Point Blue Report

Effects of re-forestation treatments on birds in the Moonlight Fire

2019 Report to Plumas National Forest

April 20, 2020

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Conservation science for a healthy planet

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SUMMARY

As of 2019 it has been 12 years since the Moonlight Fire burned. Point Blue has monitored birds and vegetation in this fire since 2009. Our plans to monitor the effects of implementation of forest restoration treatments on birds included additional monitoring at new treatment and control locations. Treatments started in 2018, and include removal of shrubs and snags followed by planting conifers. Establishing the initial treatment and control monitoring sites did not result in particularly well matched samples, so we filtered the field locations based on vegetation and landscape conditions to better match the sub-samples to each other. In this report we describe initial indications of the impacts of treatments on birds and vegetation, and describe ways to optimize future monitoring to maximize our ability to recognize the effects of restoration treatments on birds in order to inform forest managers in developing post-fire reforestation strategies.

Results of this initial analysis indicate that the restoration treatments did result in strong changes in vegetation (measured through satellite imagery), as well as decreases in birds associated with shrubs and snags. Open forest birds were minimally affected. Only one bird species increased in abundance following the treatments (American Robin) while 21 species were minimally affected, and 16 species declined following treatments including several species that were no longer detected at any treated locations. The vegetation and landscape conditions within the sub-samples are well matched overall, with the range of most major vegetation metrics largely overlapping between the impact and control samples. However, the control sub-sample that was added new in 2019 has lower herbaceous vegetation cover and lower snag basal area, and is located at lower elevations overall than the other sub-samples, while the impact sub-sample that was treated in 2018 had higher snag basal area than other sub-samples.

INTRODUCTION

The debate that surrounds management of post-fire habitat in the Sierra Nevada weighs several potentially contradictory objectives such as wildlife habitat, fuel management and fire risk, timber resource production, and establishment of desired future forest conditions. We promote the idea that ecological monitoring is necessary to assess the costs and benefits among these objectives and to maximize the benefits that restoration or other management decisions can provide. Because the choice of whether to implement management activities in post-fire habitat can alter the resulting forest composition for decades, it is important to monitor post-fire habitat and the species that occupy those habitats under different management prescriptions. Doing so can help managers understand whether important habitats are being maintained. In this report we describe our sampling strategy and initial findings of monitoring birds within restoration treatments and control locations in the Moonlight Fire area with specific implications and guidance for these treatments and future restoration projects in other post-fire areas.

METHODS

Sampling design and modifications

The Moonlight Fire burned 64,997 acres (26,303 ha) in Lassen and Plumas Counties during the summer of 2007. In 2015 we selected 132 sampling locations in the Moonlight fire area to inventory birds and help guide the proposed reforestation treatments (Campos and Burnett 2016). Site selection of these sampling locations occurred in a GIS framework, using the reforestation polygon layer provided by the Plumas National Forest overlaid on polygons delineating completed salvage units. We selected an impact sample from within proposed reforestation treatment units that had not received any prior post-fire salvage or reforestation treatments. Within these proposed reforestation units, we manually distributed points ≥250 m apart and >125 m from treatment unit boundaries and >125 m away from any salvaged area (roadside or otherwise), in a way that maximized sampling density. A few reforestation units were not sampled because they were either too narrow to meet the above rule or, in one case, a single polygon that could only fit 3 points was isolated from any other units. This resulted in 73 sampling locations in reforestation units among 9 transects with 5–10 points per transect. We then selected a control sample from locations that will not be treated. We anchored these around six of our pre-existing Moonlight Fire transects that were predominately in high severity by adding up to 7 additional points to those transects. We dropped any existing points on these transects that were <125 m from a salvage unit boundary. All control locations were >125 m outside of any post-fire treatment, past or proposed. This resulted in 59 sampling locations across six transects.

Following the 2015 field season we altered the control and impact samples to account for changes in treatment scheduling and to balance the range of vegetation types, fire severity, elevation, and other physiographic aspects of the control and treatment samples that may influence bird response. Of the 59 original control locations we kept 44 and call these points the “Control1” sub-sample. These points were surveyed for birds in both 2015 and 2019 except for 7 points that were missed due to logistical or other constraints; 2 were not surveyed in 2015, and 5 were not surveyed in 2019. We also added 26 points to bolster the control sample prior to the 2019 field season and call these the “Control2” sub-sample. All of the points in Control2 are scheduled for treatment in the fall of 2021, after the completion of our bird and vegetation data collection for this study. Of the original 73 impact sample points, 42 points are scheduled for treatment between 2019 and 2020, and these points we call the “Impact1” sub-sample (2 points were surveyed in 2015 but not in

2019), while 21 points were treated in 2018 and we call this the "Impact2" sub-sample (all of these points were surveyed both 2015 and 2019). Ten of the original 73 impact points were dropped due to logistical constraints (e.g. steep terrain). The final samples consist of 133 points, 70 in the control sample and 63 in the impact sample. At the time of this report we had pre- and post-treatment bird survey data for 21 of the 63 impact points.

Summary of sub-samples

- Control1: 44 locations selected in 2015; surveyed for birds in 2015 and 2019.
- Control2: 26 points selected in 2019; surveyed for birds in 2019 only.
- Impact1: 42 points selected in 2015; surveyed for birds in 2015 and 2019; not yet treated, no post-treatment data.
- Impact2: 21 points selected in 2015; surveyed for birds in 2015 and 2019; treated in 2018, post-treatment data collected in 2019.

We understand the treatment schedule is somewhat fluid, and not all impact points in our Impact 1 sample may be treated by 2020. For example, not all of the units scheduled for treatment in 2019 were treated. Any Impact points untreated by 2020 will be retained in the control sample.

The samples received an uneven number of vegetation surveys from 2015–2019. Of the 44 Control1 points, 42 received vegetation surveys in 2016, and 15 in 2019. All Control2 points were surveyed in 2019, and all Impact1 points were surveyed in both 2016 and 2019, but Impact2 points were only surveyed in 2016, with no post-treatment vegetation data collected in 2019 due to herbicide treatments in these units ongoing during our vegetation survey window. Though we do not have field survey data, the post-treatment vegetation conditions would largely reflect a drastic reduction in shrubs and snags to meet the specifications of 20% shrub cover and 4-6 snag per acre retention in the site preparation contracts in 2018 and 2019

(Appendix B). All points that were scheduled for treatment in 2019 or 2020 have been surveyed for birds. We do not plan to survey these field sites in 2020, but the final bird survey sampling will be in 2021, at which time we will also complete post-treatment vegetation surveys.

Field surveys

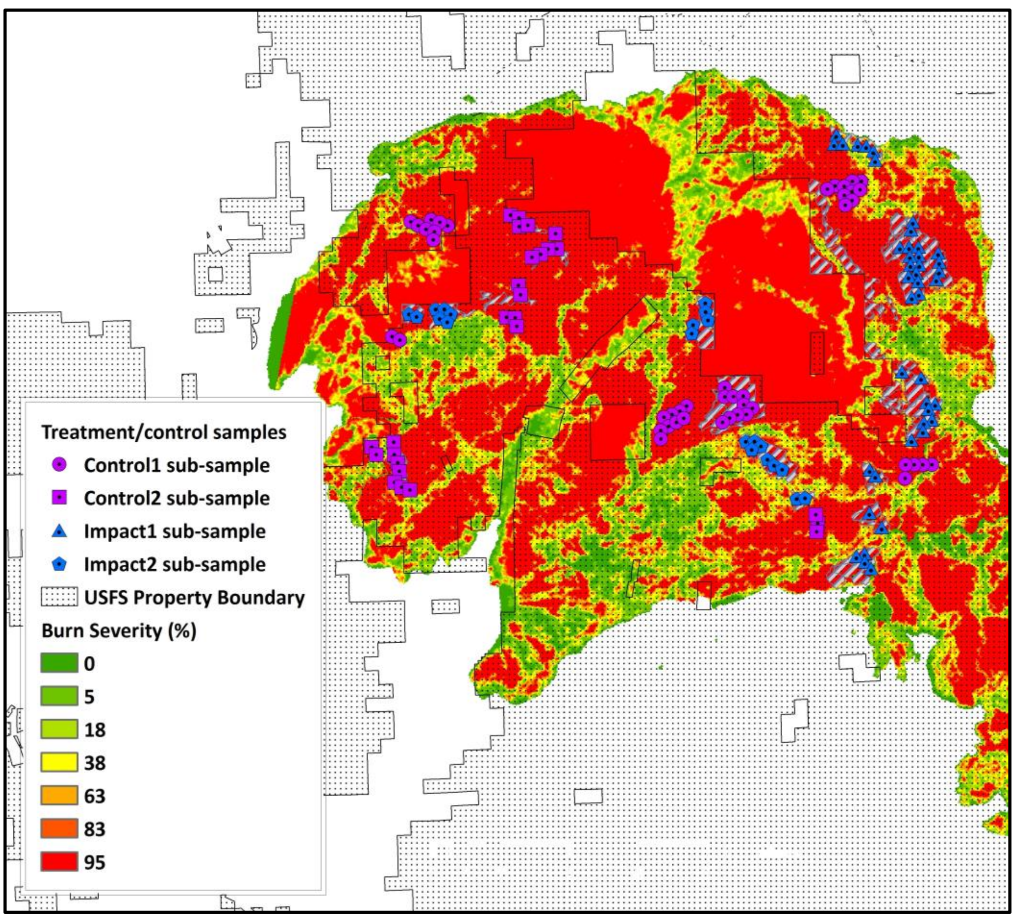
Surveyors conducted standardized five-minute exact-distance bird point counts at each point count station. With the aid of rangefinders, surveyors estimated the exact distance to each individual bird. The initial detection cue (song, visual, or call) for each individual was also recorded. Counts began around local sunrise, were completed within four hours, and did not occur in inclement weather. Surveyors received three weeks of training to identify birds and estimate distances and passed a double-observer field test. All transects were visited up to twice during the peak of the breeding season from mid-May to late-June.

Vegetation data was collected within a 50-m radius plot centered at each point count station following a modified relevé protocol (Campos and Burnett 2016). On these plots we visually estimated shrub cover, live tree cover, herbaceous cover, as well as the relative cover of each species in the shrub and tree layers. We also measured the basal area of live trees and snags using a 10-factor basal area key at five fixed locations in each plot.

Analyses: Bird abundance in Moonlight Fire restoration areas

We used passive point count data collected at impact and control locations to evaluate the abundance of 3 guilds and 37 bird species in the project areas. To evaluate each guild or species abundance at our point count locations, we built generalized linear mixed models with Poisson error and logarithmic link function using the function "lmer" in package lme4 version 1.1-17, in program R x64 version 3.3.1. Our sample units were the individual point count locations for each year (i.e. a point surveyed in 2015 is considered an independent sampling unit from that same point surveyed in 2019), and the dependent variable was the count of all individuals detected within 100 m of observers, summed across visits. We included both current vegetation measurements and pre-fire vegetation structure in the abundance models, though we could not use our field vegetation survey measurements because no post-treatment vegetation surveys have been completed yet.

Figure 1. Survey locations in the Moonlight fire area are shown on top of USFS ownership and burn severity (measured as % canopy cover change). Treatment units are shown under sampling locations as striped polygons.



The name of each transect was used as a random intercept to account for repeated measures across years and spatial correlations. We included 8 fixed effects in the models: year; a binary variable indicating whether each point was treated or not (only the Impact2 sample = 1); a Normalized Difference Wetness Index (NDWI) vegetation index score; the interaction between treatment and NDWI to account for lower NDWI scores that result from vegetation removal rather than natural succession or other disturbances; elevation; pre-fire canopy cover ("WHRDENSITY" from the U.S. Forest Service Existing Vegetation layer derived from 2005 LANDSAT satellite imagery, Mayer and Laudenslayer 1988, USDA Forest Service 2009); burn severity as measured by the relative differenced normalized burn ratio (RdNBR); the distance from each point to the nearest patch of low severity or unburned forest (calculated using ArcGIS); and an offset value equal to the number of visits to account for variable effort due to different numbers of point count visits within each year at each location.

We then used the fitted models to estimate abundance for each species at each point and show these results by plotting point abundance with box plots organized by sample (Control1, Control2, Impact1, Impact2) and year (2015, 2019). We visually interpret box plots to assess whether the sub-samples are similar, whether there is a strong yearly change across all sub-samples, and whether the treatments had a strong effect in the Impact2 sub-sample by comparing the difference in medians and upper/lower quartiles between 2015 and 2019 relative to the other sub-samples. In the same way we also show vegetation survey results (shrub cover, high shrub height, herbaceous vegetation cover, snag basal area, average snag diameter, live basal area) as well as remotely sensed spatial data (elevation, slope, NDWI, 2015 Lidar understory cover measurements, pre-fire CWHR Density from Eveg, pre-fire

CWHR Size from Eveg, RdNBR, and distance to low severity or unburned forest patch).

Based on our local knowledge and published information about the habitat associations of these species in the Sierra Nevada, we grouped species into three broad forest condition guilds: post-fire snags, early seral understory, and mid- to late-seral open canopy forest. These guilds represent structural forest conditions that are created by fire: (1) snags created by fire, (2) early successional understory vegetation established following stand-replacing or frequent fire, and (3) open and mature conditions created by mixed-severity fire. There are 7 species in the post-fire snags guild, 9 species in the early seral understory guild, and 9 species in the open forest guild, each of which include year-round residents, short-distance migrants, and Neotropical migrants. The open mature forest (OMF) species are those that occur along forest edges and openings and/or utilize shade intolerant resources from the sub-canopy to the forest floor and included: Western Wood-Pewee (*Contopus occidentalis*), Olive-sided Flycatcher (*Contopus cooperi*), Warbling Vireo (*Vireo gilvus*), American Robin (*Turdus migratorius*), Nashville Warbler (*Oreothlypis ruficapilla*), Yellow-rumped Warbler (*Setophaga coronata*), Chipping Sparrow (*Spizella passerina*), Black-headed Grosbeak (*Pheucticus melanocephalus*), and Western Tanager (*Piranga ludoviciana*). The early seral forest (ESF) guild is comprised of species that use herbaceous and shrub habitats and included: Mountain Quail (*Oreortyx pictus*), Dusky Flycatcher (*Empidonax oberholseri*), Spotted Towhee (*Pipilo maculatus*), Green-tailed Towhee (*Pipilo chlorurus*), Fox Sparrow (*Passerella iliaca*), Chipping Sparrow (*Spizella passerina*),Yellow Warbler (*Setophaga petechia*), MacGillivray's Warbler (*Geothlypis tolmiei*), and Lazuli Bunting (*Passerina amoena*). Finally, the post-fire snag (PFS) guild is comprised of species that use fire-killed trees: Lewis' Woodpecker, Hairy Woodpecker (*Picoides villosus*), Black-backed

Woodpecker (*Picoides arcticus*), White-headed Woodpecker (*Picoides albolarvatus*), Northern Flicker (*Colaptes auratus*), House Wren (*Troglodytes aedon*), and Mountain Bluebird (*Sialia currucoides*). We include boxplot figures for abundance of each guild, as well as (in the Appendix) each individual species, and highlight ecologically informative patterns from both guilds and individual species.

