Public Lands Service Coalition

Before/After-Control/Impact (BACI) Ecosystem Management Evaluation

Final Report

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Sarah B. Ramirez, PhD
Postdoctoral Research Associate

Allie McCreary, PhD
Assistant Professor, College of Forestry, Wildlife and Environment

AUBURN
College of Forestry, Wildlife and Environment

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Acknowledgements

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Cover photo provided by the Texas Conservation Corps during field data collection.

Executive Summary

Millions of acres of public lands across the United States are imperiled by invasive species and wildfires, which reduce ecosystem health, decrease the productivity of public lands for wildlife, diminish recreation assets, and threaten the safety of communities. There is a need to manage public lands to sustain ecosystem services and enhance human safety. Agencies responsible for managing these lands, including the Forest Service, National Park Service, Bureau of Land Management, state parks, and others, often complete such mission-critical work through collaboration with AmeriCorps-funded partners whose members assist agencies in mitigating the spread of invasive weeds and reducing wildfire fuel loads that threaten communities and ecosystem services. For this evaluation, a cohort of environmental stewardship AmeriCorps programs (i.e., the Public Lands Service Coalition or PLSC) conducted a multi-state evaluation to assess the impact AmeriCorps members have on reducing invasive species and minimizing wildfire fuel loads on public lands.

For this evaluation, a Before-After-Control-Impact (BACI) quasi-experimental design was utilized to strengthen evidence of AmeriCorps members' environmental stewardship. The evaluation measured outcomes on project sites treated by AmeriCorps members and assessed the same set of ecosystem indicators on comparison sites. Assessment of treatment, or impact, plots and control plots was performed before and after treatment was conducted in impact areas. This evaluation focused on understanding the ability of AmeriCorps members to reduce invasive species populations and reduce wildfire risk on public lands.

Photo 1: *A plot created by the Student Conservation Association to perform invasive species management.*

To conduct this evaluation, each participating PLSC program (n = 12, see Table 1 for full list) identified at least one project during the 2022/23 season to evaluate, either an invasive

species or fuel load management project on public lands. For the identified project, treatment areas (where Corps members would be performing work) and comparable control areas were established. Within both treatment and control areas, Corps established 30x30 meter plots and, within each plot, four (4) thirty-meter transects. Corps members then collected data along those transects. For invasive species projects vegetation cover metrics were recorded. For fuel projects, a number of metrics were collected including litter depth, canopy cover, height of the lowest live branch, and circumference at breast height. Data were collected in both control and treatment areas prior to work starting in the treatment areas, again about three months after work was completed in the treatment area, and finally, one year after work had been completed in treatment areas. This yielded a 'before', 'near-term after', and 'moderate-term after' data set for both the 'treatment' and 'control' areas.

Data were analyzed descriptively and then using inferential statistics to explore significant differences between plots before and after treatment and between control and treatment areas. Analysis was completed at the plot level, wherein an average for each outcome of interest was computed. Then, t-tests and a regression model that accounted for initial differences between control and treatment areas were employed to detect statistically significant changes in the outcome variables.

This report highlights the overall outcomes of ecosystem management projects implemented by twelve Conservation Corps programs between 2021-2023.

Activities implemented by AmeriCorps members are having positive outcomes on the landscape by:

A) reducing the prevalence of target invasive species for up to a year following treatment,

B) increasing prevalence of beneficial species across the landscape, and

C) reducing the fuel load for up to a year following treatment.

Overall, management activities performed for both fuel reduction management and invasive species management by Corps members achieved the goals of the respective projects and had positive impacts on the environment. However, with invasive species projects other (non-target) invasive species did increase on impact plots around a year after initial treatment, and, with fuel

reduction projects, some stand density metrics were not reduced with treatment on fuels reduction impact plots. Further longitudinal evaluation of collaborative ecosystem management, namely invasive species and fuel laid management, on public lands is needed. Specifically, this study calls for further assessment regarding how to control non-target invasive species when targeted species are reduced and how to align stand density metrics with intended wildfire reduction outcomes. This study demonstrates that in near- and moderate-term evaluations, AmeriCorps members are making a positive impact on ecosystem management within public land jurisdictions across twelve unique sites. While near- and moderate-term outcomes differ somewhat, the study here supports the continued (and possibly increased) collaboration between conservation corps programs and public land management agencies to create resilient landscapes and provide high-value ecosystem services.

Background

Existing studies have demonstrated that invasive species reduce biological diversity and have negative impacts on human well-being (Rai & Singh, 2020; Pysek & Richardson, 2010) and wildfire fuels reduction can positively benefit wildlife (Fontaine & Kennedy, 2012; Pilliod et al., 2008) as well as enhance the safety of built environments in the wildland-urban interface (Stevens et al., 2014). Public land management agencies consider ecosystem management, including the control of invasive species and fuel loads, mission-critical work, and central to their agency's purpose. Often, public land management personnel partner with external entities, such as AmeriCorps conservation corps programs to complete such mission-critical tasks (McCreary et al., 2012). Understanding how AmeriCorps partnerships contribute to ecosystem management objectives through collaborative partnerships with public land management agency sponsors, will establish the role of AmeriCorps members in contributing to positive environmental outcomes on public lands (e.g., Conner, 2016, Davis, 2015).

Evaluation Procedures

To understand the positive environmental impact of AmeriCorps programs that partner with public land management agencies, a systematic evaluation was designed to assess two key areas of this work: invasive species management and fuel load (or stand density) reduction. Twelve conservation corps programs, each partnered with a national forest, national park, state park, or other public land management agency (see Table 1), identified a project related to one of these two ecosystem management outcomes. These twelve programs are referred to as the Public Lands Service Coalition (PLSC) and all had a vested interest in evaluating the outcomes of their program in terms of ecosystem improvements. An external evaluation team designed an evaluation protocol based on a before-after/control-impact (BACI) design and collaborated with each conservation corps program to collect project data on twelve unique project sites. The data were collected by AmeriCorps programs and analyzed by the evaluation team to understand the outcomes of ecosystem management activities performed by AmeriCorps members.

The long-term outcomes of these types of habitat management projects include enhancing biodiversity including native flora and fauna. Evaluating long-term outcomes would require an evaluation approach spanning several years as these outcomes are not evident until many years after treatment. Instead, this evaluation focused on assessing the short- and moderate-term

outcomes of habitat management by PLSC AmeriCorps members. The primary research questions of this evaluation were:

Invasive Species Management Projects

- Do areas of land treated for invasive species removal by AmeriCorps members demonstrate **less invasive species cover in *near-term*** evaluations compared to similar plots of untreated land?
- Do areas of land treated for invasive species removal by AmeriCorps members demonstrate **more native plant growth in *near-term*** evaluations compared to similar plots of untreated land?
- Do areas of land treated for invasive species removal by AmeriCorps members demonstrate **less invasive species cover in *moderate-term*** evaluations compared to similar plots of untreated land?
- Do areas of land treated for invasive species removal by AmeriCorps members demonstrate **more native plant growth in *moderate-term*** evaluations compared to similar plots of untreated land?

Fuels Reduction Projects

- Do areas of land treated for fuels removal by AmeriCorps members demonstrate **reduced fuel load indicators (e.g., litter depth and canopy closure) and indications of reduced stand density (e.g., height to the lowest living branch, tree circumference) in *near-term* evaluations** compared to similar plots of untreated land?
- Do areas of land treated for fuels removal by AmeriCorps members demonstrate **reduced fuel load indicators (e.g., litter depth and canopy closure) and indications of reduced stand density (e.g., height to the lowest living branch, tree circumference) in *moderate-term* evaluations** compared to similar plots of untreated land?

