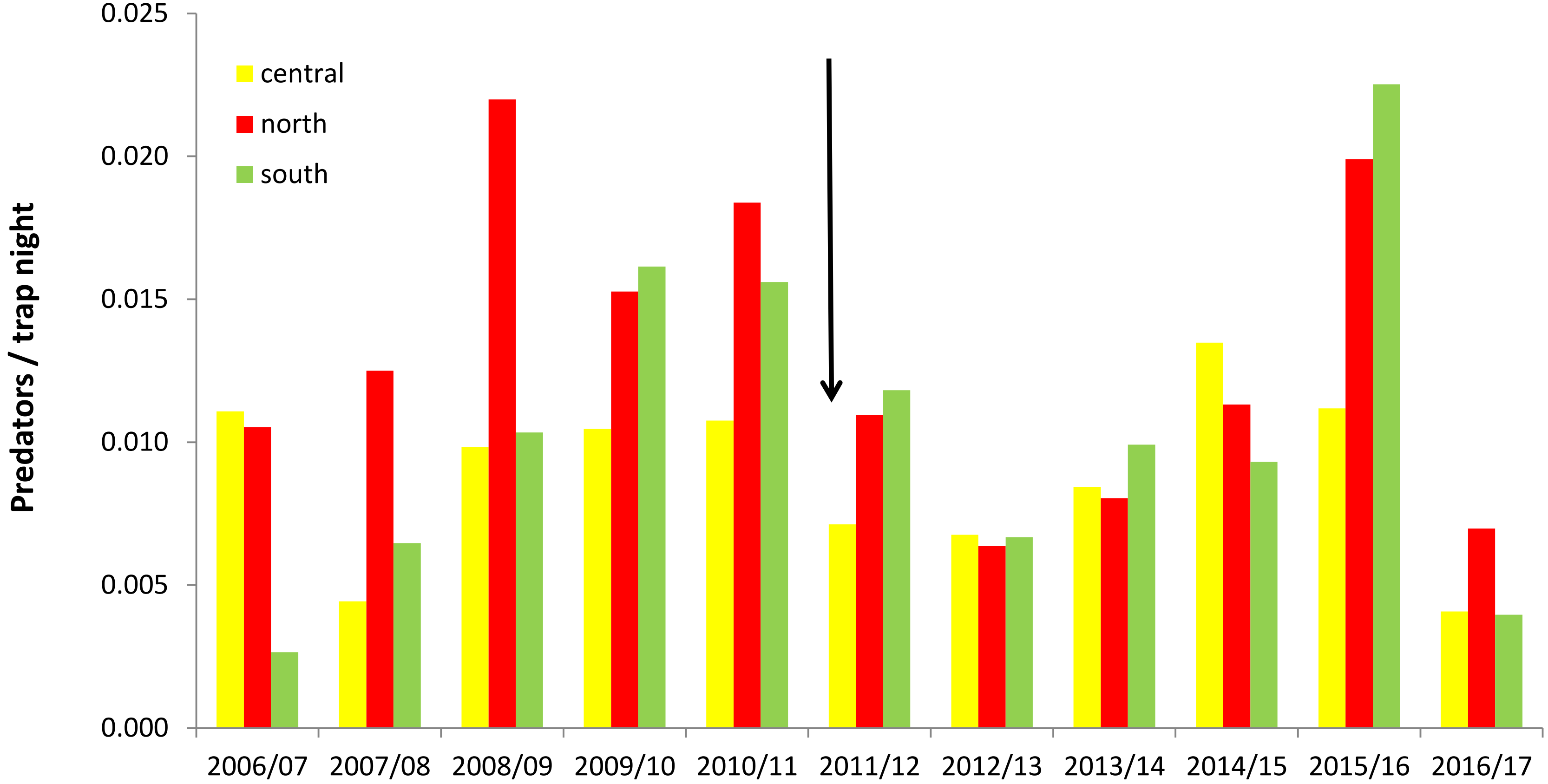


Figure 16 Annual trends in the numbers of predators (all species combined, excluding rodents) trapped by DOC in BSMI (see Figures 2 and 3 for details on strata). In contrast with Figure 14, the results show that after trapping began in Poutiri Ao ō Tāne in mid-2011 (see black arrow) the number of predators trapped in BSMI decreased from mid-2011 to mid-2015, peaking again in 2015/16, before dropping again in 2016/17.

5 Recommended survey design

It was decided (in the contracted milestone for this work) that if the data from BSMI were of insufficient quality to determine if predator trapping at Poutiri Ao ō Tāne is having a measurable effect on predator abundance indices at BSMI, a modelling approach should be taken as an alternative method for answering this question. Specifically, the model would assess the contribution of immigration to predator capture rates in BSMI, and the effects of using different control buffer widths and control intensities in buffers.

Essentially this approach aims to tease out the relative contributions to predator abundance indices in BSMI of immigration versus *in situ* recruitment of predators. If immigration into BSMI from an adjacent 'source' population is significant, the model aimed to determine how large the buffer around BSMI needed to be, and how intensively the buffer needed to be trapped to reduce predators migrating into BSMI to a very low level.