RESULTS

The control and impact sub-samples have comparable vegetation structure as indicated by field measurements of shrub cover (Figure 2a), shrub height (Figure 2b), herbaceous vegetation cover (Figure 2g), and snag diameter (Figure 2h). The control and impact sub-samples also appear to be similarly matched in dominant shrub species cover composition, except for the Control1 sub-sample, which is more dominated by tobacco brush (*Ceanothus velutinus*); this pattern is only evident in 2015 because locations dominated by tobacco brush in the Control1 sample did not receive vegetation surveys in 2019 (Figures 2c-f). There does appear to be a difference in snag basal area within the control and impact samples, where the Control1 and Impact2 sub-samples appear to have higher snag basal area on average (Figure 2i). Though it is difficult to determine with any confidence because of the differences in vegetation sampling between years, the decline in snag basal area as evidenced in the Control1 sub-sample may indicate that standing snag resources have decayed significantly between 2015 (8 years post-fire) and 2019 (12 years post-fire).

The distribution of survey locations shows that while the Control2 sub-sample locations tend to be at lower elevations, when Control1 and Control2 sub-samples are combined and Impact1 and Impact2 sub-samples are combined the distributions of elevations are comparable (Figure 3a). The Impact2 sub-sample also has very few high slope (>20 degrees) locations that are present in the other sub-samples (Figure 3b). NDWI is consistent between 2015 and 2019 in the control sub-samples, but there is an apparent decrease in NDWI within the impact sub-samples (Figure 3c-d). In the Impact2 sub-sample we can attribute this decline to the treatments. The small decline at Impact1 locations may be attributable to NDWI imagery taken after some treatments were implemented in 2019. LIDAR measurements indicate that the Control1 sub-sample had a larger number of high understory cover (>50%) locations than the other sub-samples in 2013 (Figure 3e).

Pre-fire vegetation estimates show that forest densities were comparable across all 4 sub-samples, while the Control1 and Control2 sub-samples had a larger proportion of large diameter (30” DBH) trees than the impact sub-samples (Figure 3f-g). Burn severity was comparable across all four sub-samples (Figure 3h), while distance to nearest unburned or low severity patch was also comparable except for a small set of locations in the Control2 sub-sample which were farther (>2000m) from such patches than in any of the other three sub-samples (Figure 3i).

Figure 2: Vegetation survey data plots. Control1 sub-sample consists of 44 points, 42 received vegetation surveys in 2015, and 15 of the 44 points were surveyed in 2019. The 26 Control2 points were surveyed only in 2019, the 42 Impact1 points were surveyed in both years, and the 21 Impact2 points were surveyed only in 2015.

Figure 2a: sum of cover of all shrubs (not including tree species seedlings).

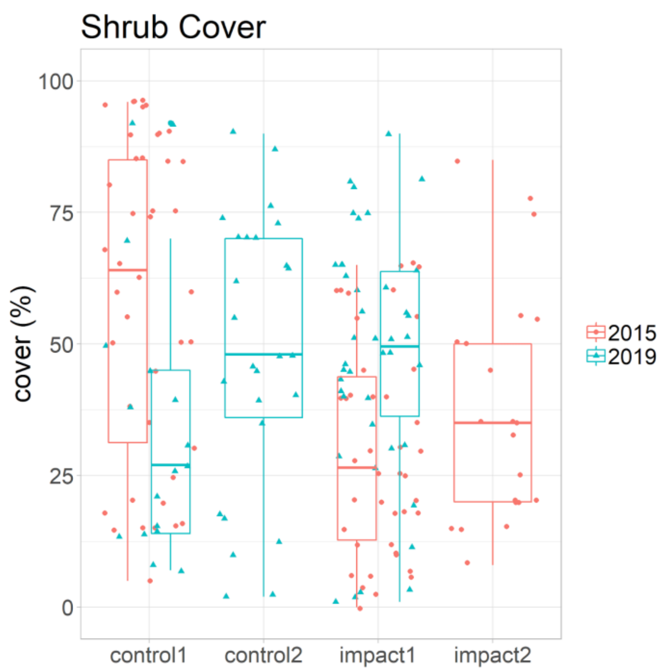


Figure 2b: average high shrub height.

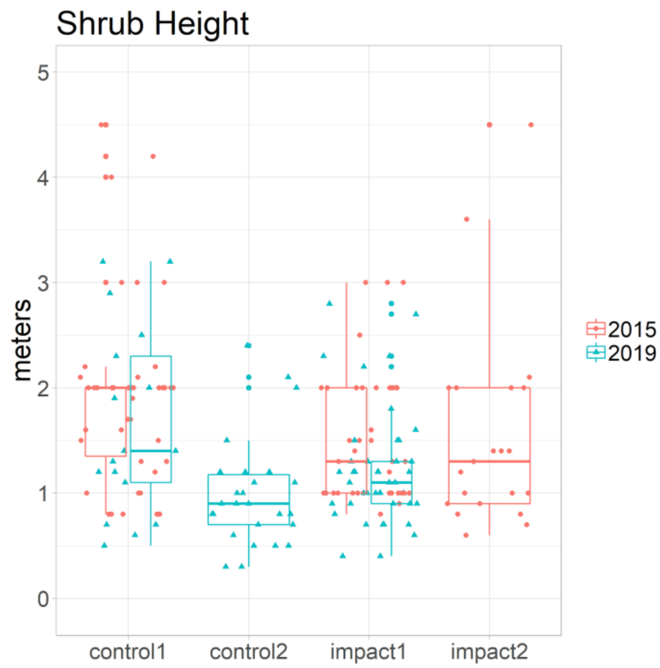


Figure 2c: cover of Mountain Whitethorn (*Ceanothus cordulatus).*

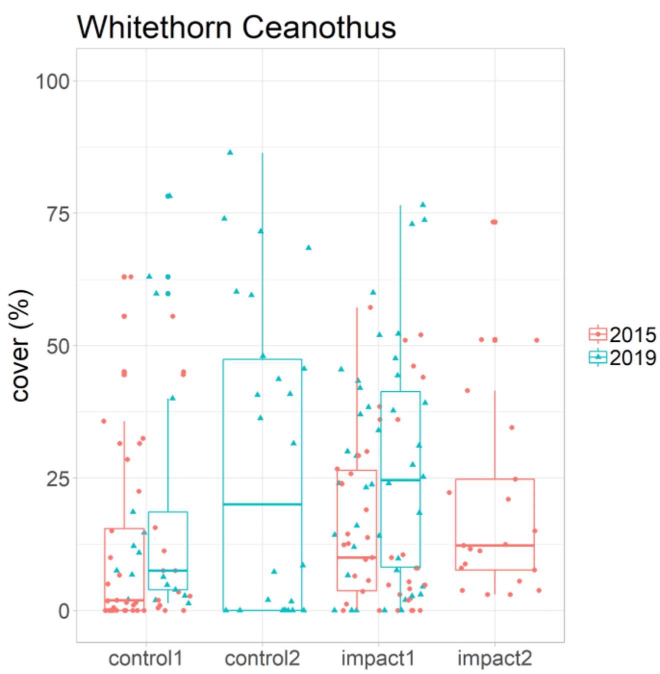


Figure 2d: cover of Greenleaf Manzanita (*Arctostaphylos patula*).

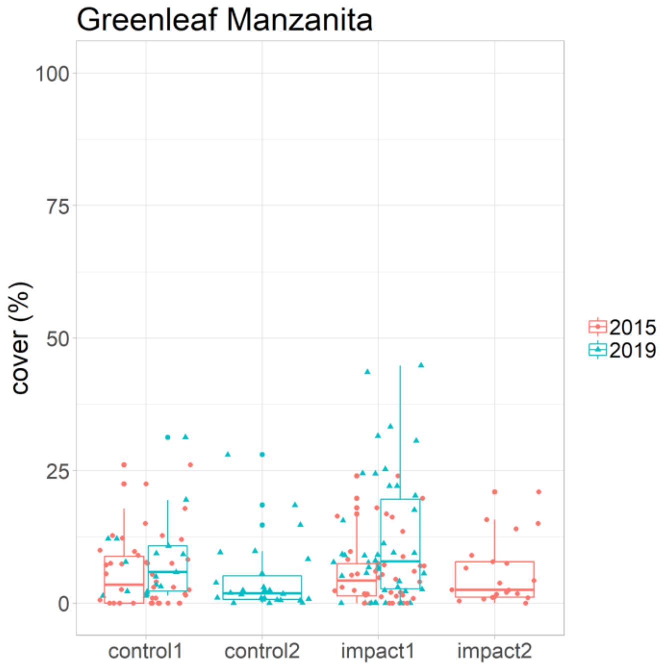


Figure 2e: cover of Tobacco Brush, Snowbrush Ceanothus (*Ceanothus velutinus*).

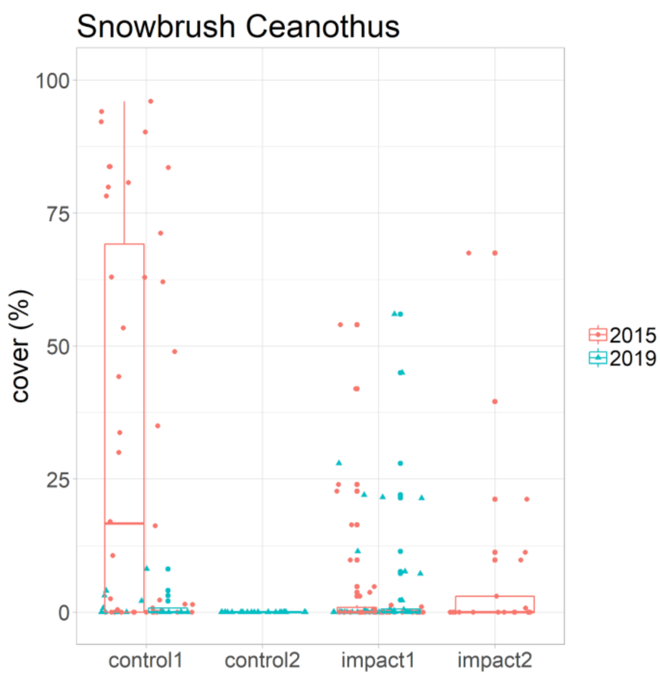


Figure 2f: cover of Willow species, mostly Scouler's Willow (*Salix spp.*).

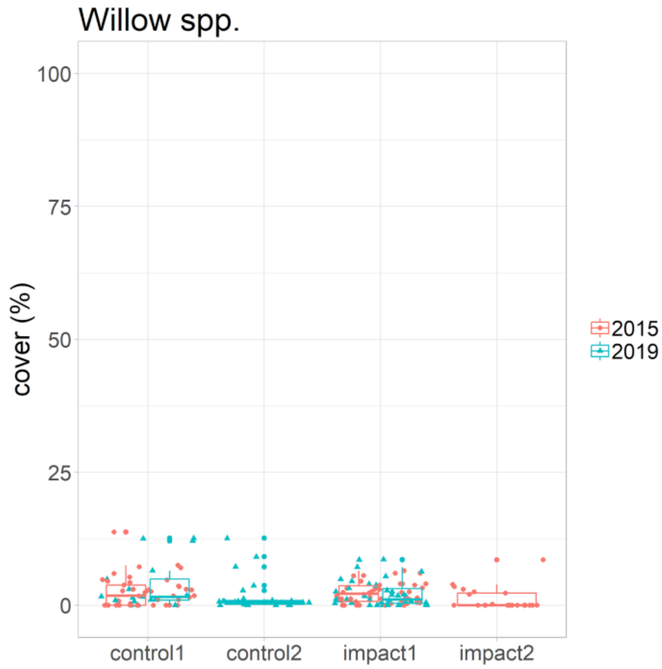


Figure 2g: sum of cover of all herbaceous vegetation.

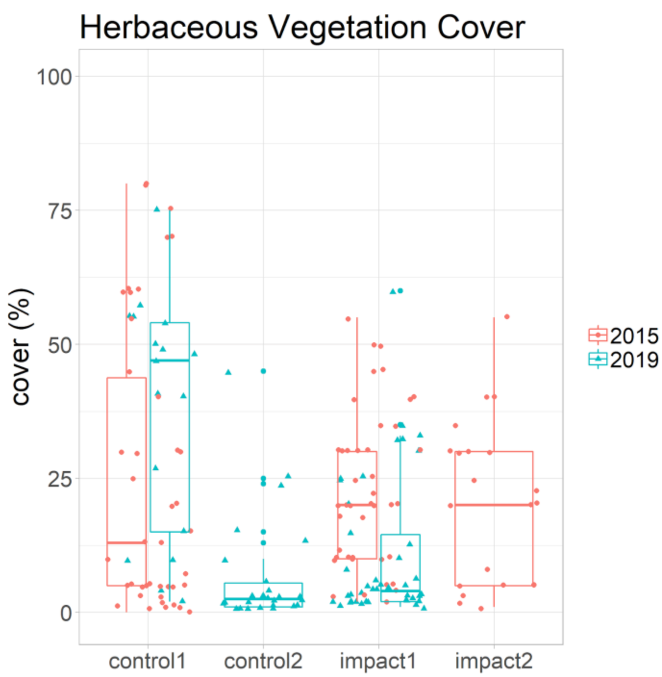


Figure 2h: average diameter of standing dead trees (snags).