Sampling Approach

For this evaluation, PLSC programs collected field data to assess the impact their AmeriCorps members have in either reducing invasive species populations (8 projects) or reducing fuel load on public lands (4 projects) in 9 different states throughout the United States (Table 1; Figure 1). All fuels reduction projects were conducted in forested habitats, while three invasive species removal projects were in forested habitats and the remaining five were in fields

or grasslands. Invasive species projects used a combination of herbicide spot treatments and mechanical management tactics to reduce the presence of a total of nine different target species (Figure 2). The most common management technique applied by AmeriCorps members across the unique project sites was cutting the target species and then applying herbicide to the cut stem. AmeriCorps members conducting fuels reduction projects most often used chainsaws to thin the stand (2 projects) and/or thinned and piled timber for future burning (2 projects).

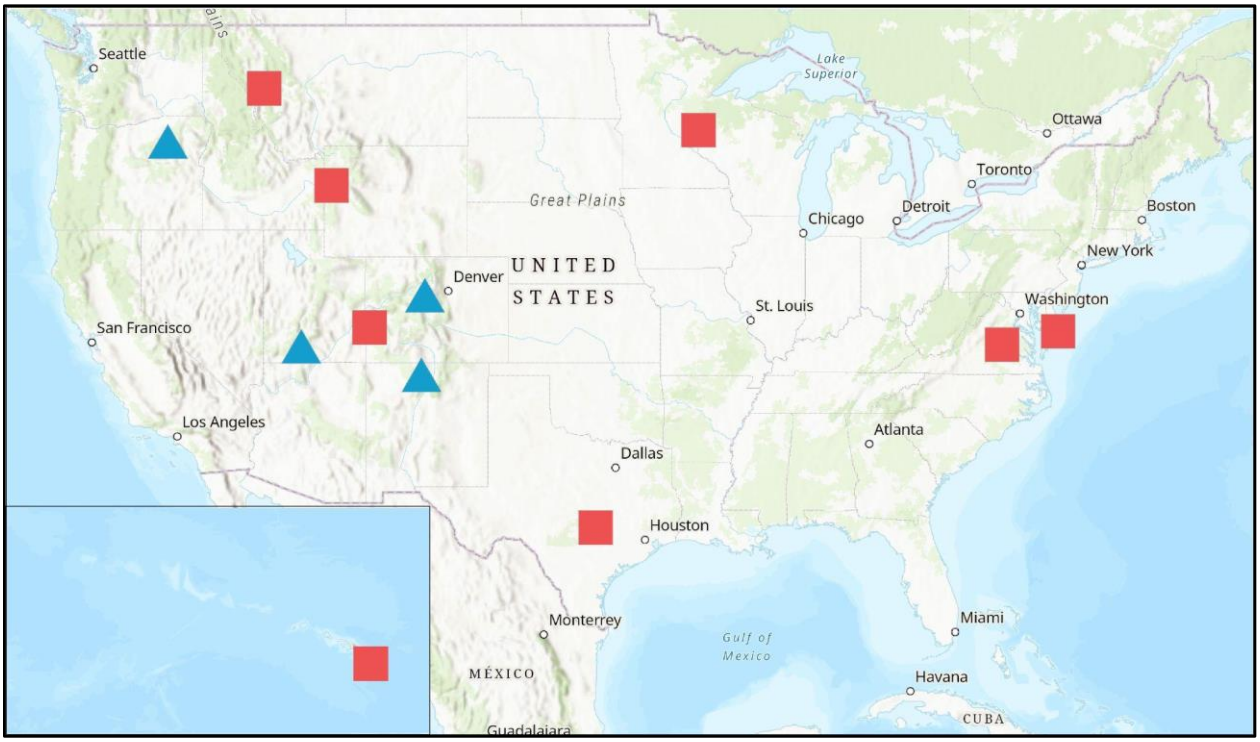

Figure 1. General locations of fuels reduction projects (n=4, blue triangles) and invasive species projects (n=8, red squares). Inserted image shows location of one invasive species project in Hawaii.

Figure 2. Targeted species of invasive species projects. top: wavyleaf grass, spotted knapweed, Chinese photinia; middle: tamarisk, privet, hawkweed; bottom: small carpetgrass, nandina, vetch.

Table 1. Descriptions of invasive species and fuel reduction projects.

Project Type	Program Name	State	Agency Partner*	Habitat	Target Species	Herbicide	Mechanical Management	Start Date	Near-term Date	Moderate-term Date
Invasive Species	American Conservation Experience	WY	NPS	non-forested	spotted knapweed	Milestone	herbicide spot treatment	7/5/2022	9/10/2022	7/9/2023
	Montana Conservation Corps	MT	USFS	non-forested	spotted knapweed	Milestone	cut and sprayed with herbicide	7/5/2022	10/5/2022	10/19/2023
	KUPU Corps	HI	NWR	forested	Chinese photinia	Polaris AC	cut and sprayed with herbicide	8/1/2022	10/31/2022	11/29/2023
	Conservation Legacy	CO	BLM	non-forested	tamarisk	Garlon 3a	cut and sprayed with herbicide	10/10/2022	8/5/2023	10/25/2023
	American YouthWorks (TX & LA)	TX	EF	forested	privet and nandina	Garlon 3a	removed by hand or cut/spray stumps	4/19/2022	12/15/2022	12/5/2023
	Conservation Corps (MN & IA)	MN	SP	non-forested	hawkweed & vetch	Transline	herbicide spot treatment	6/16/2022	10/20/2022	6/27/2023
	Student Conservation Association	MD	NPS	non-forested	small carpetgrass	herbicide	none	8/11/2022	11/7/2022	10/10/2023
	Virginia Service & Conservation Corps	VA	SP	forested	wavyleaf grass	Ranger Pro	hand pulling	5/25/2022	9/14/2022	---
Fuels Reduction	Mt. Adams Legacy	OR	USFS	forested	N/A	N/A	thinning/piling small trees	8/5/2022	2/1/2023	8/24/2023
	Colorado Youth Corps Association	CO	USFS	forested	N/A	N/A	cut/piled timber to burn	9/1/2022	---	7/26/2023
	Utah Conservation Corps	UT	NPS	forested	N/A	N/A	thinning with chainsaws	7/14/2022	11/22/2022	11/10/2023
	Rocky Mountain Youth Corps	NM	O	forested	N/A	N/A	thinning with chainsaws	10/31/2023	12/1/2023	---

*Agency partner codes: BLM=Burueau of Land Management; EF=Exprimental Foresty (University-Managed); NPS=National Park Service; NWR=National Wildlife Refuge; O=Other; SP=State Park; USFS=USDA Forest Service.

Photo 2: *Target species for the Texas & Louisiana Conservation Corps project: Nandina domestica*

Control and Treatment Areas

Together, each conservation corps program, their agency sponsor, and the evaluation team identified project areas including "treatment" areas where AmeriCorps members would be completing invasive species or fuel reduction management tasks and comparable "control" areas where no work would be completed in the 2022/23 season. Control areas were selected based on similarity to treatment areas in terms of slope, aspect, and vegetation composition and density. Within each control and treatment area, AmeriCorps members established two 30x30 meter plots. Then, within each of those plots, four (4) thirty-meter transects per plot were established, each spaced 6 meters apart vertically, see sampling design illustrations in Figures 3, 4, and 5 below.

Using the quasi-experimental design (QED), Before-After-Control-Impact (BACI) approach, plot areas were not randomly assigned within each Corps' habitat management project. Conservation corps program staff coordinated with the evaluators and public land management agency sponsors to determine the location of both treatment and control plots. The locations of the plots were distributed throughout the project area to coincide with both areas where work

was and was not performed and to capture efforts in areas in which it was safe and efficient to collect data.

