Short-term impacts of island restoration on seabirds in Gwaii Haanas

# BACI

Task 2e) Test whether restoration resulted in an increase in seabird vocalization metrics, by species (abundance), using BACI design.

##### Experimental Design

This BACI experimental design included multiple control and impact sites, across multiple years before and after impact (i.e. rat eradication). ARU monitoring locations ('sites') were located within island groups ('islands'), which were classified as 'control' or 'impact'. The number of sites within islands ranged from 1 to 8. Two response variables were considered: (1) the proportion of recordings with detection of at least one individual across a common within-season time-period (p(presence)); (2) the proportion of recordings with detection of more than one individual (i.e. overlapping calls) across a common within-season time-period (p(presence > 1). Separate BACI analyses were carried out for each species (Ancient Murrelet, Cassin's Auklet, Fork-Tailed Storm-Petrel), eradication phase (Phase 1, Phase 2) and response (p(presence), p(presence > 1)).

In phase 1, rat eradication occurred by bait station post-breeding season, 2011. There were two impact islands (Arichika and Bischofs) and three control islands (Alder, Hotspring, Ramsay) and in general, 2 years of sampling...

In phase 2, eradication of rats took place post-breeding season, 2013. There were two impact sites (Faraday, Murchison) and 4 control sites (Alder, Hotspring/House, Ramsay) and in general, 3 years of sampling before impact (2011, 2012, 2013) and 2 years of sampling after impact (2014, 2015). In total, there were 53 replciate:year combinations (after filtering out replicates that sampled outside of our time-window; see below). Replicates were located at fixed locataions across years. The sampling design was unbalanced; the number of replicates at each site ranged from 1 to 8, and replicates did not consistently sample in all years (2011-2015).

Variation occurred in sampling duration (i.e. start and end time) of ARUs: across years (e.g. 2011, 2013), within-years (e.g. April 26 - June 06) and within each night (e.g. 12:00am - 3:40am), which made it necessary to constrain our analysis to a common time window, which was justified by observed vocalization probability. We selected the maximum mean vocalization probability within a sliding window of 14 days (within-season) and 1 hour (i.e. 3 recordings; within-night) for each species (Figure ...). Cassin's Auklets had one large peak in vocalization in early April and another (somewhat smaller) in early-mid May; we used a sampling window in early May because many ARUs were not yet operational in early April. We assumed these windows to be representative of the breeding population for that season, i.e. a period of minimal permanent egress/ingress of breeders. Further, since ARUs were often operating in April-June, these windows were generally well represented by monitoring locations in each year.

##### Statistical model

Prior to analysis, each response was logit-transformed (empirical logit transformation) to account for proportions being bounded at 0 and 1. Coefficients, marginal means and BACI contrast and confidence limits were back-transformed after model fitting for presentation in tables. For each species:phase:response combination, we fit a linear mixed-effects model within R, using the lmer() function within the lme4 package. Due to the unbalanced experimental design (e.g. not all monitoring locations consistently monitored in every year), the response was calculated at each monitoring location rather than each island group; this allowed for testing random effects of site, nested within island. For all models, fixed effects included period (Before/After), siteclass (Control/Impact), and period:siteclass interaction; random effects included year, island and site (nested within island).

We used ANOVA (type 3 with Kenward-Roger approximation for degrees of freedom) to determine statistical significance of fixed effects. The interaction term (period:siteclass) is the 'BACI effect' and indicates a difference in before-after response for control and impact groups. For all coefficients, a p-value < 0.05 indicated statistical significance. We also determined the magnitude of the BACI effect (contrast) by calculating the difference of the differences in marginal means (uCA = uCB - uIA + uIB) along with 95% confidence limits; these analyses were done using the lsmeans package. The contrast can be interpreted as percent increase in the response in the impact area relative the the control area; confidence limits not including 0 indicate an effect.