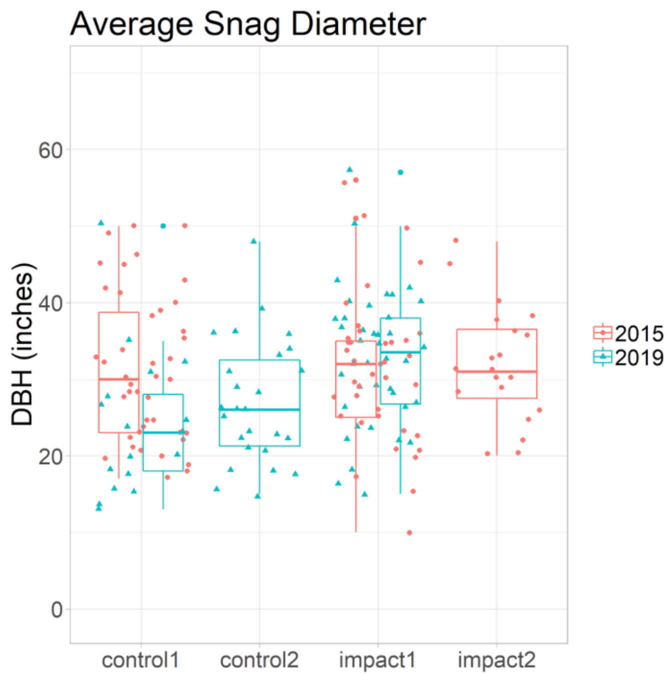


Figure 2i: total basal area of standing dead trees (snags).

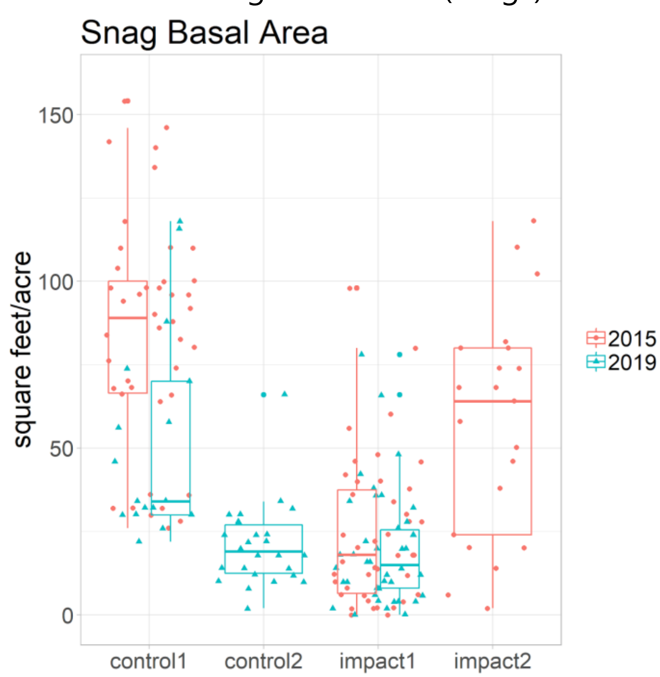


Figure 2j: total basal area of live trees.

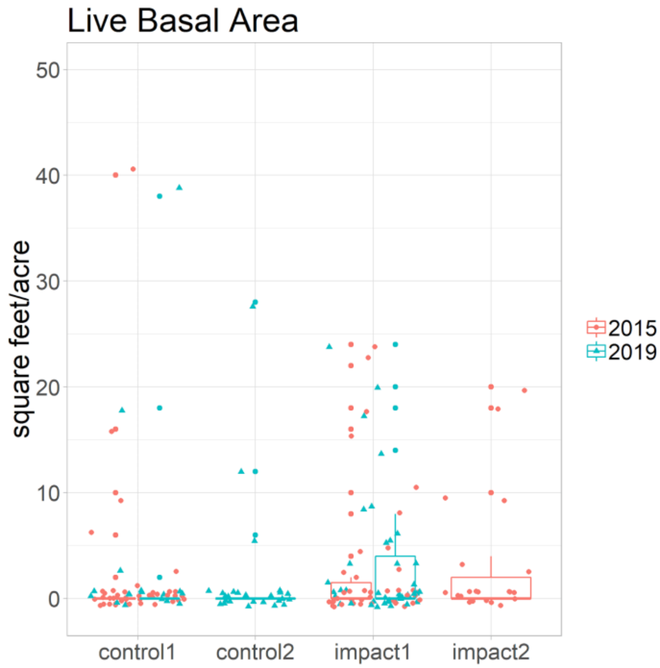


Figure 3: Remote sensing and GIS-derived habitat and environmental variables. All sample points are included in these figures.

Figure 3a: elevation sampled from Sierra Nevada 30m resolution digital elevation model (DEM).

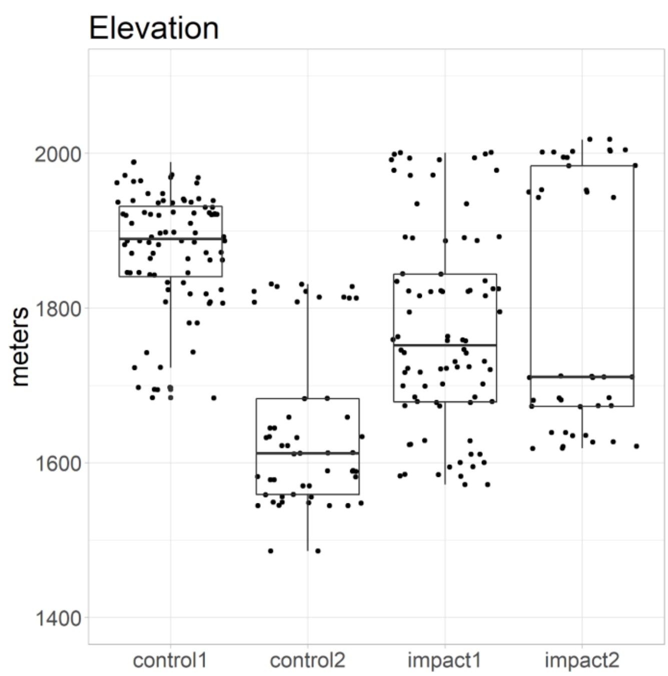


Figure 3b: slope calculated from Sierra Nevada 30m resolution digital elevation model (DEM).

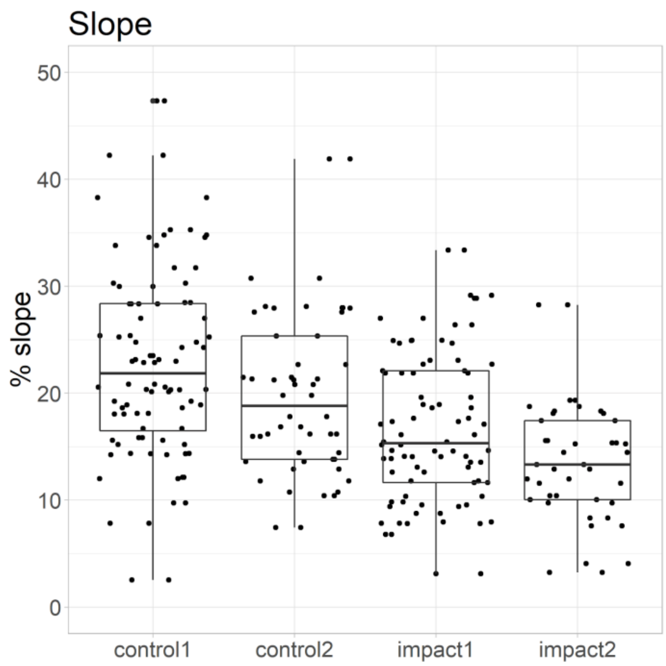


Figure 3c: Normalized-difference Wetness Index (NDWI) values calculated from 30m resolution LANDSAT 8 imagery.

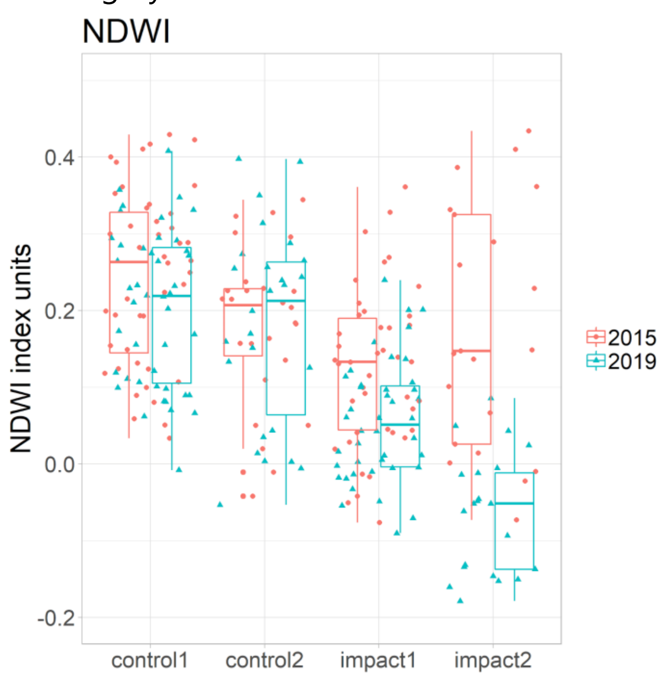


Figure 3d: difference in Normalized-difference Wetness Index (NDWI) values between 2015 and 2019 (a measure of relative vegetation change, positive values indicate increase in green vegetation).

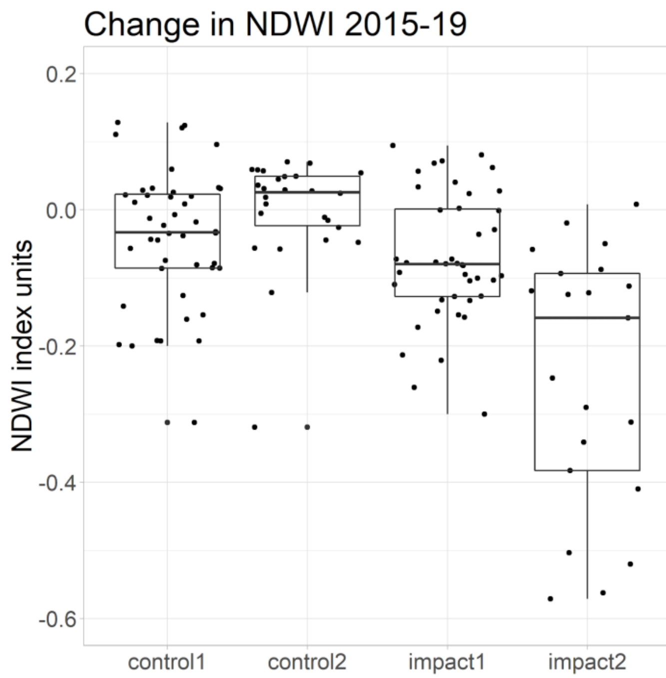


Figure 3e: understory vegetation cover as measured by LIDAR in 2015.

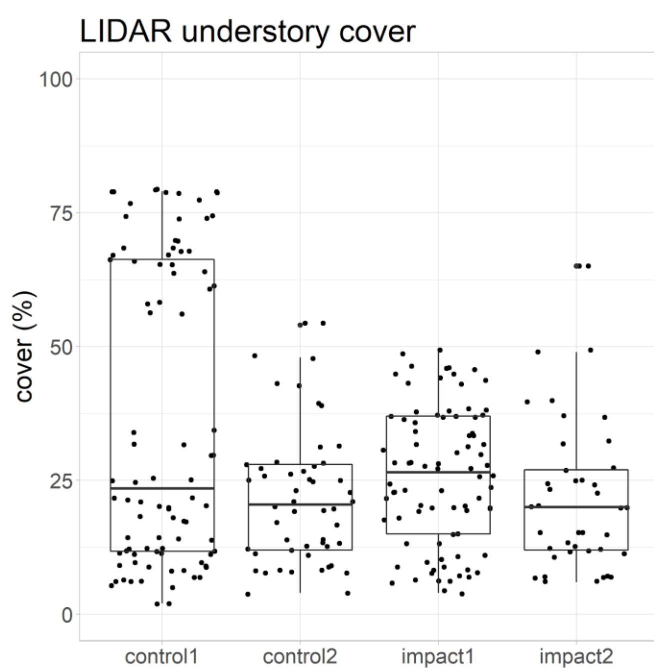


Figure 3f: pre-fire tree density sampled from U.S. Forest Service California Existing Vegetation (Eveg) layer derived from 2005 LANDSAT satellite imagery.

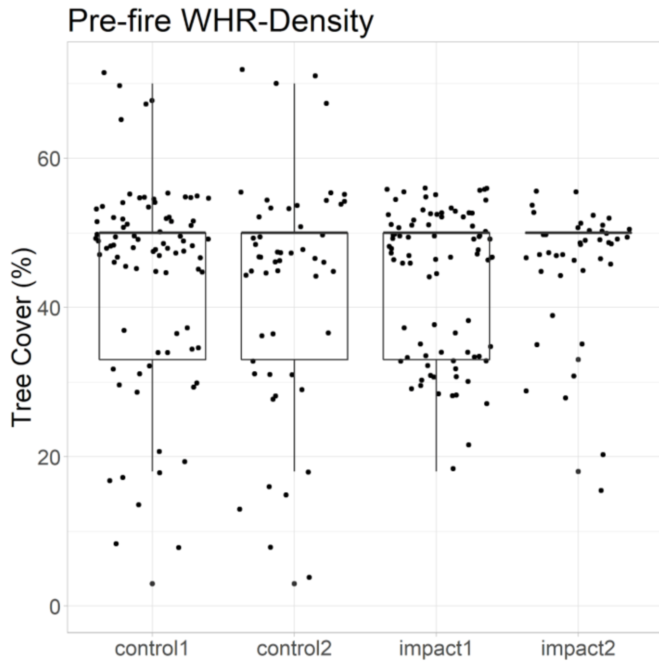


Figure 3g: pre-fire average tree size sampled from U.S. Forest Service California Existing Vegetation (Eveg) layer derived from 2005 LANDSAT satellite imagery.

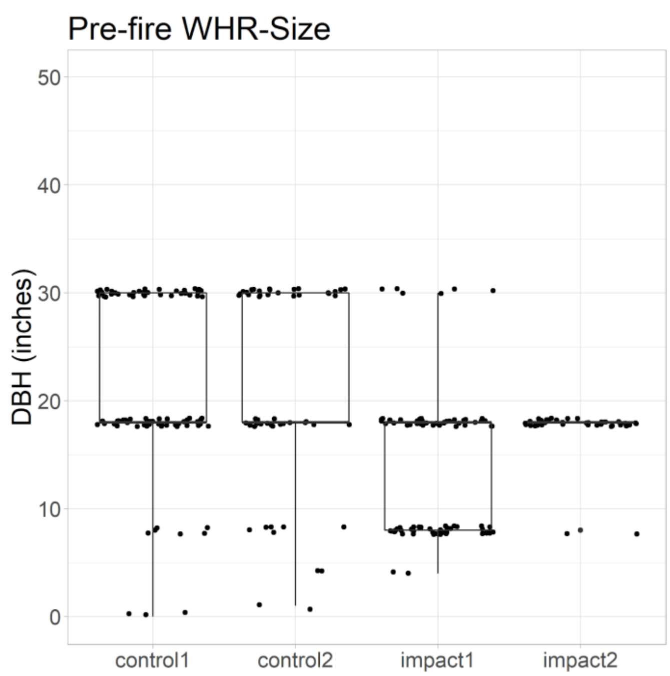


Figure 3h: post-fire burn severity (relative differenced normalized burn ratio, RdNBR) derived from LANDSAT satellite imagery.