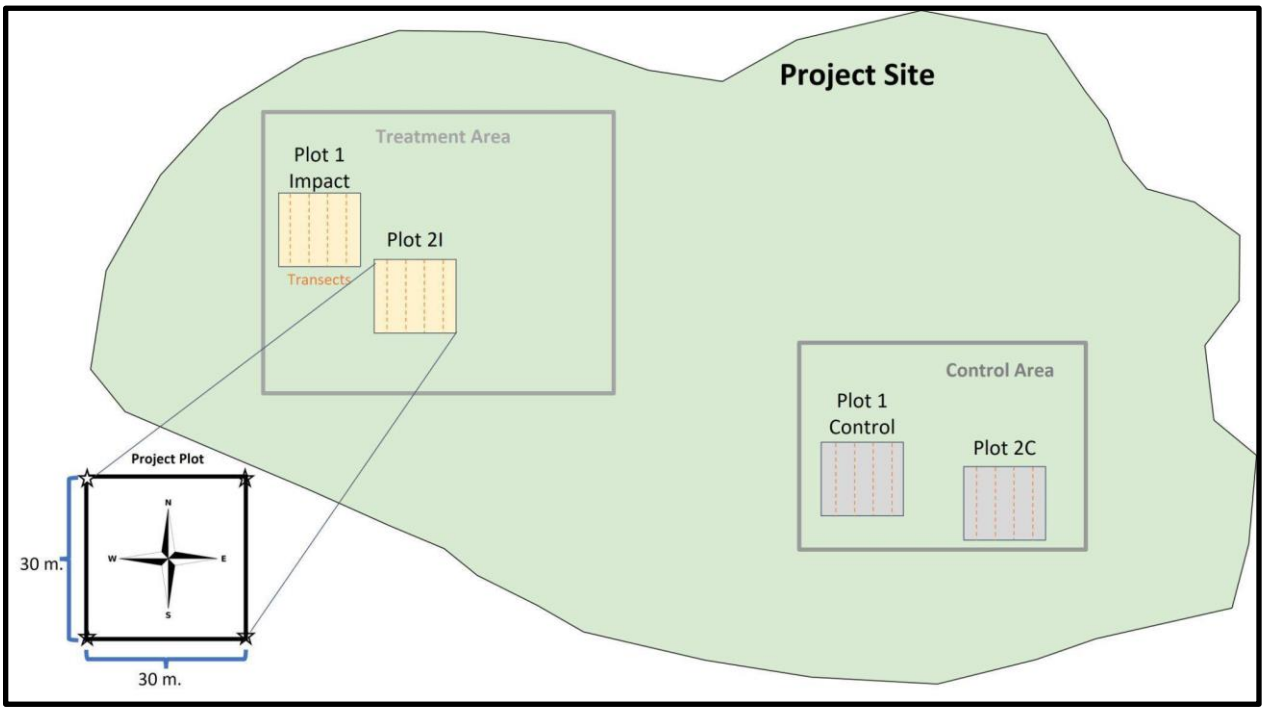

Figure 3. Illustration of sample site with treatment and control areas defined and paired plots with transects delineated.

A power analysis, using the package "Emon" and function power BACI (e.g., Barry et al., 2017) in Program R (hereafter, R), to determine the number of plots, transects, and data collection points was conducted following pilot testing of the sampling approach in summer and fall of 2021. Based on these findings, final sampling approaches were designed for both invasive species removal and fuel reduction projects, see Figures 4 and 5 below. An initial assessment for invasive species removal using the percent changes observed within plots evaluated by two pilot Corps in 2021 suggested that approximately 9-14 total transects would be required to detect large effect sizes (>0.8) with 80% power. We assumed fuel reduction projects would have similar requirements to detect large effect sizes. Therefore, the final evaluation protocol was designed so that data would be collected on 16 transects (8 control and 8 treatment) both before and after work was conducted in the project area.

Ecosystem Improvement Indicators

Assessment protocols for invasive species and fuel reduction management projects were designed by the external evaluation team who trained corps staff in the application of the appropriate protocol for their project. Professional conservation corps employees managed the data collection to ensure consistent application of sampling protocols and data collection procedures. The external evaluators monitored data collection to ensure rigor in data management and analysis.

For invasive species management plots, data was collected at every 1-meter interval, along each of the four transects within a plot (see Figure 4). At each of these points, crew members indicated whether the prevailing land cover consisted primarily of either:

- The target invasive species cover
- Another invasive species cover (i.e., another weedy species)
- Beneficial (i.e., native) vegetation cover
- Bare ground cover

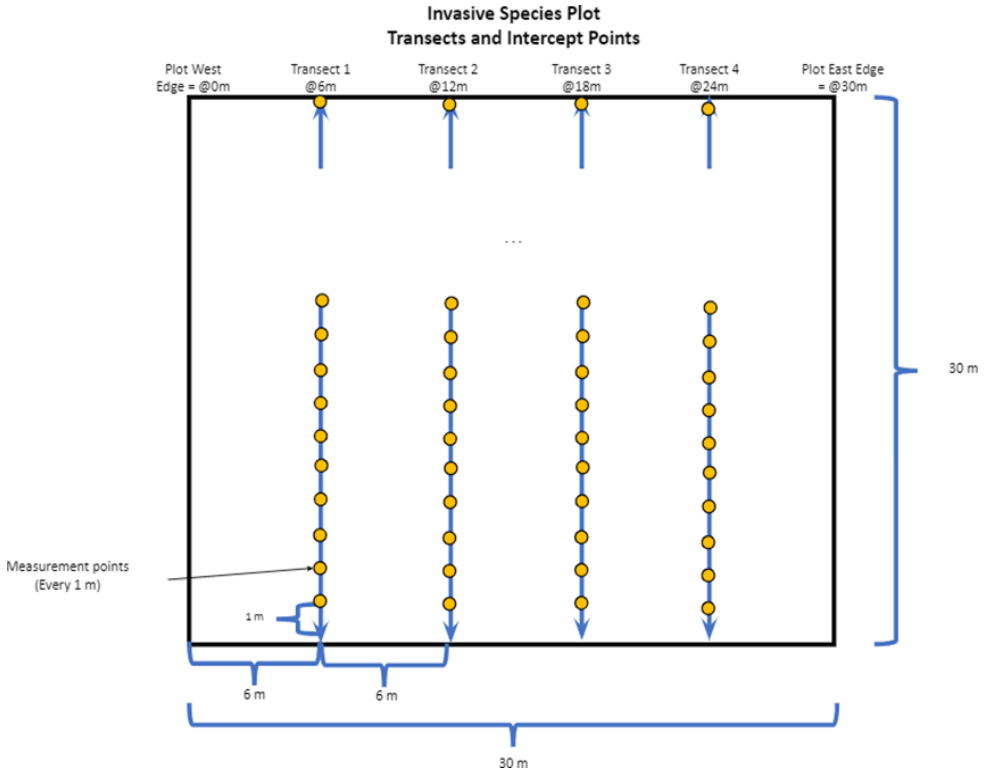

Figure 4. An illustration of invasive species project sampling protocols.

For fuels reduction management plots, data was collected within a 1x3-meter micro-plot at every 3-meter interval, along each of the four transects within the plot (see Figure 5). Within the micro-plot at each of these points, crew members provided measurements of the following vegetation cover metrics:

- Leaf litter depth (inches; at point of transect)
- Canopy coverage (%; average for micro-plot)
- Height to the lowest live branch (LLB; feet; average for micro-plot)
- Circumference of tree at breast height (CBH; inches; average for micro-plot)