Key assumptions of the model:

* System is in equilibirum before and after impact.
  + This assumption may not be valid as recovery of seabird breeding population may occur over a longer time period than is accounted for in this study.
* Variance is homogeneous, data are normally distributed.
  + We used several diagnostic plots (residuals vs. fitted values, qqplot for normality) to test validity of the statistical model and associated p-values.
* Observations are independent within each site-year combination and across years.
  + Sites were spaced sufficeintly far apart in space to warrant assumption of independence.

## Ancient Murrelet

Figure 1: Phase 1 temporal coverage by site. Colour indicates site class ('Control', 'Impact'). Vertical black lines indicate 2-week sampling window used for Ancient Murrelet analysis (May 11 - May 24)

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Figure 2: Phase 2 temporal coverage by site. Colour indicates site class ('Control', 'Impact'). Vertical black lines indicate 2-week sampling window used for Ancient Murrelet analysis (May 11 - May 24).

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### Mean proportions by island

Figure 3: Phase 1, Ancient Murrelet; Mean proportion of recordings with detected presence (left panel) and more than one individual detected. Color indicates whether island was control or impact; shape indicates island group

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Figure 4: Phase 2, Ancient Murrelet; Mean proportion of recordings with detected presence (left panel) and more than one individual detected. Color indicates whether island was control or impact; shape indicates island group

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### Statistical model results

#### Phase 1, p(presence)

Table 1: Summary model coefficients; Ancient Murrelet, Phase 1, proportion of recordings with detected presence.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Term | Estimate | SE | df | p-value |
| Intercept | 0.327 | 1.389 | 2.1 | 0.835 |
| Period | 0.246 | 0.369 | 18.6 | 0.513 |
| Site Class | -6.166 | 1.964 | 2.1 | 0.083 |
| Period:SiteClass | 0.362 | 0.522 | 18.6 | 0.496 |

Table 2: BACI marginal means; Ancient Murrelet, Phase 1, proportion of recordings with detected presence.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Site Class | Period | Marginal Mean | SE | df | Lower CL | Upper CL |
| Control | Before | 4.694 | 2.080 | 2.6 | -2.484 | 11.871 |
| Impact | Before | -4.389 | 1.950 | 2.0 | -12.637 | 3.860 |
| Control | After | 4.680 | 2.014 | 2.3 | -2.945 | 12.304 |
| Impact | After | -3.678 | 1.947 | 2.0 | -11.958 | 4.602 |

Table 3: BACI effect and 95% confidence intervals; Ancient Murrelet, Phase 1, proportion of recordings with detected presence.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Estimate | SE | df | Lower CL | Upper CL | p-value |
| -0.724 | 1.044 | 18.6 | -2.912 | 1.464 | 0.496 |

#### Phase 1, p(presence>1)

Table 4: Summary model coefficients; Ancient Murrelet, Phase 1, proportion of recordings with more than one individual detected.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Term | Estimate | SE | df | p-value |
| Intercept | -1.873 | 0.760 | 3.5 | 0.079 |
| Period | 0.711 | 0.786 | 2.7 | 0.439 |
| Site Class | -6.171 | 0.856 | 2.1 | 0.017 |
| Period:SiteClass | -0.639 | 0.611 | 19.0 | 0.309 |

Table 5: BACI marginal means; Ancient Murrelet, Phase 1, proportion of recordings with more than one individual detected.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Site Class | Period | Marginal Mean | SE | df | Lower CL | Upper CL |
| Control | Before | 1.668 | 1.362 | 8.3 | -1.455 | 4.792 |
| Impact | Before | -6.420 | 1.033 | 2.9 | -9.761 | -3.079 |
| Control | After | 3.313 | 1.188 | 5.1 | 0.274 | 6.353 |
| Impact | After | -6.053 | 1.026 | 2.9 | -9.400 | -2.706 |

Table 6: BACI effect and 95% confidence intervals; Ancient Murrelet, Phase 1, proportion of recordings with more than one individual detected.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Estimate | SE | df | Lower CL | Upper CL | p-value |
| 1.278 | 1.222 | 19 | -1.28 | 3.836 | 0.309 |