Figure 3h: measured distance from each point to the edge of a low severity or unburned forest patch - higher values indicate that the point is within a large patch of high burn severity.

We compared average avian abundance within the 2019 Impact2 sub-sample relative to 2015 and the corresponding control sample patterns. In this early stage without a rigorous statistical test of the effects of treatment on bird abundance, we were able to observe some general patterns across all species by visually examining the abundance estimates in control and treatment samples and across years (Figure 4, Appendix). First, we found that hardly any species increased following treatment (see Appendix for individual species abundance estimate boxplots). Only one of the 37 species (American Robin) and none of the 3 guilds increased (Table 2). Species that decreased following treatment were more numerous, including 15 of the 37 species, and 2 of 3 guilds. The majority of species (21), and 1 of 3 guilds, were either not sensitive to treatment or evidence was insufficient to conclude an effect. There was also a strong decline in abundance, regardless of treatment, between 2015 and 2019 for several species, some of which are woodpeckers or snag-dependent species. These species include Black-backed Woodpecker, Brown Creeper, Dark-eyed Junco, Dusky Flycatcher, Hairy Woodpecker, Mountain Bluebird, Mountain Chickadee, Northern Flicker, White-breasted Nuthatch, Western Bluebird, Western Wood-pewee, White-headed Woodpecker, and Yellow-rumped Warbler.

Figure 4: Bird abundance model results summed across all species within each of three guilds.

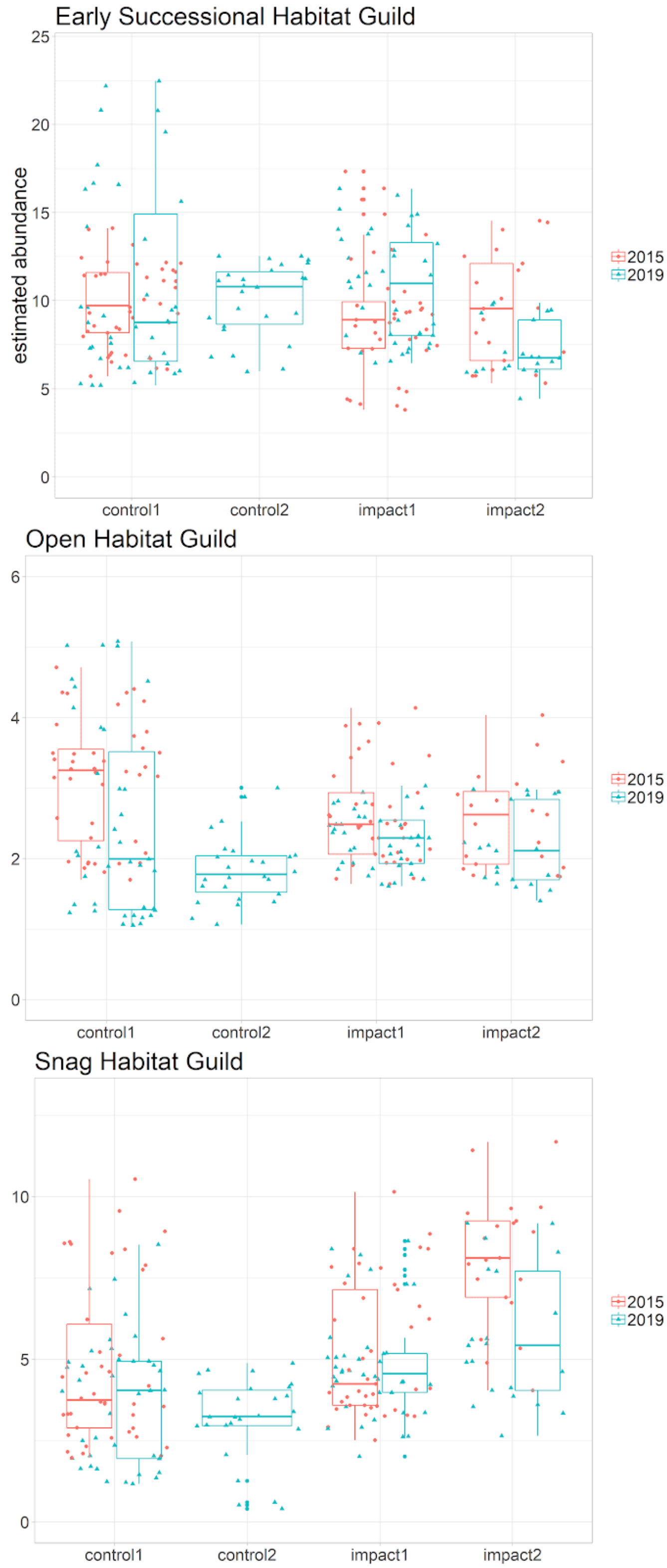


Table 2: Species and guild (in bold) responses to treatments assessed visually from box plots of abundance (see Appendix for species abundance boxpots)

Species that increase after treatment (n = 0 guilds, 1 species)	Species that were not sensitive to treatment (n= 1 guild, 21 species)	Species that decline after treatment (n= 2 guilds, 15 species) [species labeled "absent" were present in pre-treatment surveys but absent following treatments]
American Robin	**Open/Mature Forest Guild** Black-backed Woodpecker Brown Creeper Chipping Sparrow Dark-eyed Junco Dusky Flycatcher Fox Sparrow Hammond's Flycatcher Hairy Woodpecker Lazuli Bunting Lewis' Woodpecker Mountain Bluebird Mountain Chickadee Mountain Quail Nashville Warbler Northern Flicker Steller's Jay Tree Swallow	**Early Seral Forest Guild** **Pre-Fire Snags Guild** Black-headed Grosbeak (absent) Brewer's Sparrow Cassin's Finch (absent) Green-tailed Towhee House Wren MacGillivray's Warbler Olive-sided Flycatcher Red-breasted Nuthatch (absent) Song Sparrow Spotted Towhee (absent) Warbling Vireo (absent) Western Tanager Western Wood-pewee (absent) Wilson's Warbler (absent) Yellow-rumped Warbler (absent)

	White-breasted Nuthatch Western Bluebird White-headed Woodpecker Yellow Warbler	

DISCUSSION

Our study design and monitoring activities to-date appear to have positioned us well for evaluating the short-term effects of Moonlight Fire reforestation treatments on birds. The control and impact samples appear well matched overall, especially once the sub-samples are combined for final analyses. However, there are a few minor differences that should be noted and potentially taken into account for future analyses. The Control1 sub-sample in particular appears to include more points of very high shrub cover and high shrub height than the other sub-samples, a pattern that is also observable in herbaceous vegetation cover, as well as both the NDWI and LIDAR measurements. In addition to understory cover, the Control1 sub-sample has higher snag basal area on average, as well as average landscape position on higher elevation and slope. It appears that a large portion of the understory cover difference can be attributed to tobacco brush. If this result indicates a strong difference in vegetation composition and other habitat difference, then it could also lead to a difference in bird species composition, and thus perhaps including a measurement of tobacco brush relative or absolute cover, along with elevation, slope, and other potentially important explanatory variables is warranted in bird abundance models to account for these known differences. Accounting for these co-variates will increase our ability to fit models and identify significant treatment effects on bird species and guilds. Vegetation changes resulting from treatments appear to be as expected given that NDWI is much lower in 2019 at the treated points in comparison to the same points pre-treatment.

Our bird guild and individual species abundance results show that open habitat species are not strongly affected by treatments, while shrub and snag birds tend to decline. Only one species, American Robin, appears to increase following treatments, perhaps taking advantage of the cleared areas and increase in exposed soil as they do following moderate severity fire (Taillie et al. 2018). Yearly decline across a wide range of snag-associated birds indicates that the decay of snags may be a strong factor in many species abundance changes between 2015 and 2019. Given that snags decline across both the control and impact samples, in addition to snag removal within treatments in the impact sample, it may be difficult to isolate the effect of snag removal on bird abundance. The effect of snag removal on bird habitat quality may be swamped by natural decay rather than the site preparation treatments. In contrast, because the treatments create a markedly different vegetation structure while understory vegetation is stable or increasing at control locations, it will be much easier to attribute the removal of shrubs and other live vegetation changes to declines in bird guilds and species. Our results do suggest habitat value for snag dependent wildlife is declining in the fire, potentially reducing negative effects of snag removal to this suite of species at this post-fire successional stage, compared to the shrub associates who are more likely to be impacted by treatments 12 years post-fire (Taillie et al. 2018).

Other studies show that snag removal and preparation for replanting have strong effects on shrub cover, snag density, and bird communities in many other regions such as boreal forest (e.g. Lain et al. 2008), Mediterranean woodlands (e.g. Rost et al 2012), and Australia (e.g. Lindenmayer et al. 2018). Studies in California show similar results (e.g. Hutto et al. 2020), notably that that removal of snags along with site preparation for planting new trees (by removing shrubs) leads to increases in abundance for very few species over the short term, while leading to reductions in abundance for many more species. But active post-fire management including shrub removal can have positive effects on other aspects of ecological integrity, such as promoting native species diversity (Bohlman et al. 2016), and native grasses and other important vegetation components can be resilient to snag removal (Knapp and Ritchie 2016). A balance between active and passive techniques along with promotion of an active fire regime may have the most positive consequences for fire-adapted landscapes (White et al. 2019).

We are planning field activities in 2020 and 2021 to wrap-up data collection for this study. In August or September 2020, we hope to complete vegetation surveys at all impact locations receiving treatment in 2018 and 2019; however, recent developments with the COVID-19 pandemic may preclude us from collecting this data in 2020. In 2021, we will complete bird surveys at all sample locations, and vegetation surveys at all sample locations except those that we may have surveyed in 2020.

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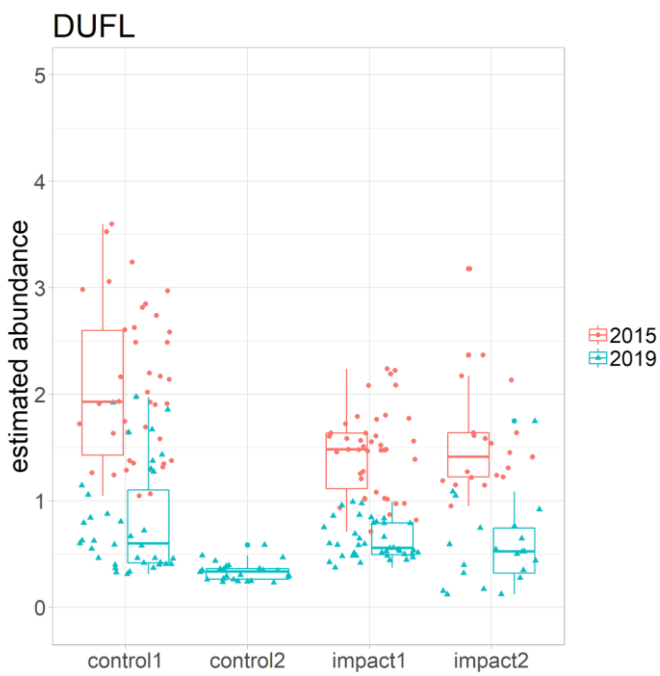
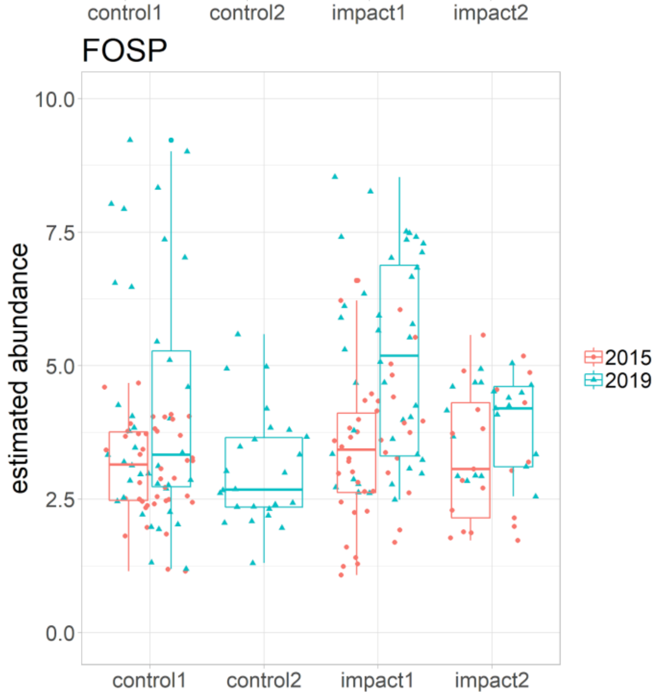
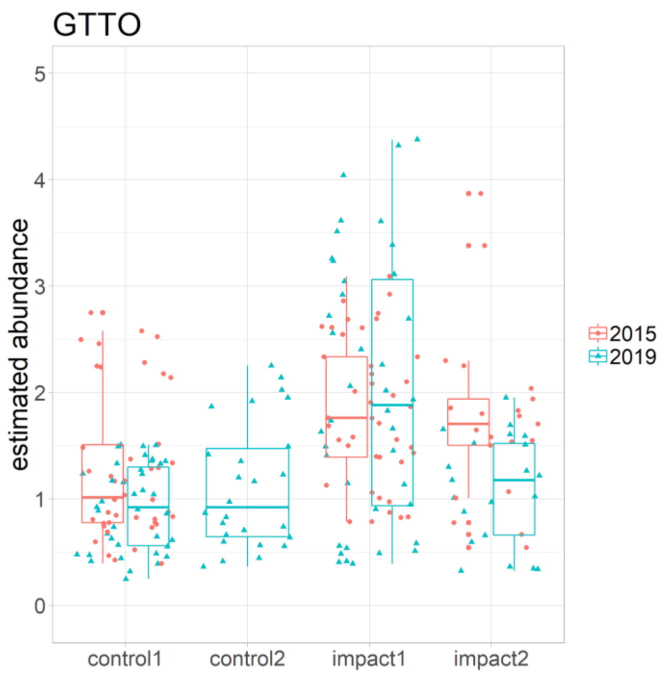
APPENDICES

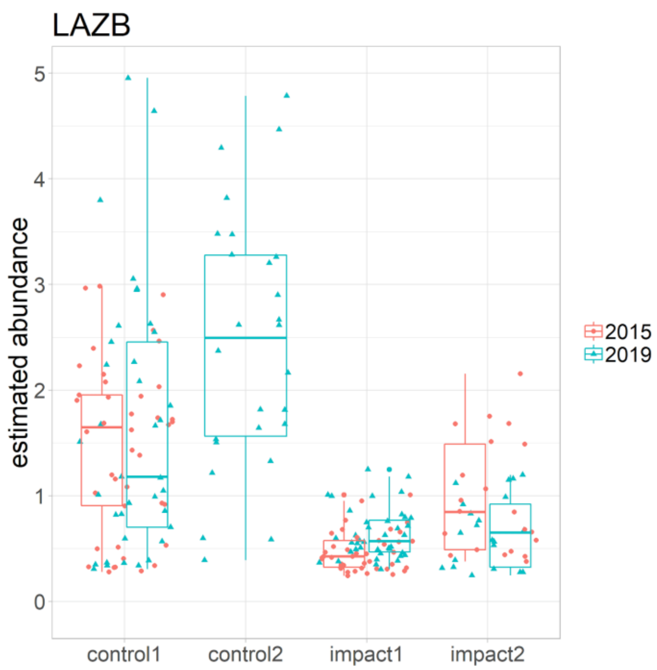
Appendix 1. Boxplots of estimated abundance from fitted models for all individual species.