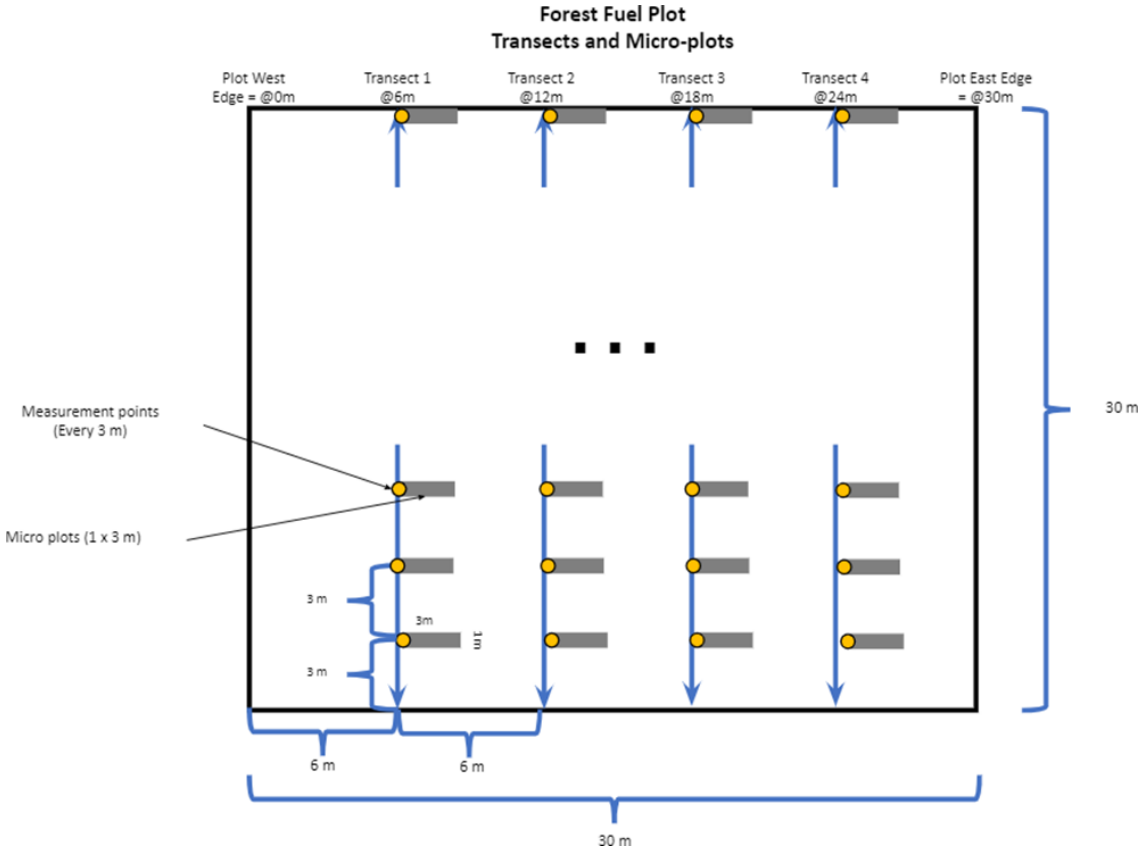

Figure 5. An illustration of fuels reduction project sampling protocols.

Corps members collected data at these designated points along each transect in plots in both the treatment and matched control area using a 'paired design' (Tubbesing et al., 2019).

Most projects recorded their "before" measurements between April and October 2022. Near-term data was collected after an average of about 4.4 months from the initial (e.g., before) data collection. Moderate-term data was collected after an average of about 14.3 months after the initial (e.g., before) data collection (Table 1). Some Corps were unable to collect either near-term after or moderate-term after data due to weather conditions (e.g., deep snow) or other constraints. Adaptations were made to the evaluation design based on instances where field data collection was inhibited.

Analysis

Field data were submitted by the conservation corps programs to the evaluation team using a web-based data collection interface (Kobo Toolbox) with offline capabilities to facilitate field-based data collection. Data were downloaded from the Kobo Toolbox online server to a local PC and stored in an Excel spreadsheet by the evaluation team. Members of the evaluation team organized each data set checking for completeness and the identification of plots following the paired sampling design strategy. Data was then uploaded into R statistical computing software (R Core Team 2023) to run descriptive statistics and inferential statistical tests.

Descriptive Statistics

For each project, using R, the evaluation team calculated the mean value for each variable of interest. For fuel reduction projects, the mean canopy coverage, leaf litter depth, height to the lowest living branch, and tree circumference were calculated per micro-plot for both control and impact plots at each time point of measurement: before treatment, near-term after treatment, and moderate-term after treatment. For invasive species projects, the proportion of each land cover class (beneficial species, target species, other weeds, and bare ground) was calculated for each plot by dividing the total number of observation points dominated by each land cover class by the number of observation points sampled (i.e., 120 land cover class observation points per plot). Then, the mean proportion of each land cover class for control and impact plots at each time point of measurement was calculated. We created bar charts to visualize the average values for each variable calculated for each project.

Next, also using R, the evaluation team calculated the changes in mean fuel load and stand density measurements or land cover type classes for each of the three time periods between

field measurements (before to near-term after treatment, before to moderate-term after treatment, and between near-term and moderate-term after treatment) by subtracting the mean value of the earlier measurement from the mean value of the later measurement. For example, an invasive species plot that consisted of 50% target species in July 2022 and later 20% target species in July 2023 would show a change of (negative) -0.30, or a 30% decrease in target species present on that plot 12 months after the treatment was conducted. Bar charts were created to visualize these changes between control and impact plots and over time.

Missing data. Some projects were unable to collect complete datasets for each plot or each sampling period due to extenuating circumstances (e.g., weather conditions such as unexpected snowfall). For plots that were missing data for at least one impact or control plot, the averages were calculated using the data that was available. For example, for a fuel reduction project, if data was only collected on one control plot during the near-term sampling period, the average near-term canopy cover was calculated using a single set of data rather than an average across two sets of data (i.e., an average of one instead of two control plots). If an entire sampling period was missing from the data set (i.e., moderate-term after data was not collected), we only reported the changes in the variables of interest for the sampling periods where data was available (i.e., before to moderate-term after comparisons were made only).

Inferential Statistics

T-tests are often used to test for significant differences between the means of two groups. For BACI studies in particular, t-tests can be used to look for significant differences in changes of measurements between the control and impact plots over time. Therefore, separate t-tests were utilized to examine if there were significant differences in the variables of interest for invasive species projects (i.e., changes of the proportions of prevailing land cover: beneficial species, target species, other weed species, and bare ground) and fuels reduction projects (i.e., CBH, LLB, canopy cover, and leaf litter depth) over the three study time periods: before to near-term after treatment, before to moderate-term after treatment, and between near-term and moderate-term after treatment. A series of four t-tests per sampling period were conducted, for a total of 12 t-tests for each unique study site (n=12). Additionally, linear regression models were employed to further investigate the statistical significance of the variables of interest for each project and to provide an estimate of the effect of the management strategy on the change in each measurement. For projects with missing data (as described above), we omitted t-tests and linear regression tests

for periods where only one control or impact plot was measured, or measurements were not recorded for an entire sampling period. The results from the t-tests and linear regression models were used to accept or reject the following hypotheses:

Invasive Species Management Projects

- Treatment did not affect target invasive species cover.
- Treatment did not affect native/beneficial non-invasive cover.

Fuel Reduction Projects

- Treatment did not affect fuel load measurements.
- Treatment did not affect stand density measurements.

Photo 3: *Management activities performed by Colorado Youth Corps included thinning the stand and piling the timber for later burning.*

Results

For this evaluation, we have summarized the results from the eight invasive species projects and four fuel reduction projects to determine the impacts of AmeriCorps members' management actions on their respective project goals. To determine the quantitative impact or outcomes of these projects, data were inspected for descriptive qualities and then inferential analyses were conducted to look for statistically significant changes in areas where Corps' members completed invasive species management or fuel reduction management tasks.

Descriptive statistics

We summarized fuel reduction and invasive species management project outcomes as changes in the variables of interest over two sampling periods: before to near-term after treatment (i.e., near-term outcomes), and before to moderate-term after treatment (i.e., moderate-term outcomes). We have described these patterns as increases (+), decreases (-), or no change (o) in either fuel load indicators (i.e., canopy cover and leaf litter depth), stand density measurements (i.e., the height of the lowest live branch and tree circumference at breast height) or the average proportion of different land cover types (target species, native species, other weedy species, and bare ground). Projects missing near-term data were omitted from near-term descriptive results, while projects missing moderate-term data were omitted from moderate-term descriptive results.