#### Phase 2, p(presence)

Table 7: Summary model coefficients; Ancient Murrelet, Phase 2, proportion of recordings with detected presence.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Term | Estimate | SE | df | p-value |
| Intercept | -0.190 | 0.691 | 5.9 | 0.792 |
| Period | 0.304 | 0.755 | 3.1 | 0.713 |
| Site Class | -7.077 | 0.730 | 5.7 | 0.000 |
| Period:SiteClass | 0.994 | 0.488 | 28.2 | 0.051 |

Table 8: BACI marginal means; Ancient Murrelet, Phase 2, proportion of recordings with detected presence.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Site Class | Period | Marginal Mean | SE | df | Lower CL | Upper CL |
| Control | Before | 5.095 | 1.070 | 11.5 | 2.752 | 7.439 |
| Impact | Before | -5.906 | 0.960 | 5.6 | -8.300 | -3.512 |
| Control | After | 4.532 | 1.152 | 9.1 | 1.929 | 7.136 |
| Impact | After | -4.483 | 0.981 | 4.4 | -7.102 | -1.863 |

Table 9: BACI effect and 95% confidence intervals; Ancient Murrelet, Phase 2, proportion of recordings with detected presence.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Estimate | SE | df | Lower CL | Upper CL | p-value |
| -1.987 | 0.975 | 28.2 | -3.984 | 0.01 | 0.051 |

#### Phase 2, p(presence>1)

Table 10: Summary model coefficients; Ancient Murrelet, Phase 2, proportion of recordings with more than one individual detected.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Term | Estimate | SE | df | p-value |
| Intercept | -1.827 | 0.773 | 3.5 | 0.087 |
| Period | 0.716 | 1.045 | 2.9 | 0.544 |
| Site Class | -6.729 | 0.502 | 20.7 | 0.000 |
| Period:SiteClass | 0.653 | 0.506 | 31.6 | 0.206 |

Table 11: BACI marginal means; Ancient Murrelet, Phase 2, proportion of recordings with more than one individual detected.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Site Class | Period | Marginal Mean | SE | df | Lower CL | Upper CL |
| Control | Before | 2.752 | 1.110 | 5.6 | -0.005 | 5.509 |
| Impact | Before | -7.418 | 1.073 | 4.5 | -10.271 | -4.565 |
| Control | After | 3.112 | 1.266 | 4.3 | -0.296 | 6.519 |
| Impact | After | -5.752 | 1.160 | 3.1 | -9.375 | -2.129 |

Table 12: BACI effect and 95% confidence intervals; Ancient Murrelet, Phase 2, proportion of recordings with more than one individual detected.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Estimate | SE | df | Lower CL | Upper CL | p-value |
| -1.306 | 1.011 | 31.6 | -3.367 | 0.755 | 0.206 |

## Cassin's Auklet

Figure 5: Phase 1 temporal coverage by site. Colour indicates site class ('Control', 'Impact'). Vertical black lines indicate 2-week sampling window used for Cassin's Auklet analysis (May 01 - May 14).

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Figure 6: Phase 2 temporal coverage by site. Colour indicates site class ('Control', 'Impact'). Vertical black lines indicate 2-week sampling window used for Cassin's Auklet analysis (May 01 - May 14).

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### Mean proportions by island

Figure 7: Phase 1, Cassin's Auklet; Mean proportion of recordings with detected presence (left panel) and more than one individual detected. Color indicates whether island was control or impact; shape indicates island group

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Figure 8: Phase 2, Cassin's Auklet; Mean proportion of recordings with detected presence (left panel) and more than one individual detected. Color indicates whether island was control or impact; shape indicates island group

-1.png)

### Statistical model results

#### Phase 1, p(presence)

Table 13: Summary model coefficients; Cassin's Auklet, Phase 1, proportion of recordings with detected presence.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Term | Estimate | SE | df | p-value |
| Intercept | -1.794 | 0.915 | 4.7 | 0.110 |
| Period | 0.681 | 0.740 | 2.4 | 0.441 |
| Site Class | -2.509 | 1.135 | 3.5 | 0.101 |
| Period:SiteClass | -0.016 | 0.569 | 28.6 | 0.978 |