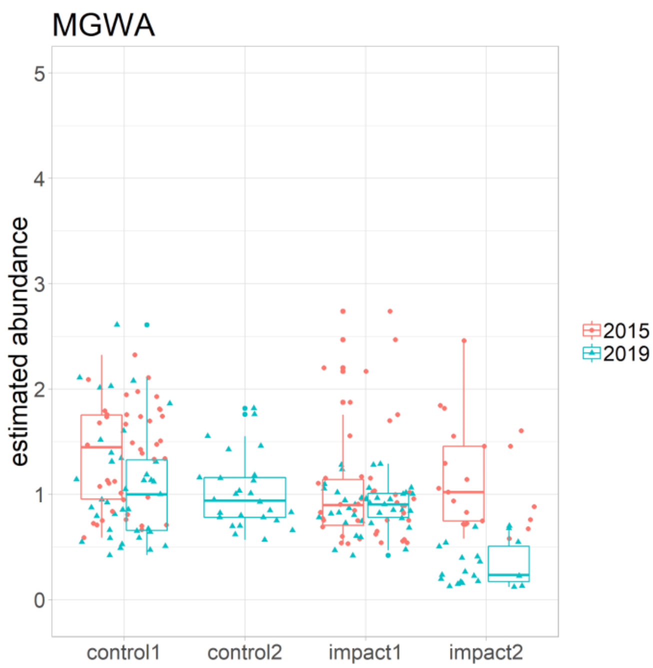
<u>Early Successional Habitat Guild</u>

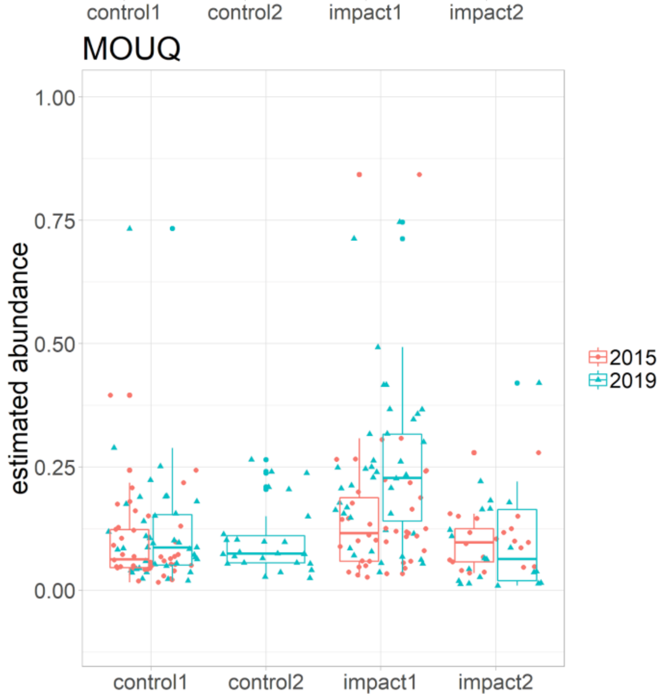


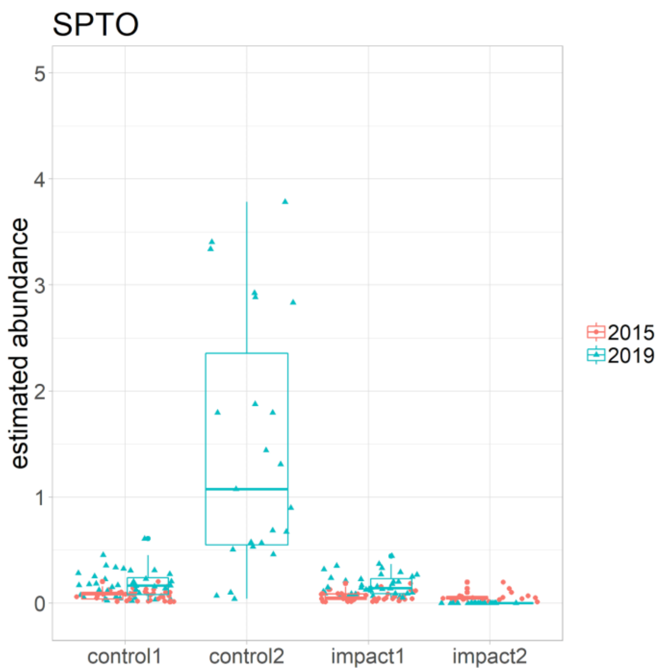


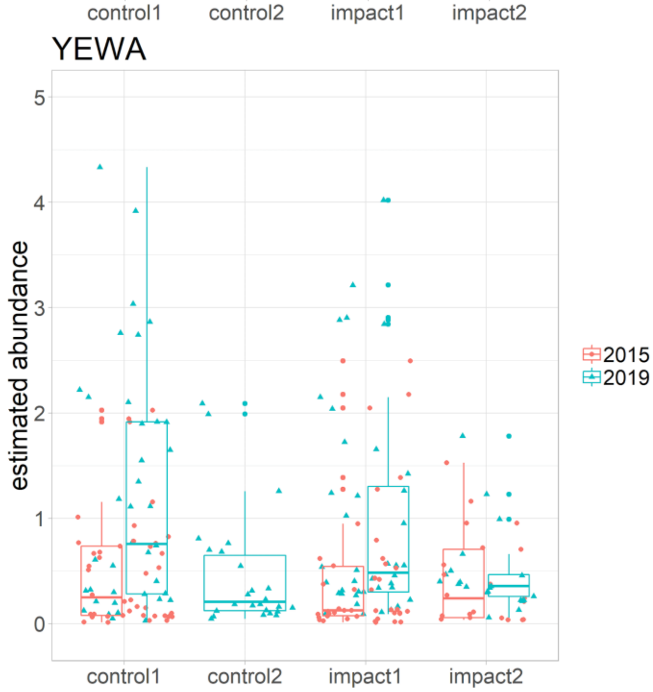

GTTO
estimated abundance
0
1
2
3
4
5
control1
control2
impact1
impact2
2015
2019


LAZB
estimated abundance
0
1
2
3
4
5
control1
control2
impact1
impact2
2015
2019

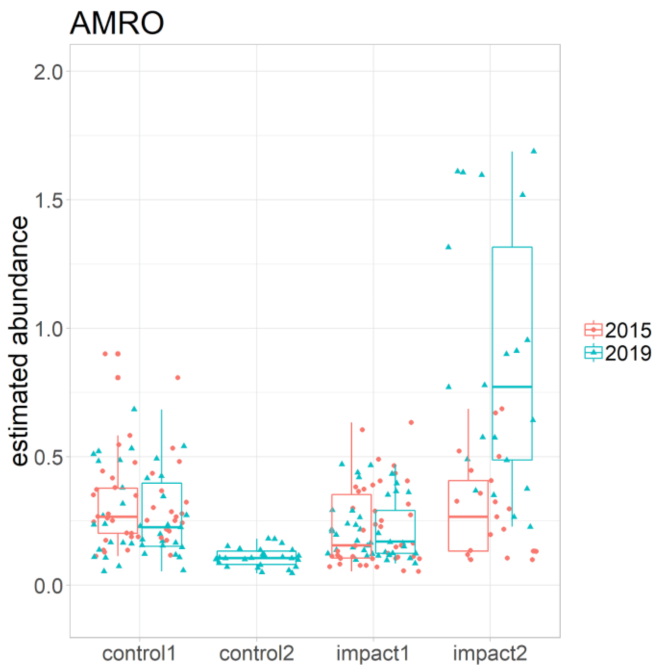

MGWA
estimated abundance
5
4
3
2
1
0
control1
control2
impact1
impact2
2015
2019

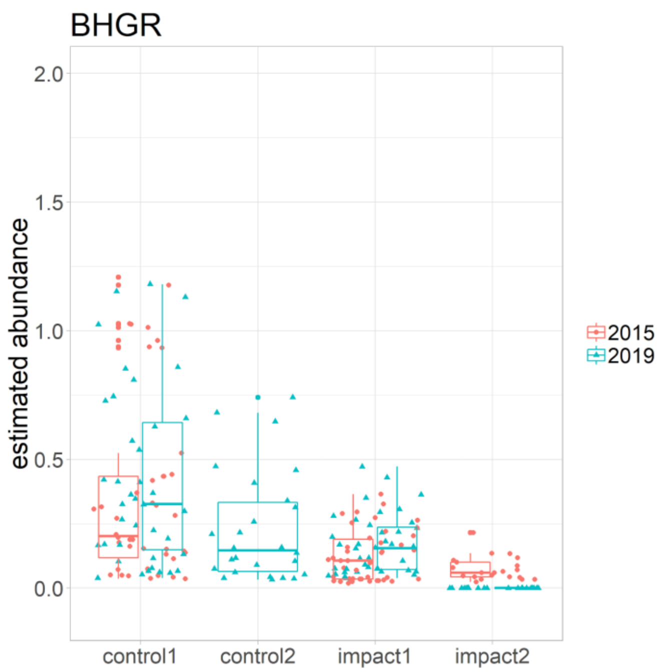

MOUQ
estimated abundance
1.00
0.75
0.50
0.25
0.00
control1
control2
impact1
impact2
2015
2019