Invasive Species Management

Near-term Invasive Species Outcomes

Overall, the trends of near-term changes of target species, native species, other weedy species, and bare ground varied among the seven invasive species management projects on control plots (one project did not measure near-term control plots; Table 2). Four projects indicated an increase in both the proportions of the targeted invasive species and other weedy species, as well as decreases in native species on the plots. Two projects experienced decreases in both the targeted invasive species and native species, but the proportion of other weedy species in the plots increased. The only project with control plots that had an increase in native species was also associated with a decrease in other weedy species and no change in the amount of the targeted invasive species in control plots.

Seven of the eight invasive species projects resulted in near-term decreases in the associated targeted invasive species, and native species also increased for 4 of these projects (Table 2). For the remaining 3 projects where native species did not increase, there was either an increase in bare ground (2 projects) or an increase in other weedy species (1 project). The one project where the target species increased was also associated with a decrease in native species and increases in both other weedy species and bare ground.

Table 2. Before to near-term after changes in land cover prevalence on invasive species management projects.

Program Name	Months	T	N	W	G
American Conservation Experience	2.2	+/-	-/+	+/o	-/-
Montana Conservation Corps	3.1	+/-	-/+	+/+	-/-
KUPU Corps	3.0	o/-	+/-	-/-	+/+
Conservation Legacy	10.0	-/-	-/-	+/+	-/+
American YouthWorks (TX & LA)	8.0	+/-	-/+	x/x	+/+
Conservation Corps (MN & IA)	4.2	-/-	-/-	+/+	x/x
Student Conservation Association	2.9	na/-	na/+	na/+	na/+
Virginia Service & Conservation Corps	3.7	+/+	-/-	+/+	+/+

Presented as Control/Impact. T = Target, N = Native, W = other weeds, G = bare ground.
Symbols represent decreases (-), increases (+), or no change (o) in the cover type. "x" indicates the cover type was not present in any plots; "na" indicates no near-term data reported for control plots.

Photo 5: *Study area used by American Conservation Experience for invasive species management.*

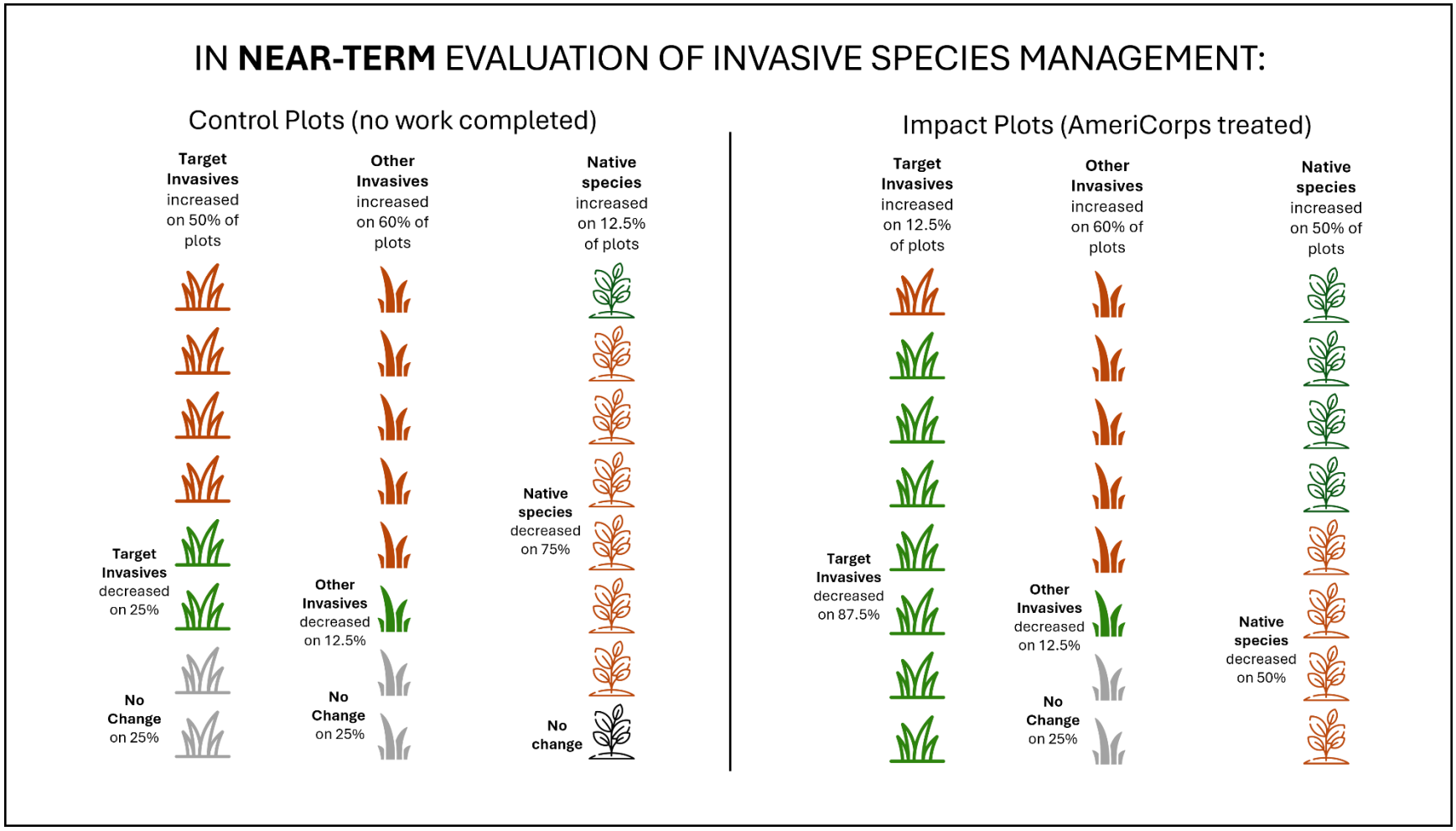

Figure 6. Infographic: Near-term outcomes of invasive species management.

Moderate-term Invasive Species Outcomes

Six of the seven invasive species projects included in the moderate-term results had increases in the targeted invasive species on control plots (Table 3). Of these 6 projects, native species on control plots decreased during three projects and increased during the other three projects. The remaining project showed decreases in both target species and native species, but an increase in other weedy species. The proportions of other weedy species and bare ground typically showed contrasting results for control plots, such as the three projects with increases in other weeds and decreases in bare ground or two projects with decreases in other weeds and increases in bare ground.

Similar to near-term patterns on impact plots, seven of the eight invasive species management projects had decreases in the targeted invasive species (Table 3). However, only three projects resulted in increases of native species on impact plots and none of the projects differed between control and impact plots in the moderate-term trends of native species. Other weedy species increased in all projects' impact plots but one (the exception was the only project with decreases in both targeted invasive and other weedy species).

Table 3. Before to moderate-term changes in land cover prevalence on invasive species management projects.

Program Name	Months	T	N	W	G
American Conservation Experience	12.3	+/-	-/o	+/+	-/+
Montana Conservation Corps	15.7	+/+	+/+	+/+	-/-
KUPU Corps	16.2	+/-	-/-	-/+	+/+
Conservation Legacy	12.7	-/-	-/-	+/+	-/-
American YouthWorks (TX & LA)	19.8	+/-	+/+	x/x	-/-
Conservation Corps (MN & IA)	12.5	+/-	-/-	-/+	x/x
Student Conservation Association	14.2	+/-	+/+	-/-	+/o

Presented as Control/Impact. T = Target, N = Native, W = other weeds, G = bare ground.

Symbols represent decreases (-), increases (+), or no change (o) in the cover type. "x" indicates the cover type was not present in any plots; "na" indicates no near-term data reported for control plots.