Table 14: BACI marginal means; Cassin's Auklet, Phase 1, proportion of recordings with detected presence.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Site Class | Period | Marginal Mean | SE | df | Lower CL | Upper CL |
| Control | Before | -0.509 | 1.485 | 10.1 | -3.812 | 2.794 |
| Impact | Before | -4.042 | 1.347 | 4.2 | -7.706 | -0.377 |
| Control | After | 0.470 | 1.239 | 5.6 | -2.620 | 3.560 |
| Impact | After | -3.094 | 1.338 | 4.1 | -6.769 | 0.581 |

Table 15: BACI effect and 95% confidence intervals; Cassin's Auklet, Phase 1, proportion of recordings with detected presence.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Estimate | SE | df | Lower CL | Upper CL | p-value |
| 0.031 | 1.137 | 28.6 | -2.296 | 2.358 | 0.978 |

#### Phase 1, p(presence>1)

Table 16: Summary model coefficients; Cassin's Auklet, Phase 1, proportion of recordings with more than one individual detected.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Term | Estimate | SE | df | p-value |
| Intercept | -3.772 | 0.763 | 4.0 | 0.008 |
| Period | 0.420 | 0.573 | 2.3 | 0.531 |
| Site Class | -2.634 | 0.961 | 3.0 | 0.072 |
| Period:SiteClass | 0.112 | 0.414 | 23.2 | 0.789 |

Table 17: BACI marginal means; Cassin's Auklet, Phase 1, proportion of recordings with more than one individual detected.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Site Class | Period | Marginal Mean | SE | df | Lower CL | Upper CL |
| Control | Before | -2.150 | 1.195 | 8.2 | -4.896 | 0.595 |
| Impact | Before | -5.987 | 1.122 | 3.5 | -9.302 | -2.672 |
| Control | After | -1.668 | 1.033 | 4.8 | -4.349 | 1.013 |
| Impact | After | -5.281 | 1.118 | 3.4 | -8.607 | -1.955 |

Table 18: BACI effect and 95% confidence intervals; Cassin's Auklet, Phase 1, proportion of recordings with more than one individual detected.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Estimate | SE | df | Lower CL | Upper CL | p-value |
| -0.224 | 0.827 | 23.2 | -1.934 | 1.487 | 0.789 |

#### Phase 2, p(presence)

Table 19: Summary model coefficients; Cassin's Auklet, Phase 2, proportion of recordings with detected presence.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Term | Estimate | SE | df | p-value |
| Intercept | -2.432 | 0.777 | 6.0 | 0.020 |
| Period | -0.133 | 0.659 | 2.6 | 0.855 |
| Site Class | -3.219 | 0.935 | 4.3 | 0.023 |
| Period:SiteClass | -0.152 | 0.398 | 31.9 | 0.706 |

Table 20: BACI marginal means; Cassin's Auklet, Phase 2, proportion of recordings with detected presence.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Site Class | Period | Marginal Mean | SE | df | Lower CL | Upper CL |
| Control | Before | -0.138 | 1.090 | 10.6 | -2.548 | 2.271 |
| Impact | Before | -4.539 | 1.149 | 4.8 | -7.530 | -1.548 |
| Control | After | -0.175 | 1.146 | 9.6 | -2.743 | 2.394 |
| Impact | After | -4.878 | 1.168 | 4.7 | -7.947 | -1.809 |

Table 21: BACI effect and 95% confidence intervals; Cassin's Auklet, Phase 2, proportion of recordings with detected presence.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Estimate | SE | df | Lower CL | Upper CL | p-value |
| 0.303 | 0.796 | 31.9 | -1.318 | 1.925 | 0.706 |