SPTO
estimated abundance
0
1
2
3
4
5
control1
control2
impact1
impact2
2015
2019

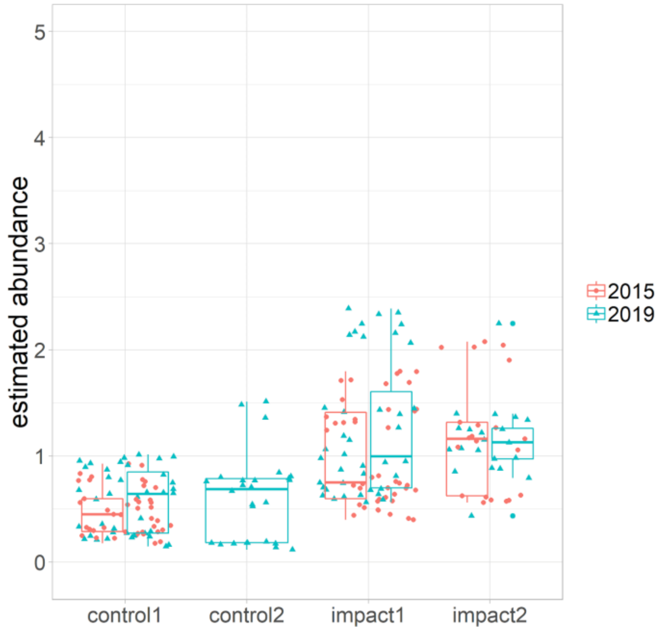

YEWA
estimated abundance
0
1
2
3
4
5
control1
control2
impact1
impact2
2015
2019

Open Habitat Guild

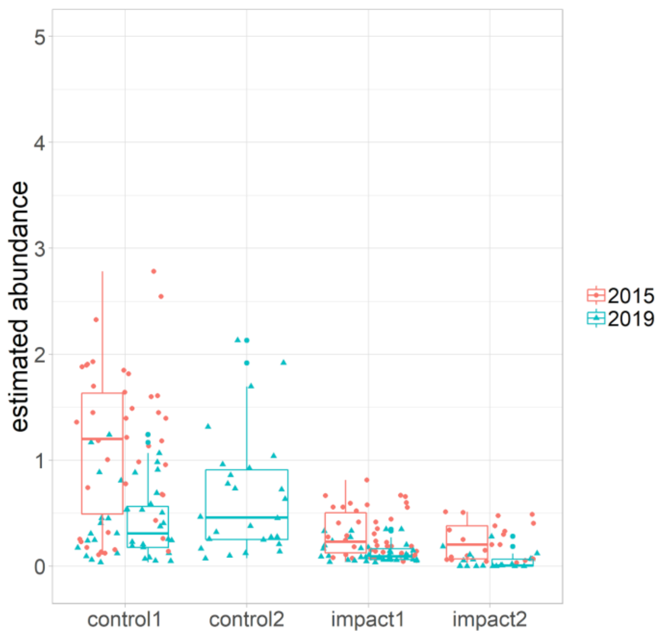


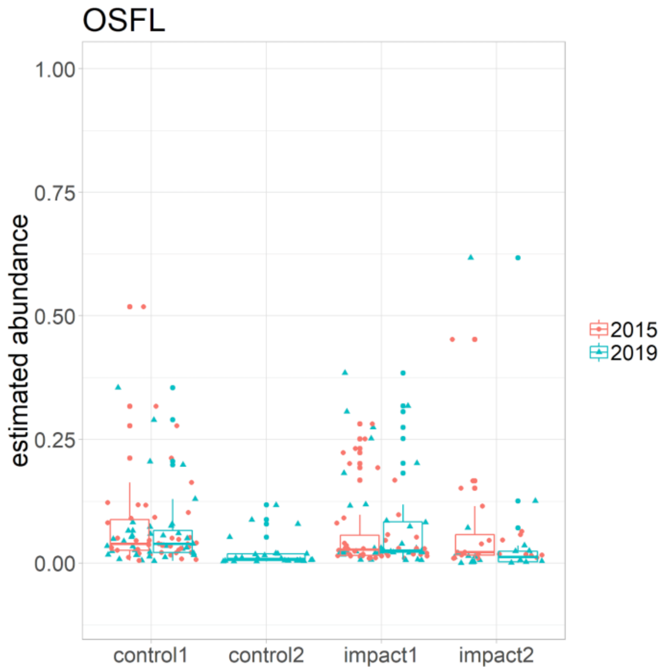


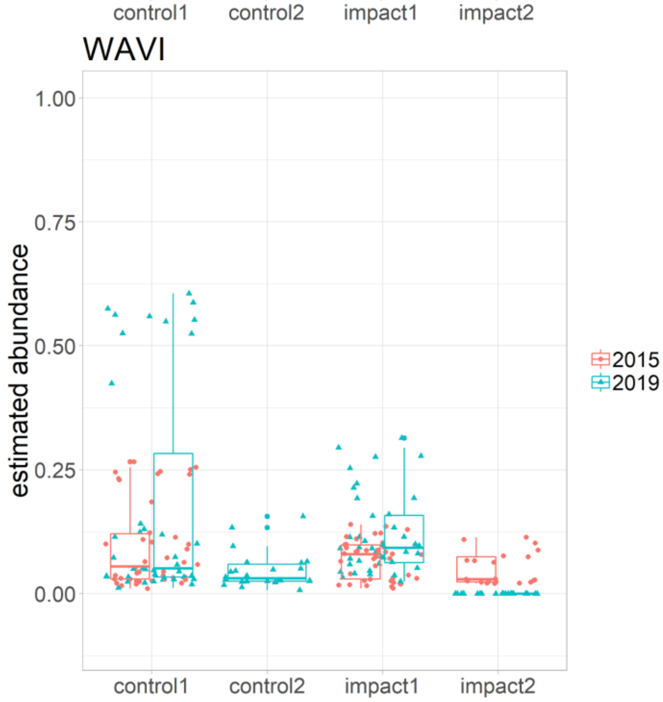
CHSP

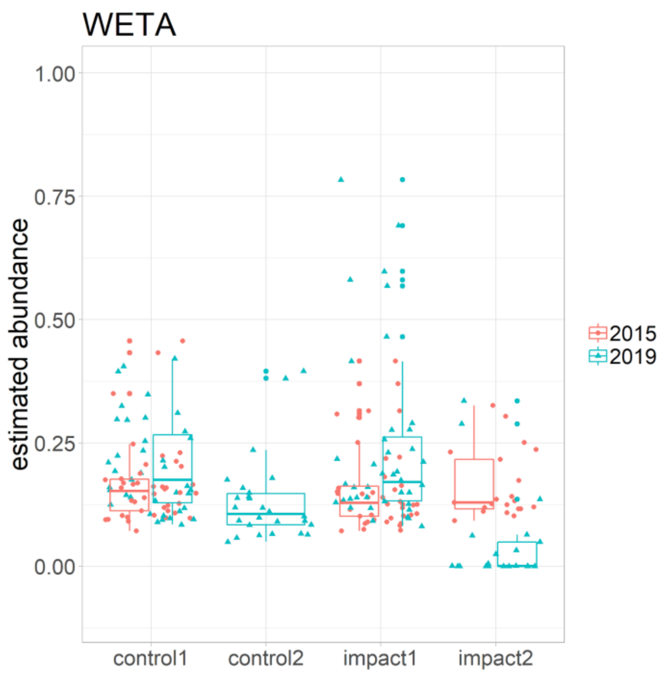

estimated abundance
0
1
2
3
4
5
control1
control2
impact1
impact2
2015
2019

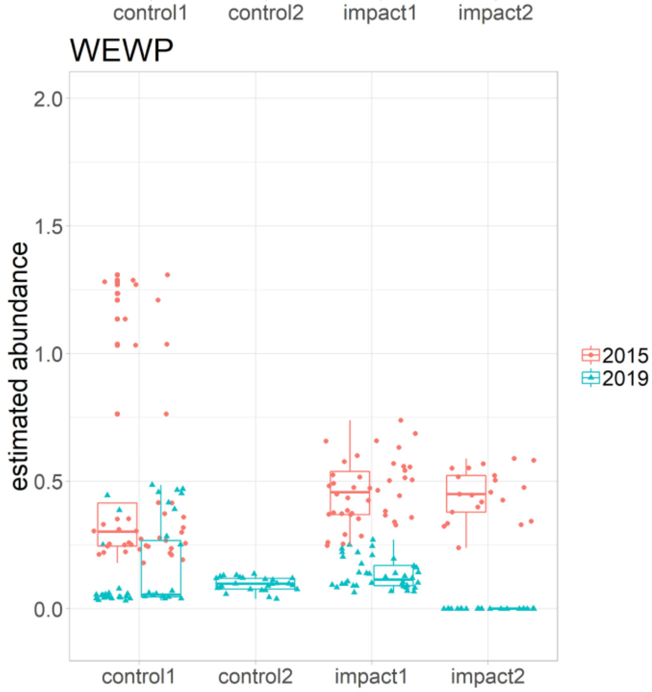
NAWA

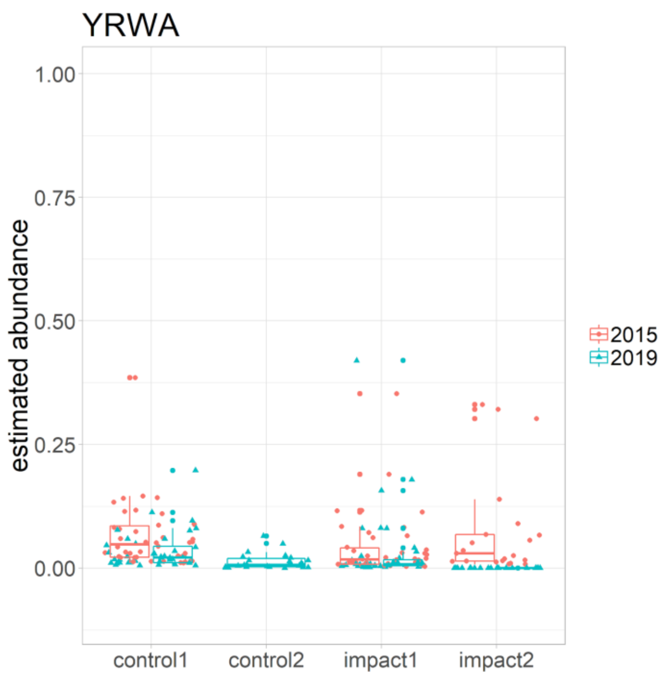

estimated abundance
0
1
2
3
4
5
control1
control2
impact1
impact2
2015
2019


OSFL
1.00
0.75
0.50
0.25
0.00
estimated abundance
control1
control2
impact1
impact2
2015
2019

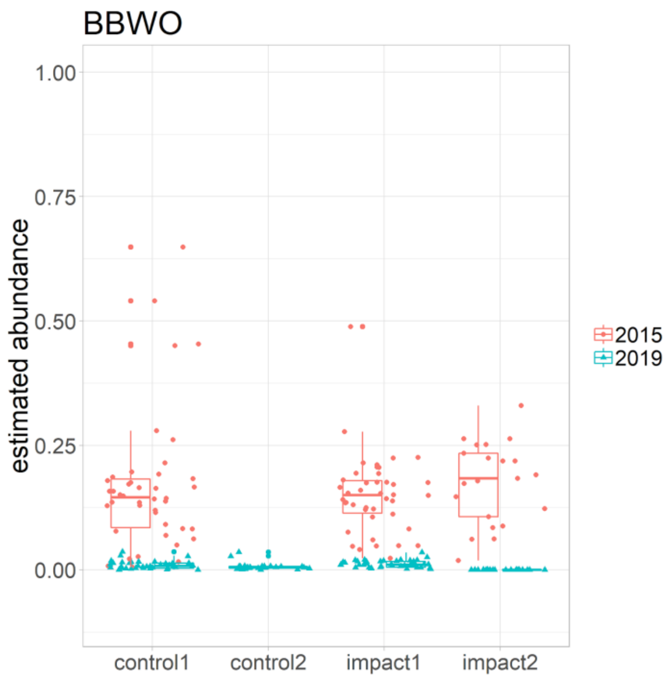

WAVI
1.00
0.75
0.50
0.25
0.00
estimated abundance
control1
control2
impact1
impact2
2015
2019

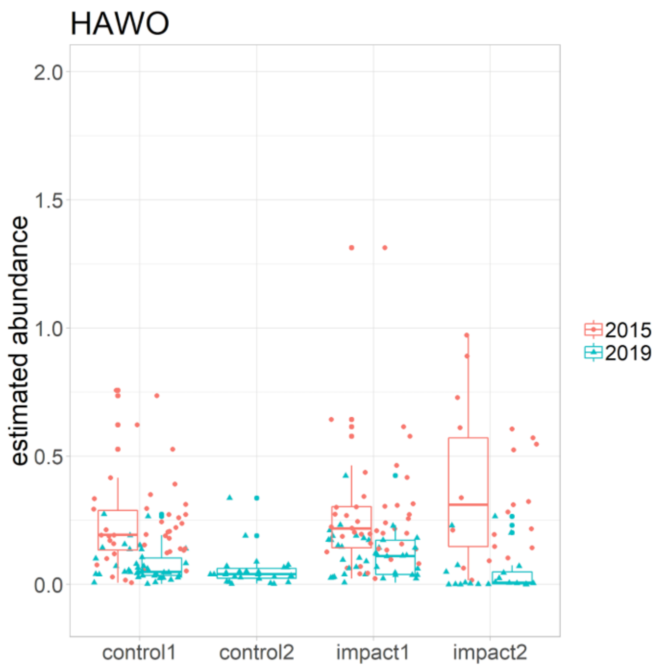

WETA
1.00
0.75
0.50
0.25
0.00
estimated abundance
control1
control2
impact1
impact2
2015
2019

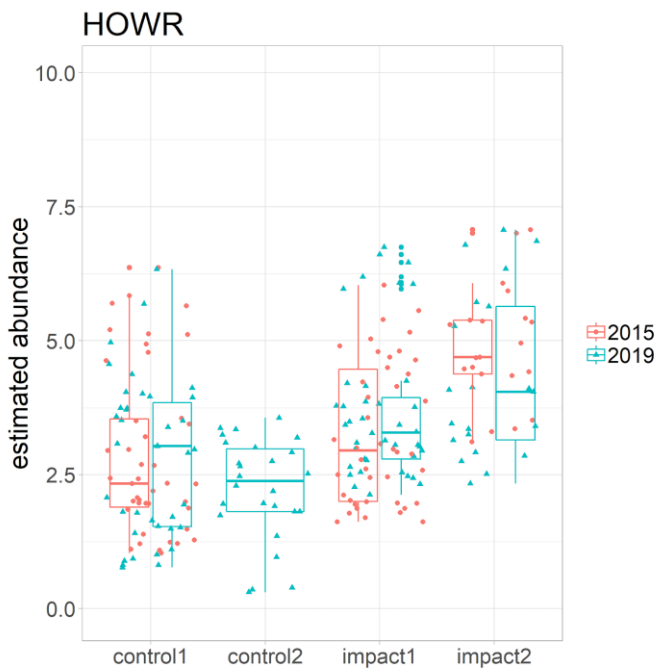

WEWP
2.0
1.5
1.0
0.5
0.0
estimated abundance
control1
control2
impact1
impact2
2015
2019

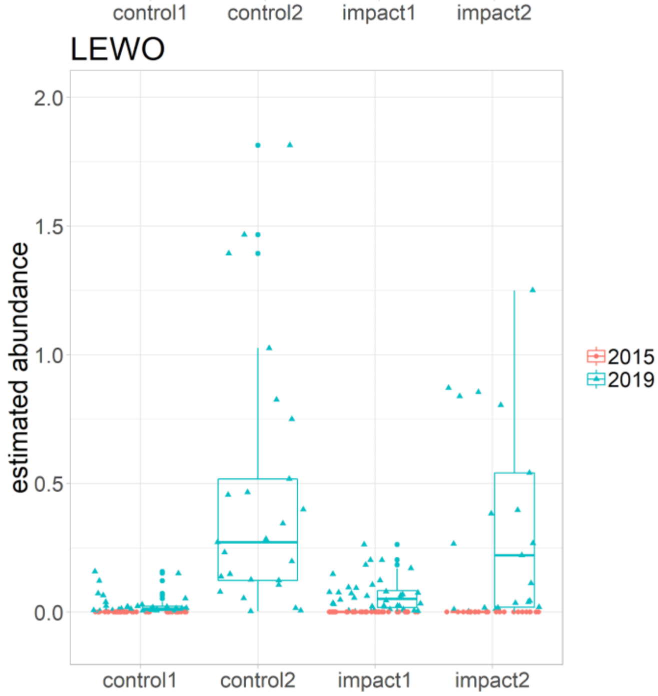

YRWA
estimated abundance
1.00
0.75
0.50
0.25
0.00
control1
control2
impact1
impact2
2015
2019