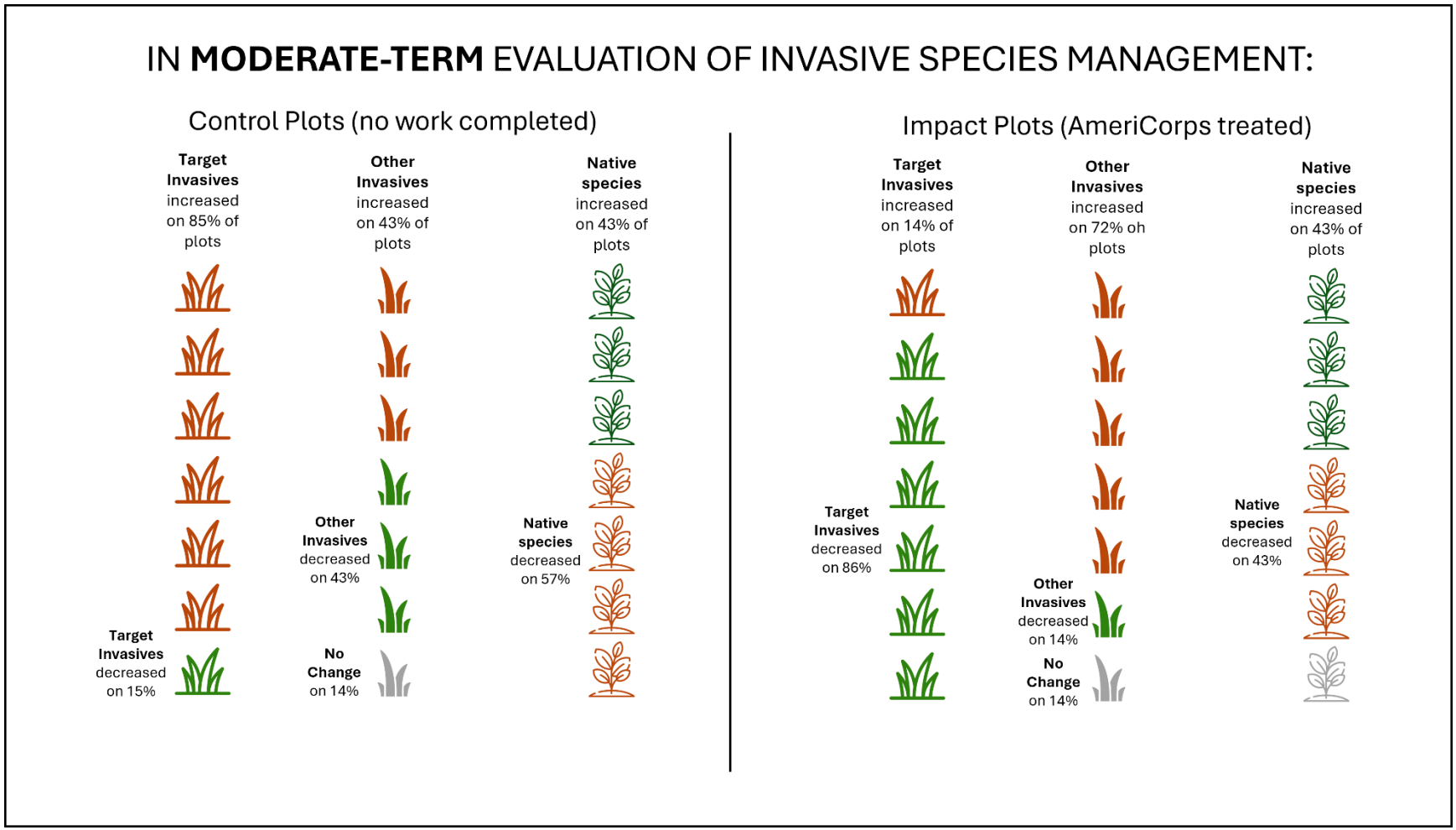

Figure 7. Infographic: Moderate-term outcomes of invasive species management.

Fuels Reduction Management

Near-term Fuels Reduction Outcomes

The two fuels reduction projects with calculated near-term changes on control plots had mixed results. On plots for one study, canopy cover, leaf litter, circumference at breast height, and lowest live branch all decreased while for the second site, leaf litter was the only measurement that decreased (Table 4). Impact plots for these two studies showed the same near-term patterns as control plots. For the third study which provided only impact plot measurements, there were increases in both canopy cover and circumference at breast height, while there was no change in leaf litter or the lowest live branch.

Table 4. Changes in average fuel load indicators (C = canopy cover, LL = leaf litter depth) and stand density measures (LLB = lowest live branch, CBH = circumference at breast height) for plots of fuel reduction projects.

Time Period	Program Name	Months	C	LL	CBH	LLB
Before to Near-term After	Mt. Adams Legacy	6.0	-/-	-/-	-/-	-/-
	Utah Conservation Corps	4.4	+/+	-/-	+/+	+/+
	Rocky Mountain Youth Corps	1.0	na/+	na/o	na/+	na/o
Before to Moderate-term After	Mt. Adams Legacy	12.8	-/-	-/-	-/-	-/-
	Colorado Youth Corps Association	10.9	+/-	+/-	+/+	+/+
	Utah Conservation Corps	16.1	+/+	-/-	+/-	-/-

Presented as Control/Impact. Symbols represent decreases (-), increases (+), or no change (o); "na" indicates no near-term data reported for control plots.

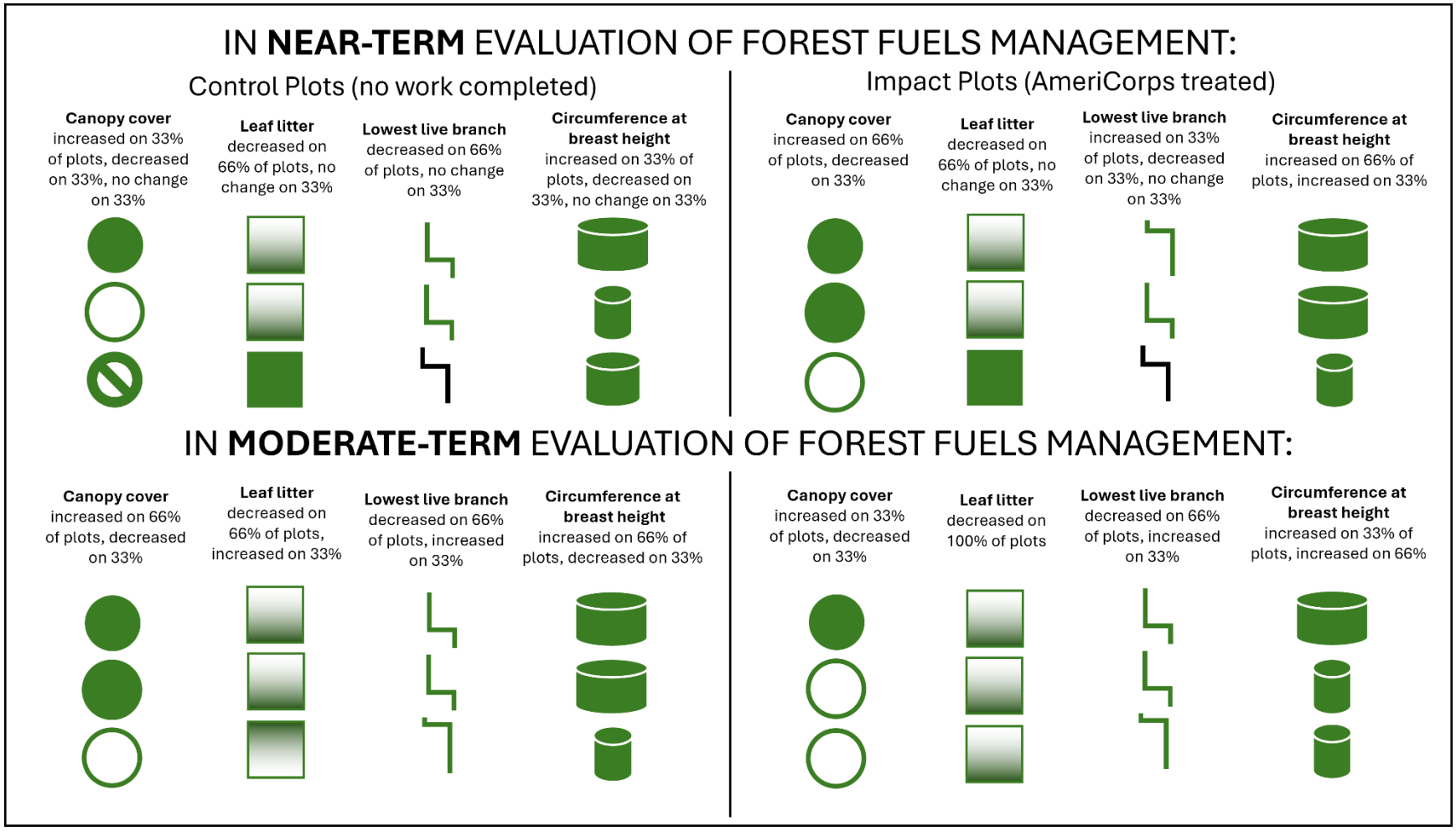

Figure 8. Infographic: Outcomes of forest fuels management.