#### Phase 2, p(presence>1)

Table 22: Summary model coefficients; Cassin's Auklet, Phase 2, proportion of recordings with more than one individual detected.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Term | Estimate | SE | df | p-value |
| Intercept | -4.070 | 0.747 | 3.3 | 0.009 |
| Period | 0.093 | 0.476 | 3.0 | 0.858 |
| Site Class | -2.627 | 0.988 | 2.7 | 0.087 |
| Period:SiteClass | -0.256 | 0.381 | 32.2 | 0.507 |

Table 23: BACI marginal means; Cassin's Auklet, Phase 2, proportion of recordings with more than one individual detected.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Site Class | Period | Marginal Mean | SE | df | Lower CL | Upper CL |
| Control | Before | -2.406 | 1.037 | 6.6 | -4.891 | 0.078 |
| Impact | Before | -5.865 | 1.135 | 2.5 | -9.908 | -1.823 |
| Control | After | -2.019 | 1.060 | 7.0 | -4.526 | 0.487 |
| Impact | After | -5.990 | 1.138 | 2.5 | -10.032 | -1.948 |

Table 24: BACI effect and 95% confidence intervals; Cassin's Auklet, Phase 2, proportion of recordings with more than one individual detected.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Estimate | SE | df | Lower CL | Upper CL | p-value |
| 0.511 | 0.761 | 32.2 | -1.039 | 2.062 | 0.507 |

## Fork-Tailed Storm Petrel

Figure 9: Phase 1 temporal coverage by site. Colour indicates site class ('Control', 'Impact'). Vertical black lines indicate 2-week sampling window used for Fork-Tailed Storm-Petrel analysis (May 01 - May 14).

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Figure 10: Phase 2 temporal coverage by site. Colour indicates site class ('Control', 'Impact'). Vertical black lines indicate 2-week sampling window used for Fork-Tailed Storm-Petrel analysis (May 01 - May 14).

-1.png)

### Mean proportions by island

Figure 11: Phase 1, Fork-Tailed Storm-Petrel; Mean proportion of recordings with detected presence (left panel) and more than one individual detected. Color indicates whether island was control or impact; shape indicates island group

-1.png)

Figure 12: Phase 2, Fork-Tailed Storm-Petrel; Mean proportion of recordings with detected presence (left panel) and more than one individual detected. Color indicates whether island was control or impact; shape indicates island group

-1.png)

### Statistical model results

#### Phase 1, p(presence)

Table 25: Summary model coefficients; Fork-Tailed Storm-Petrel, Phase 1, proportion of recordings with detected presence.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Term | Estimate | SE | df | p-value |
| Intercept | -2.301 | 1.998 | 2.5 | 0.349 |
| Period | 0.955 | 0.718 | 3.2 | 0.270 |
| Site Class | -3.545 | 2.810 | 2.4 | 0.316 |
| Period:SiteClass | 0.468 | 0.918 | 25.3 | 0.615 |

Table 26: BACI marginal means; Fork-Tailed Storm-Petrel, Phase 1, proportion of recordings with detected presence.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Site Class | Period | Marginal Mean | SE | df | Lower CL | Upper CL |
| Control | Before | -0.236 | 2.928 | 4.4 | -8.113 | 7.640 |
| Impact | Before | -5.718 | 3.017 | 2.2 | -17.488 | 6.052 |
| Control | After | 0.647 | 2.626 | 2.9 | -7.901 | 9.194 |
| Impact | After | -3.899 | 3.010 | 2.2 | -15.726 | 7.929 |

Table 27: BACI effect and 95% confidence intervals; Fork-Tailed Storm-Petrel, Phase 1, proportion of recordings with detected presence.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Estimate | SE | df | Lower CL | Upper CL | p-value |
| -0.936 | 1.836 | 25.3 | -4.716 | 2.844 | 0.615 |

#### Phase 1, p(presence>1)

Table 28: Summary model coefficients; Fork-Tailed Storm-Petrel, Phase 1, proportion of recordings with more than one individual detected.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Term | Estimate | SE | df | p-value |
| Intercept | -3.978 | 1.503 | 2.5 | 0.092 |
| Period | 1.074 | 0.485 | 4.2 | 0.087 |
| Site Class | -2.144 | 2.108 | 2.4 | 0.399 |
| Period:SiteClass | -0.342 | 0.548 | 19.8 | 0.540 |