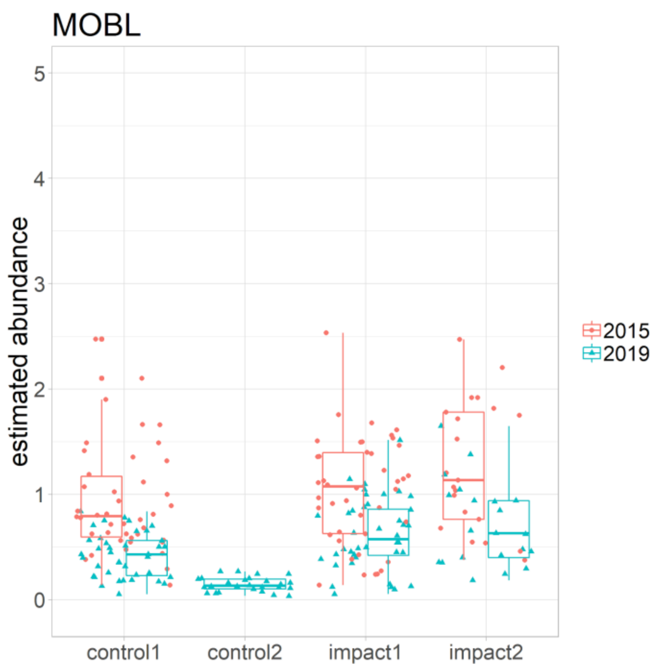
Snags Habitat Guild

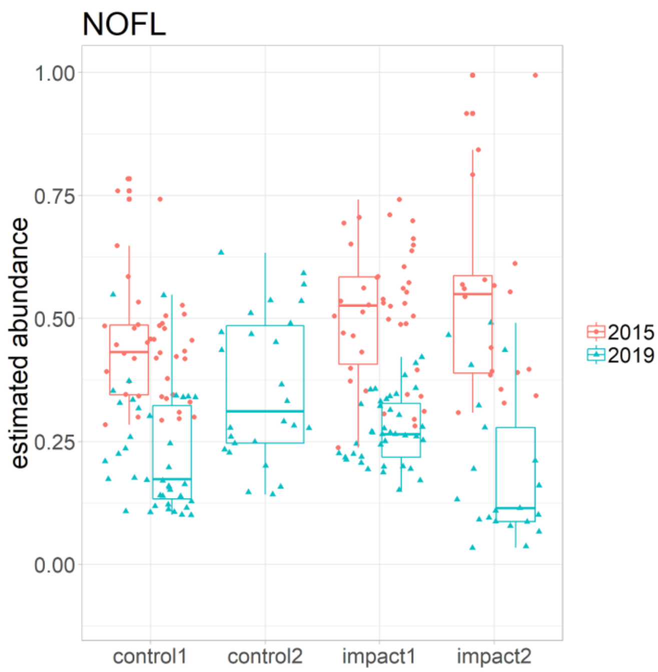


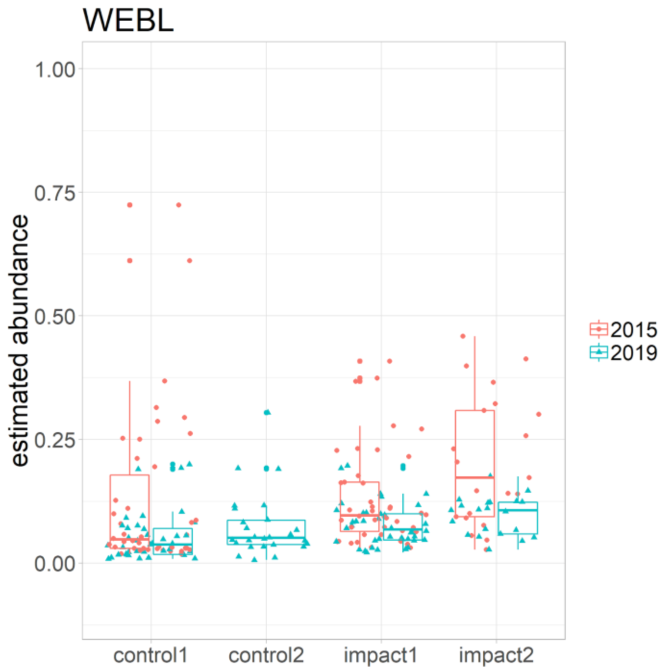


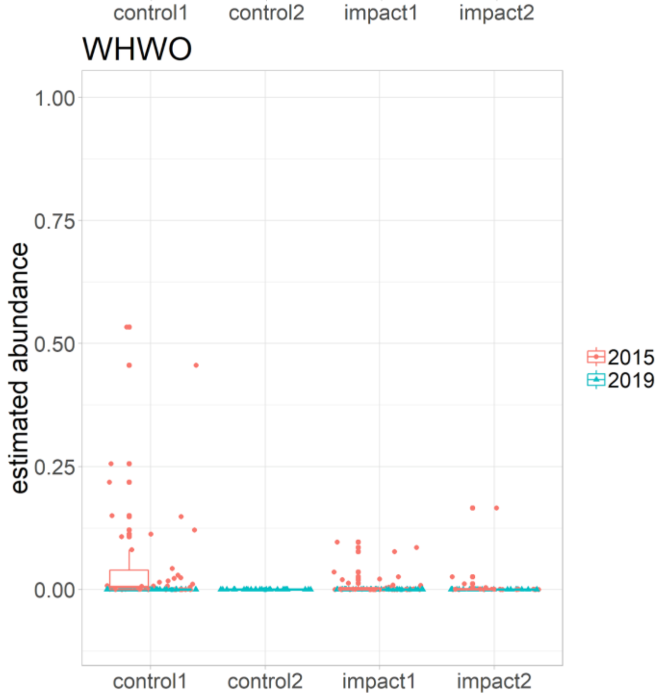

HOWR
estimated abundance
10.0
7.5
5.0
2.5
0.0
control1
control2
impact1
impact2
2015
2019


LEWO
estimated abundance
2.0
1.5
1.0
0.5
0.0
control1
control2
impact1
impact2
2015
2019

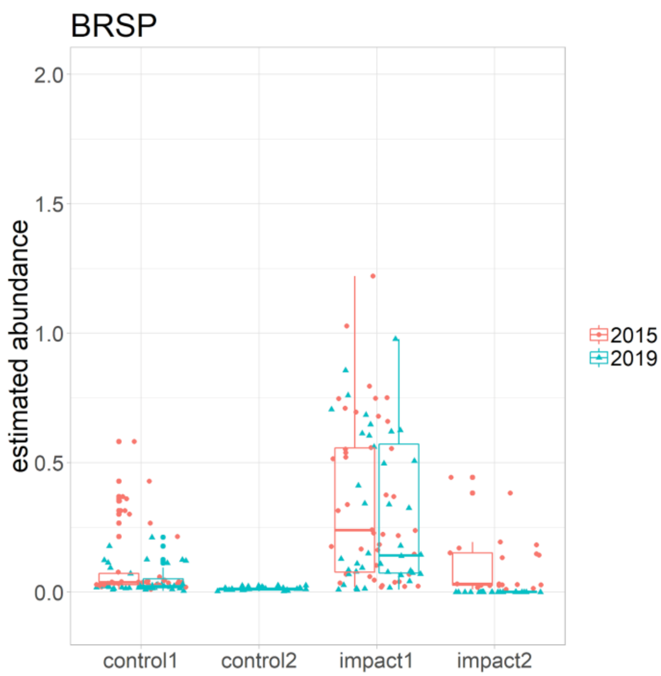

MOBL
estimated abundance
5
4
3
2
1
0
control1
control2
impact1
impact2
2015
2019

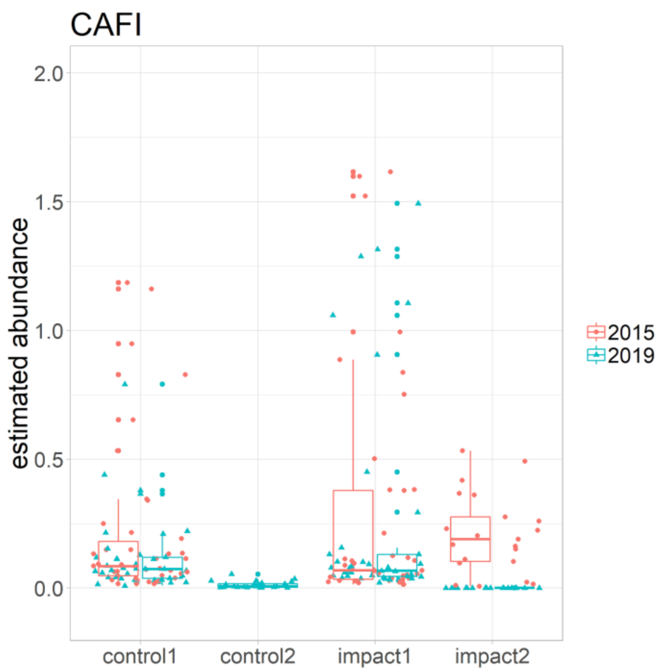

NOFL
estimated abundance
1.00
0.75
0.50
0.25
0.00
control1
control2
impact1
impact2
2015
2019

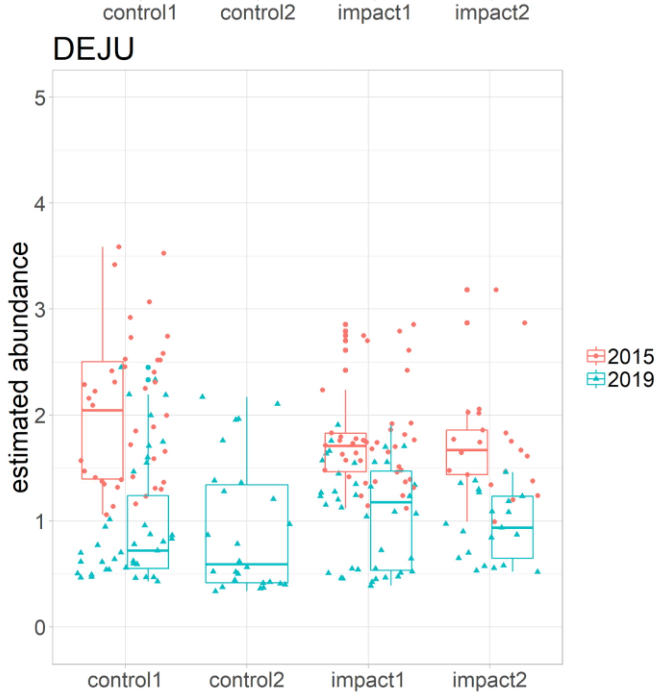

WEBL
estimated abundance
1.00
0.75
0.50
0.25
0.00
control1
control2
impact1
impact2
2015
2019

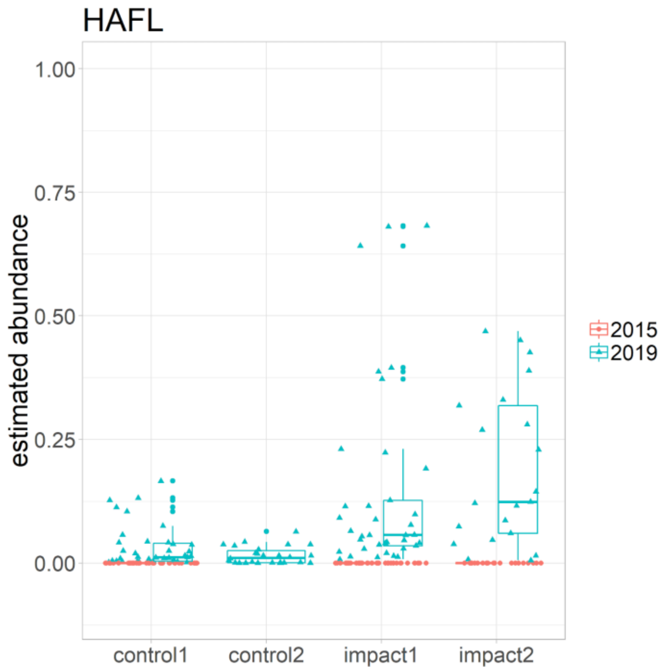

WHWO
estimated abundance
1.00
0.75
0.50
0.25
0.00
control1
control2
impact1
impact2
2015
2019

Other (non-guild) species




CAFI
estimated abundance
2.0
1.5
1.0
0.5
0.0
control1
control2
impact1
impact2
2015
2019