Moderate-term Fuels Reduction Outcomes

On control plots of fuels reduction projects, moderate-term patterns varied between the three studies (Table 4). These studies showed either decreases in all four measurements, increases in all four measurements, or increases in both canopy cover and circumference at breast height but decreases in leaf litter and the lowest live branch. On impact plots, all studies showed positive indications of fuel load reductions in at least one measurement. Notably, one project also had increases in both circumference at breast height and height of the lowest live branch, which would also suggest reduced stand density.

Inferential statistics

Inferential statistics were computed to understand the change over time between control and impact areas. Controlling for differences that existed in pre-treatment stand characteristics of control and treatment plots, a t-test and a regression model were used to test for statistically significant differences in change over time for control and treatment areas. We reported a result as significant if either test indicated statistical significance. Projects with missing data were omitted from inferential results and tables.

Photo 6: *Control plot used by Utah Conservation Corps in a fuels reduction management project.*

Invasive Species Management

Due to extenuating circumstances (e.g., weather), some conservation corps programs were unable to collect data at all of the recommended sampling periods, or on all plots. Therefore, the statistical analyses were only conducted using the data associated with five invasive species management projects with complete datasets. See Table 5 below for both near-term and moderate-term changes in cover types.

Table 5. Inferential results for invasive species management projects.

Time Period	Program Name	T	N	W	G
Before to Near-term After	American Conservation Experience	-	+	-	-
	Montana Conservation Corps	-	+	+	-
	KUPU Corps	o	-	+	+
	Conservation Legacy	+	-	-	+
	American YouthWorks (TX & LA)	-	+	o	+
Before to Moderate-term After	American Conservation Experience	-	+	+	+
	Montana Conservation Corps	-	+	+	-
	KUPU Corps	-	+	+	-
	Conservation Legacy	+	-	-	+
	American YouthWorks (TX & LA)	-	+	o	o

Changes in proportions of target species (T), native species (N), other weedy species (W), and bare ground (G) on impact plots were either greater than (+) or less than (-) measurements on control plots.

"o" denotes no change in the measurement on either impact or control plots.

Colored boxes indicate statistically significant differences ($P < 0.05$) between changes in control and impact plots.

Near-term Invasive Species Outcomes

We conducted statistical analyses using data from five invasive species projects with complete datasets to evaluate the near-term impacts of management activities in invasive species management (Table 5). Compared to control plots, there were greater average decreases in the targeted invasive species on impact plots in 60% of (i.e., three of five) projects, and this result was statistically significant for 40% of (i.e., two) projects. Additionally, the three projects with

decreases in target species on impact plots were also associated with greater increases in beneficial native species than control plots, with one project showing statistically significant increases in native plants. The patterns for other weedy species were not as clear. Other weedy species appeared to have taken the space of target species in one project and native species in a second project. For the two projects with greater decreases in "other" invasive species on impact plots compared to control plots, there were increases in native species for one and decreases in native species in the other.

Moderate-term Invasive Species Outcomes

Moderate-term outcomes for invasive species projects were similar to near-term outcomes. Four project sites had decreases in targeted invasive species (these changes were statistically significant for one project) along with increases in beneficial native species in all (four) of these projects. However, moderate-term analyses illustrate that increases in native species were almost always associated with increases in other invasive species, which was not the case in near-term analyses.

Based on this evaluation, we partially reject the null hypothesis that *treatment did not affect invasive species cover*. Though results do demonstrate changes in the prevalence of invasive species cover in treatment areas both over time and compared to control areas, this result was not statistically significant for all project sites. However, **in areas where AmeriCorps members are performing work, invasive species cover is reduced**. Additionally, we partially reject the second null hypothesis that *treatment did not affect native cover*. Long-term results show that in a majority of treated project areas, beneficial species populations increased in treatment areas compared to control areas, but this change was not statistically significant for any project sites.

Evaluation data suggest that in areas treated by AmeriCorps members, target invasive species cover decreased and remained suppressed up to a year after treatment.
Additionally, beneficial native species cover increased.
In comparison control areas, invasive species cover increased.

Fuels Reduction Management

Due to extenuating circumstances (e.g., weather), some conservation corps programs were unable to collect data at all of the recommended sampling periods, or on all plots. Therefore, the statistical analyses were only conducted using the data associated with two fuel reduction management projects with complete datasets. See Table 6 below for both near-term and moderate-term changes in indicators of fuel load.

Table 6. Inferential results from fuel reduction projects.

Time Period	Program Name	Months	C	LL	CBH	LLB
Before to Near-term After	Mt. Adams Legacy	6.0	-	-	-	-
	Utah Conservation Corps	4.4	+	+	-	-
Before to Moderate-term After	Mt. Adams Legacy	12.8	-	-	-	-
	Utah Conservation Corps	16.1	-	-	-	-

Measurements on impact plots were either greater than (+) or less than (-) measurements on control plots.

Colored boxes indicate statistically significant differences ($P < 0.05$) between changes in control and impact plots.

C = canopy cover, LL = leaf litter depth, LLB = lowest live branch, CBH = circumference at breast height

Photo 7: *Impact plot used by Colorado Youth Corps Association for fuel reduction management.*

Near-term Fuels Reduction Outcomes

Both of the fuel management sites included in the inferential statistical analyses had greater near-term decreases in both circumference at breast height and the height of the lowest live branch on impact plots compared to control plots, indicating lower stand density or fuel load (Table 6). However, there were mixed results about the impact of management on both canopy cover and leaf litter depth. One project had greater decreases in both fuel load measurements on impact plots compared to control plots, and the difference in canopy cover (impact v. control plot average) was statistically significant. The second project had greater increases in canopy cover and leaf litter on impact plots than control plots with the canopy cover difference statistically significantly different.

Moderate-term Fuels Reduction Outcomes

Management activity on all fuel reduction projects resulted in greater moderate-term decreases in canopy cover, leaf litter, circumference at breast height, and the height of the lowest live limb compared to control plots. This difference, in terms of canopy cover only, was statistically significant for one project.

Based on the results of this study, we partially reject the null hypothesis that *treatment did not affect fuel load measurements*. Though results do demonstrate changes in the fuel load indicators in treatment areas both over time and compared to control areas, this result was not statistically significant for all projects. However, **in areas where AmeriCorps members are performing work, canopy cover and leaf litter were reduced**. Additionally, we partially reject the second null hypothesis that *treatment did not affect stand density measurements*. Both short-term and moderate-term results show that in all treated project areas, both tree circumference and height to the lowest limb decreased, suggesting decreased stand density in treatment areas compared to control areas. However, these stand density changes were not statistically significant for any projects included in this evaluation.

Evaluation data illustrate that in areas treated by AmeriCorps members, fuel load decreased and remained suppressed up to a year after treatment.

In some comparison control areas, fuel load indicators increased.

Conclusions

The practical changes observed between control and impact areas before and after treatment, strengthened by the results that are 'statistically significant,' illustrate that AmeriCorps members are effectively contributing to ecosystem management on public lands with both invasive species management and fuel reduction outcomes.