Table 29: BACI marginal means; Fork-Tailed Storm-Petrel, Phase 1, proportion of recordings with more than one individual detected.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Site Class | Period | Marginal Mean | SE | df | Lower CL | Upper CL |
| Control | Before | -3.392 | 2.142 | 4.0 | -9.328 | 2.544 |
| Impact | Before | -6.082 | 2.251 | 2.2 | -14.940 | 2.776 |
| Control | After | -1.532 | 1.995 | 3.1 | -7.782 | 4.718 |
| Impact | After | -4.905 | 2.249 | 2.2 | -13.783 | 3.972 |

Table 30: BACI effect and 95% confidence intervals; Fork-Tailed Storm-Petrel, Phase 1, proportion of recordings with more than one individual detected.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Estimate | SE | df | Lower CL | Upper CL | p-value |
| 0.683 | 1.096 | 19.8 | -1.604 | 2.97 | 0.54 |

#### Phase 2, p(presence)

Table 31: Summary model coefficients; Fork-Tailed Storm-Petrel, Phase 2, proportion of recordings with detected presence.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Term | Estimate | SE | df | p-value |
| Intercept | -2.427 | 1.688 | 3.5 | 0.234 |
| Period | -0.079 | 0.252 | 32.2 | 0.755 |
| Site Class | -4.137 | 2.387 | 3.5 | 0.169 |
| Period:SiteClass | 0.170 | 0.357 | 32.2 | 0.637 |

Table 32: BACI marginal means; Fork-Tailed Storm-Petrel, Phase 2, proportion of recordings with detected presence.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Site Class | Period | Marginal Mean | SE | df | Lower CL | Upper CL |
| Control | Before | 0.639 | 2.039 | 4.2 | -4.932 | 6.210 |
| Impact | Before | -5.381 | 2.714 | 3.3 | -13.627 | 2.865 |
| Control | After | 0.357 | 2.037 | 4.2 | -5.212 | 5.926 |
| Impact | After | -5.323 | 2.717 | 3.3 | -13.557 | 2.911 |

Table 33: BACI effect and 95% confidence intervals; Fork-Tailed Storm-Petrel, Phase 2, proportion of recordings with detected presence.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Estimate | SE | df | Lower CL | Upper CL | p-value |
| -0.34 | 0.713 | 32.2 | -1.793 | 1.113 | 0.637 |

#### Phase 2, p(presence>1)

Table 34: Summary model coefficients; Fork-Tailed Storm-Petrel, Phase 2, proportion of recordings with more than one individual detected.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Term | Estimate | SE | df | p-value |
| Intercept | -3.810 | 1.386 | 3.9 | 0.052 |
| Period | 0.483 | 0.394 | 1.7 | 0.365 |
| Site Class | -3.602 | 1.937 | 3.7 | 0.142 |
| Period:SiteClass | -0.139 | 0.339 | 32.9 | 0.684 |

Table 35: BACI marginal means; Fork-Tailed Storm-Petrel, Phase 2, proportion of recordings with more than one individual detected.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Site Class | Period | Marginal Mean | SE | df | Lower CL | Upper CL |
| Control | Before | -1.673 | 1.658 | 4.5 | -6.076 | 2.729 |
| Impact | Before | -6.628 | 2.249 | 3.8 | -12.987 | -0.270 |
| Control | After | -0.852 | 1.662 | 4.6 | -5.249 | 3.546 |
| Impact | After | -6.085 | 2.248 | 3.8 | -12.444 | 0.274 |

Table 36: BACI effect and 95% confidence intervals; Fork-Tailed Storm-Petrel, Phase 2, proportion of recordings with more than one individual detected.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Estimate | SE | df | Lower CL | Upper CL | p-value |
| 0.279 | 0.678 | 32.9 | -1.102 | 1.659 | 0.684 |