DEJU
estimated abundance
5
4
3
2
1
0
control1
control2
impact1
impact2
2015
2019


HAFL
estimated abundance
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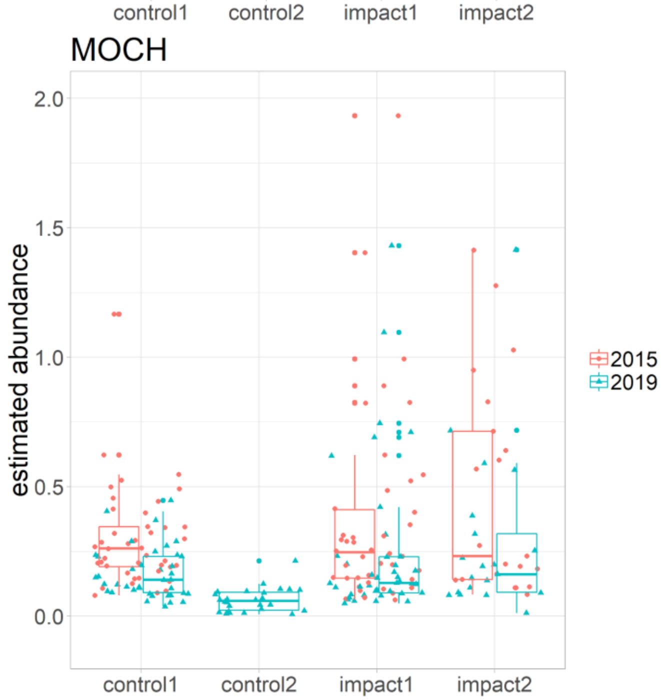
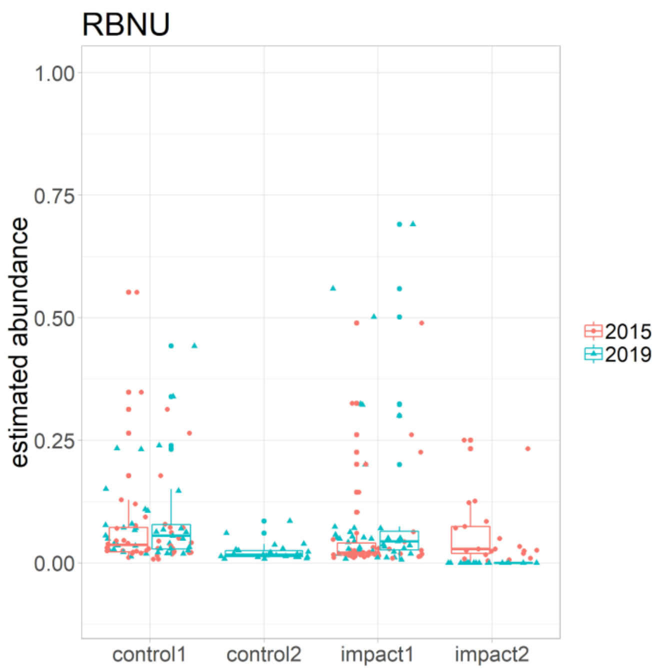
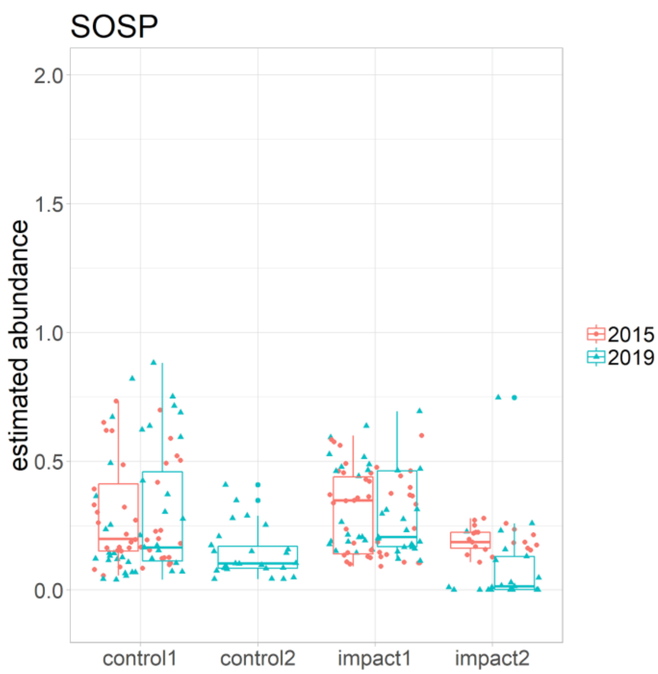
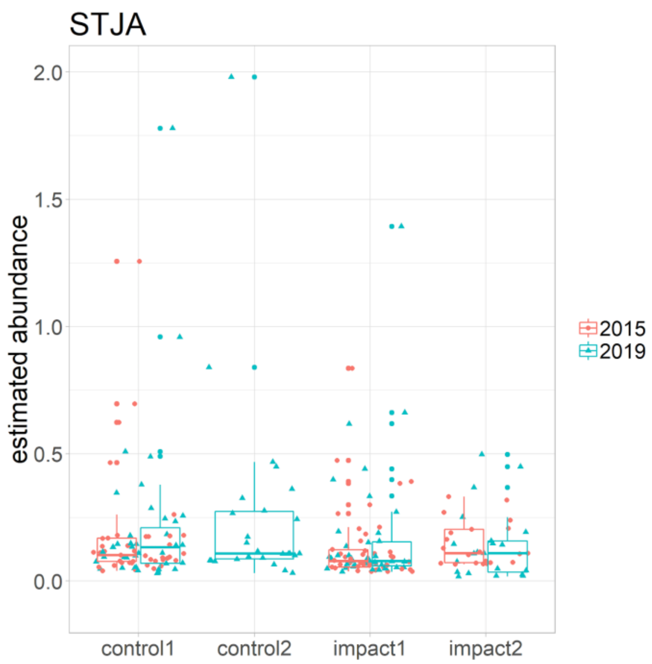
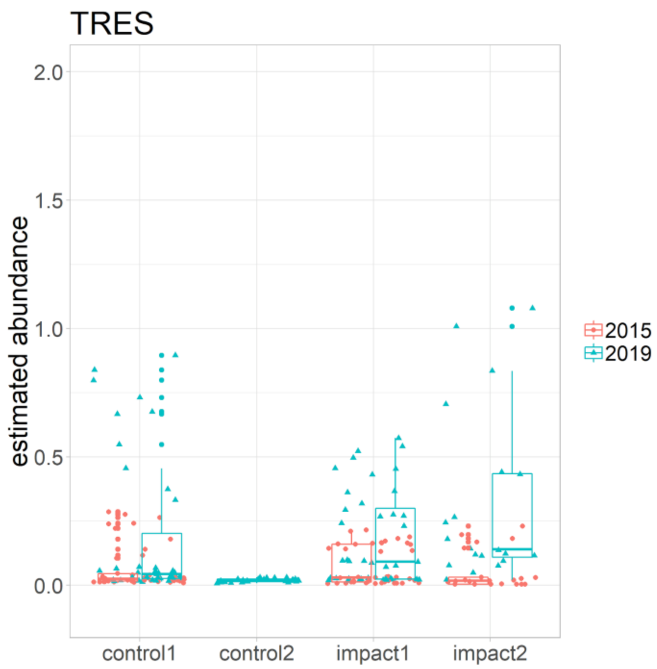
0.75
0.50
0.25
0.00
control1
control2
impact1
impact2
2015
2019

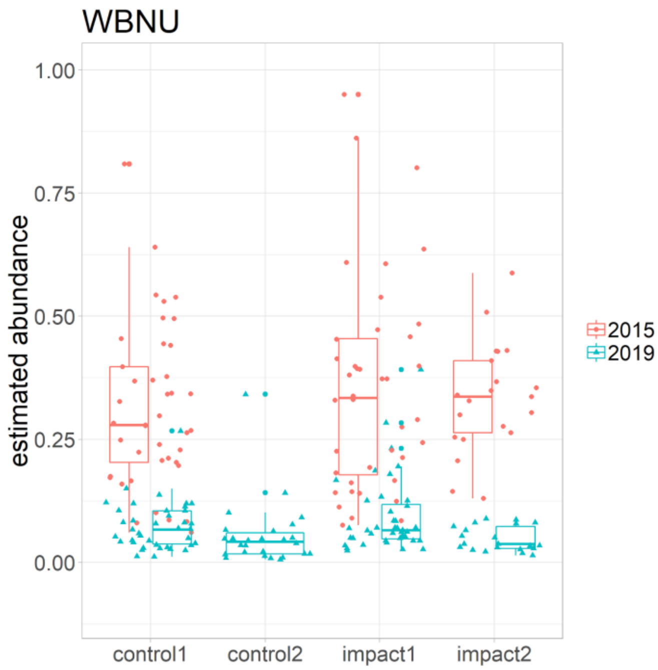

MOCH
estimated abundance
2.0
1.5
1.0
0.5
0.0
control1
control2
impact1
impact2
2015
2019

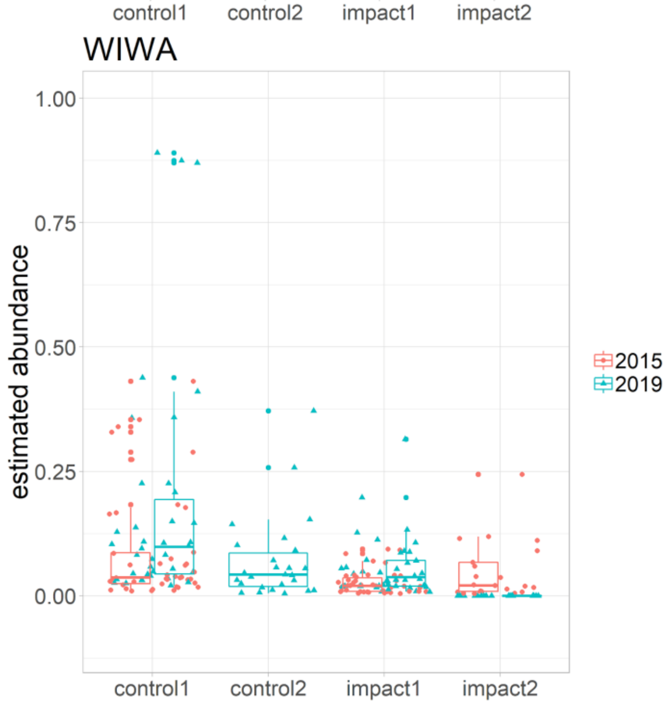

RBNU
estimated abundance
1.00
0.75
0.50
0.25
0.00
control1
control2
impact1
impact2
2015
2019


SOSP
estimated abundance
2.0
1.5
1.0
0.5
0.0
control1
control2
impact1
impact2
2015
2019


STJA
2.0
1.5
1.0
0.5
0.0
estimated abundance
control1
control2
impact1
impact2
2015
2019


TRES
2.0
1.5
1.0
0.5
0.0
estimated abundance
control1
control2
impact1
impact2
2015
2019


WBNU
estimated abundance
1.00
0.75
0.50
0.25
0.00
control1
control2
impact1
impact2
2015
2019


WIWA
estimated abundance
1.00
0.75
0.50
0.25
0.00
control1
control2
impact1
impact2
2015
2019

Appendix 2. Excerpts from Plumas National Forest site preparation project request for quotation (RFQ) documents detailing work requirements and criteria for processing vegetation and woody materials.

Excerpts from Plumas NF, Mt. Hough RD 2018 Moonlight Mechanical Site Preparation Project RFQ: 129JGP18Q0043, and 2019 Moonlight Mechanical Site Preparation Project RFQ: 129JGP19Q0018:

2. GENERAL DESCRIPTION

Description of Work: The intent of this contract is to secure services for mechanical site preparation for tree planting within the Moonlight Fire Area, which burned in September 2007. Contract objectives are to reduce fuel loads and competing vegetation to crop trees while increasing safety within treatment areas. Mechanical site preparation requires clearing of standing and down woody debris, pulling of live brush competition, piling and covering of materials for burning. Clearing and piling is to be accomplished while maintaining some ground cover, residual snag, large down woody material, live shrub component, and stream buffers to meet wildlife and hydrologic requirements.

…

12. SPECIFIC WORK REQUIREMENTS

Mechanical site preparation shall occur on slopes less than 40%, except short pitches (less than
100’ slope distance) that may be treated up to 45% slope. All tasks and standards apply to mechanical treatment. Any portions of units not mechanically treated due to slope shall be left
untreated and that quantity shall not be included in treatment acreage (See Table 1 and attached slope maps).

12.1 Primary Tasks

1. Uproot and pile competing vegetation. Retain average 20% shrub component.
2. Fell or push over damaged trees and snags up to 15 inches DBH.
3. Pile felled trees and down woody material.
4. Retain 6 snags per acre, clumped where possible.

5. Retain 10-15 tons per acre for large down woody material requirements when available.
6. Retain >50 % effective ground cover. See Definitions. Distribute concentrations of down woody material to ≥50% effective ground cover and less than 6 inches depth.
7. Avoid damage to retention features, including leave trees and saplings, snags, large downed logs, and stream buffers.

12.2 Standards and Subtasks

(a) Uproot and pile competing vegetation:

1. Within mechanically treated areas, competing vegetation 2 inches and greater stem diameter at ground level shall be uprooted below the root crown whether it is alive or dead, then shaken to remove soil and piled.
2. Any competing vegetation that meets specifications for uprooting but is not able to be pulled, shall alternatively be crushed by walking over the vegetation with the mechanical equipment.
3. Retain 20% live shrub component over each treatment unit. This may include vegetation within stream buffers and portions of treatment units not workable due to steep slopes.

(b) Fell or push over damaged trees and snags up to 15 inches DBH: Dead and damaged trees shall be cut or pushed over and prepared for piling to the following standards:

1. Damaged trees up to 15 inches DBH shall be cut or pushed over, except selected leave trees based on species and amount of fire damage. Any size live conifers with >10% green crown remaining shall be retained as Leave Trees. Selected leave trees shall not be damaged by the Contractor's operations. All work units contain varying amounts of conifers planted in 2009 and 2010. Care shall be exercised in avoiding damage to planted trees, which may include NOT pulling brush emerging within three feet of smaller leave trees so as not to damage the root system of the leave tree.
2. Bucking is only required to the extent needed for efficient piling of cut material. Trees and snags left on ground to meet woody debris retention and 50% effective ground cover guidelines should not be bucked.

3. All snags up to 15 inches DBH shall be cut or pushed over except those needed for minimum snag retention. Retain 6 snags per acre and clump where possible. The tallest and largest diameter snags are preferred for retention. Minimum snag DBH is 12 inches if needed to meet retention guidelines. Minimum snag height is 10 feet. Ponderosa pine snags are the preferred species to retain. In areas where it is unfeasible for safety concerns to leave 6 snags per acre, reducing snag retention to 4 snags per acre is acceptable as the minimum. In the few pockets where larger snags are more densely clumped in approximately ¼ acre clumps, retain these as untreated leave islands.
4. Leave all trees or snags within equipment exclusion zones adjacent to stream channels. Equipment may not “walk” within 100 feet of perennial or intermittent streams and within 25 feet of ephemeral streams or riparian areas. Equipment crossing ephemeral or intermittent streams may be allowed only in areas designated by Mt. Hough Ranger District soil scientist. Scientist shall be given 24 hours to respond. Access to unit 242 will require the Contractor to construct a “pole ford” type crossing of the stream on eastern edge of work unit. The crossing materials must be removed from the creek channel upon completion and acceptance of the work unit. (See Figure 1)
5. Trees and snags to be cut may be pushed over for reasons of safety, or when disturbance to soil from such action will be minimal.

(c) Pile felled trees and down woody material: Piles shall be neat, compact and sufficiently free of dirt to allow at least 85% consumption of the piled debris when burned. Pile slash, competing vegetation, felled trees, and down woody material to the following standards:

1. Piles shall not exceed 30 feet diameter.
2. Piles shall be located to minimize damage to residual trees (at least 25 feet from the dripline) and other retained features (saplings, snags, live brush, large down woody material) when piles are burned. No piles shall be located within 25 feet of ephemeral stream channels, nor within 100 feet of perennial or intermittent streams.
3. Piling shall be accomplished with minimal disturbance to top soil and effective ground cover (See Definitions). Retain 50% effective ground cover. Minimize turning of tracked equipment within 150 feet of intermittent or ephemeral streams and riparian areas, and within 300 feet of perennial streams.

4. Cover all piles with 70-weight or greater heavy duty paper. Paper shall be located and be of size sufficient to cover finer materials within the pile in order to promote ignition and at least 85% consumption of the pile when lit. The finer materials should be located in the middle to lower portions of the burn pile for maximum efficiency.
5. Fire line to mineral soil shall be constructed around each pile and shall be a minimum 24 inches width.

(d) Retention of large downed woody material: To meet Plumas National Forest standards and guidelines, where available, 10-15 tons per acre of large down woody material shall not be disturbed or piled. The Contractor shall leave all large woody material greater than 18 inches diameter to enhance soil productivity and wildlife habitat and to insure effective erosion control. Logs retained for this requirement generally shall be the largest diameter available in any length.

(e) Distribution of slash and down woody material:
The contractor shall create piles and/or disburse woody material to achieve ground cover at 50 to 60% of treatment area and less than 6 inches depth.

1. All woody material exceeding 3 inches in diameter at the large end and 6 feet in length shall be piled, except for material left to meet retention guidelines.
2. Where there are concentrations of woody debris greater than 6 inches deep by 20 feet diameter, pile or scatter the material to a depth of less than 6 inches.
3. Concentrations of material left shall be equally distributed throughout the unit and not exceed 60% of the unit's area. Down woody material is only one component of overall effective ground cover.
4. Wherever possible, use existing skid trails for movement of equipment and place piles on skid trails.