Given the equivocal results from BSMI reported here, the modelling approach would be the logical next step to explore these questions. However, for modelling to be informative, empirical data on dispersal and density are needed for each target species to parameterise the models. For most predators this information is not known, and assuming values for these parameters may lead to spurious results of unknown biological importance. Consequently, rather than using a modelling approach, we present three alternative options as potential next steps.

- **Option 1:** Modelling the responses of predators to management is becoming increasingly important under New Zealand's Predator-Free initiative, as well as numerous similar initiatives. However, models are often parameterised using inadequate or no empirical information (e.g. on mustelids, hedgehogs and rodents). Thus, we recommend using modern technology, such as GPS, to obtain empirical data on dispersal and natural mortality rates. Potential source immigrants may also be identifiable using genetics and long-term anticoagulant markers (e.g. bromadiolone and flocoumafen) fed to possums in baits (Fisher et al. 2014), and this would provide information on the number of immigrants and the proportion they contribute to the number of captures within the 'sink' area. Density could be estimated using presence/absence data (e.g. from camera traps) and analysed using spatially explicit models (e.g. Ramsey et al. 2015). Having this type of empirical information at their disposal, modellers would be able to assess the responses of predators to management with far greater confidence.
- **Option 2:** Because intensive trapping has been carried out both inside and outside BSMI for >5 years, the only option for testing the question 'Does predator control in one area also benefit adjacent areas?' at this site would be to stop trapping in Poutiri Ao ō Tāne. The prediction would be that the capture rate of predators within BSMI (particularly in the south) would increase because of increased immigration. However, because trapping effort (i.e. trap type, trap sites, bait type and number of days traps are set between checks) in BSMI has not been standardised historically, the trapping design in that area needs to be reconfigured, and should then be implemented for 3 years before stopping trapping in Poutiri Ao ō Tāne. After 3 years, trapping in Poutiri

Ao ō Tāne should cease, but continue in BSMI. Critically, trapping effort in BSMI must be constant before and after trapping ceases in Poutiri Ao ō Tāne. A limitation of this option is that BSMI is not entirely surrounded by a control buffer, with unknown consequences for immigration, and the spatial extent of Poutiri Ao ō Tāne is likely to be too small to adequately control the source population of predators potentially affecting BSMI.

- **Option 3:** If trapping cannot be stopped at Poutiri Ao ō Tāne, then a new trial site is required. As for option 2, the trapping effort must be held constant in the sink area and be carried out for at least 3 years before trapping of the source population is started. The BSMI–Poutiri Ao ō Tāne configuration was such that intensive trapping around BSMI only occurred in the southern area. Ideally, a buffer should be sufficiently large to control the source populations (for all predator species), completely encompass the area containing the sink population, and trapping effort should be constant throughout the buffer. This approach will probably result in a control buffer significantly larger, and thus more expensive to maintain, than Poutiri Ao ō Tāne. However, as it becomes increasingly important to understand how predator management interacts between neighbouring lands for large-scale predator control initiatives, logistical, economic and social factors increasingly become constraints that must be dealt with.

6 Conclusions

- The results from the DOC database were equivocal, i.e. it is unclear whether no observed reduction in predators trapped at BSMI was due to there being no actual effect or insufficient/inappropriate data collection.
- Although we predicted that, proportionally, the number of predators trapped after mid-2011 should be lowest in the southern portion of BSMI, immediately adjacent to Poutiri Ao ō Tāne, we found the opposite: the greatest proportional reduction of predators (excluding rodents) tended to be in the northern area of BSMI.
- Annual trends in the number of predators (excluding rodents) trapped after Poutiri Ao ō Tāne (particularly from mid-2014 to mid-2016) may be related to factors such as increases in primary prey, such as rabbits, rats and mice.
- Including rodents in analyses, we found that predator indices have increased in all strata after trapping began at Poutiri Ao ō Tāne. This is possible evidence for a release of rats and mice following the removal of top predators (i.e. a top-down effect). However, given that the number of rodents trapped increased in all strata, despite no evidence that predator indices declined in the centre of BSMI, a more likely explanation is that there may have been an increase in food availability from mid-2013 to mid-2016 (i.e. a bottom-up effect).
- Our results may be sensitive to the low number of predators (excluding rats) trapped annually. However, there were consistent temporal trends across species and species groups (i.e. an initial decrease in animals trapped (mid-2011–mid-2014), followed by an increase (mid-2014–mid-2016), and a decrease most recently), indicating a consistent effect in the data that was not attributable to trapping in Poutiri Ao ō Tāne.

7 Recommendations

- This analysis demonstrates the need to design data collection carefully to answer the question of how predator control in one area also benefits adjacent areas.
- Entering the required data into the trap database from the cat trap diary will enable cat data to be analysed separately. Based on raw data, there were fewer cats trapped at BSMI after Poutiri Ao ō Tāne began. Consequently, it may be worthwhile assessing this relationship after correcting for trapping effort.
- Within BSMI and Poutiri Ao ō Tāne there have been spatial and temporal differences in trap type used, whether they were double or single sets, and bait type used. We did not assess these factors. However, the results from our analysis suggest that including this additional intensive data manipulation exercise is probably not warranted and would be unlikely to change the general conclusions in this report.
- We discuss the pros and cons of alternative survey designs – including modelling and experimental approaches – to answer the question posed in this report
- If a modelling approach is used to assess the responses of predators to management, collecting empirical data on dispersal and density is critical for the parameterisation of models.

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