Invasive species management. Evaluation results show that in both near-term and moderate-term evaluations, AmeriCorps members reduced targeted invasive species abundance and increased native beneficial species abundance through both chemical and mechanical management activities. Invasive species management activities resulted in:

- **Decreased targeted, invasive species cover**
- **Increased native species cover**

Though not statistically significant, treatment also appeared to influence increases in other weedy species.

Fuels reduction management. Additionally, through fuel reduction management activities, AmeriCorps members reduced stand density metrics, particularly regarding leaf litter and canopy cover, with lasting (i.e., one year) impacts. Using mechanical mechanisms to decrease stand density and wildfire risk, these conservation corps programs have utilized best practices to improve ecosystem structure and function. Fuels reduction management activities resulted in:

- **Decreased canopy cover**
- **Decreased leaf litter depth**
- **Decreased circumference at breast height**

Treatment also appeared to result in decreased height to the lowest limb on trees remaining in the plots.

Photo 4. Plot used by the MN & IA Conservation Corps during an invasive species project.

These results demonstrate the ecosystem outcomes that are a result of the energy and expertise provided by PLSC AmeriCorps members. Based on the results of this study, we find that in response to our research questions:

- *Do areas of land treated for invasive species removal by AmeriCorps members demonstrate less invasive species cover and more native species cover?*
  AmeriCorps members have made positive differences in land cover prevalence with decreases in invasive species prevalence and increases in beneficial species prevalence in the areas where AmeriCorps members perform ecosystem management tasks.
- *Do areas of land treated for fuel load reduction by AmeriCorps members demonstrate reduced fuel load indicators*?
  AmeriCorps members have made practical, positive differences in reducing fuel load indicators such as decreased canopy cover, leaf litter depth, and circumference at breast height.

Further work will be key in understanding the complex nature of collaborative ecosystem management, particularly regarding invasive species control and fuel load reduction projects managed by conservation corps programs on public lands. For example, a longitudinal evaluation of project sites, such as those included in this report, will provide insights into the long-term outcomes associated with this work. Differences were found between the short and moderate-term outcomes of this study and, likely, longer-term outcomes will also vary from what was found here. For invasive species projects, it will be imperative to understand how to curb the increase of other (non-target) invasive species when targeted species are successfully reduced from the landscape. For fuel reduction projects, further research is needed to understand the interplay between conflicting increases and decreases in stand density indicators and how each indicator relates to the actual reduction of wildfire risk.

While there were differences in control and treatment areas at the onset of this evaluation, a linear regression model that accounted for these differences still shows changes in vegetation cover and fuel load indicators over time. **This evaluation provides evidence to support the continued treatment of public lands by AmeriCorps members to produce beneficial ecosystem outcomes.** When comparing the short-term to moderate-term evaluation results for

invasive species management projects, we see for many projects that observations of target species decreased in the near-term and then rose slightly in the moderate-term, or other weedy species took the place of the targeted invasive species. This may indicate that repeated treatment might be needed to maintain the positive outcomes documented in this report. For fuels reductions projects, we found consistent results among all projects that suggest that stand density may increase shortly after treatment and treatment may need to be performed multiple times to keep stand density low.

There are limitations to this evaluation. For example, control and treatment areas were not randomly selected. Also, natural variation occurs in the areas where this evaluation was performed and may have influenced results to some degree. Additionally, management techniques were those commonly used in this area for this type of task, testing other types of management techniques to reduce invasive species cover or reduce stand density may yield different results. Continuing, longitudinal evaluation of ecosystem management outcomes will be needed to make long-term conclusions about the scope and impact of AmeriCorps members' contributions.

In conclusion, this evaluation did produce strong evidence that AmeriCorps members are effectively contributing to ecosystem management, namely reducing invasive species cover, increasing native species cover, and reducing wildfire risk through reducing fuel load. This evaluation data can illustrate key short and moderate-term outcomes of their efforts and guide future project identification and implementation. Additionally, techniques may be adopted to further influence outcomes of interest in this evaluation to further improve their impact with ecosystem management.

While there are practical differences in all measured variables – after treatment, and in comparison plots – we have identified significant, long-term reductions in target species cover in invasive projects and canopy cover in fuels reduction projects.

Conservation efforts by AmeriCorps members are making practical and significant impacts in the areas where they perform ecosystem management.

Appendices

Appendix 1 – Descriptive Results of Individual Projects

Invasive Species Management

American Conservation Experience

Table A1.1. Proportions of beneficial species, target species, other weeds, and bare ground on plots before and in short- and moderate-term after points after treatment.

Before/After	Control/ Impact	Bare Ground	Beneficial Species	Target Invasive	Other Weed
B: 07/2022	Control	1%	89%	10%	0
B: 07/2022	Impact	4%	93%	3%	0
A: 09/2022	Control	0	83%	15%	2%
A: 09/2022	Impact	0	100%	0	0
A: 07/2023	Control	0	86%	13%	1%
A: 07/2023	Impact	4%	93%	0	3%

Conservation Legacy

Table A1.2. Proportions of beneficial species, target species, other weeds, and bare ground on plots before and in short- and moderate-term after points after treatment.

Before/After	Control/ Impact	Bare Ground	Beneficial Species	Target Invasive	Other Weed
B: 10/2022	Control	28%	53%	18%	1%
B: 10/2022	Impact	40%	47%	12%	1%
A: 08/2023	Control	21%	46%	0	33%
A: 08/2023	Impact	58%	35%	0	7%
A: 10/2023	Control	17%	44%	0	39%
A: 10/2023	Impact	38%	40%	0	22%

Kupu Conservation Leadership Program

Table A1.3. Proportions of beneficial species, target species, other weeds, and bare ground on plots before and in short- and moderate-term after points after treatment.

Before/After	Control/ Impact	Bare Ground	Beneficial Species	Target Invasive	Other Weed
B: 08/2022	Control	27%	36%	0	37%
B: 08/2022	Impact	22%	67%	6%	5%
A: 10/2022	Control	28%	45%	0	27%
A: 10/2022	Impact	26%	64%	5%	5%
A: 11/2023	Control	31%	30%	2%	37%
A: 11/2023	Impact	24%	66%	1%	9%

Conservation Corps, Minnesota and Iowa

Table A1.4. Proportions of beneficial species, target species, other weeds, and bare ground on plots before and in short- and moderate-term after points after treatment.

Before/After	Control/ Impact	Bare Ground	Beneficial Species	Target Invasive	Other Weed
B: 06/2022	Control	0	49%	1%	50%
B: 06/2022	Impact	0	30%	3%	67%
A: 10/2022	Control	0	43%	0	57%
A: 10/2022	Impact	0	49%	0	51%
A: 06/2023	Control	0	33%	50%	17%
A: 06/2023	Impact	0	29%	0	71%

Montana Conservation Corps

Table A1.5. Proportions of beneficial species, target species, other weeds, and bare ground on plots before and in short- and moderate-term after points after treatment.

Before/After	Control/ Impact	Bare Ground	Beneficial Species	Target Invasive	Other Weed
B: 07/2022	Control	41%	3%	39%	17%
B: 07/2022	Impact	45%	1%	47%	7%
A: 10/2022	Control	35%	1%	39%	25%
A: 10/2022	Impact	28%	3%	35%	34%
A: 10/2023	Control	2%	5%	55%	38%
A: 10/2023	Impact	2%	7%	51%	40%

Student Conservation Association

Table A1.6. Proportions of beneficial species, target species, other weeds, and bare ground on plots before and in short- and moderate-term after points after treatment.

Before/After	Control/ Impact	Bare Ground	Beneficial Species	Target Invasive	Other Weed
B: 08/2022	Control	3%	52%	41%	4%
B: 08/2022	Impact	0	38%	60%	2%
A: 11/2022	Control	--	--	--	--
A: 11/2022	Impact	3%	87%	5%	5%
A: 10/2023	Control	4%	54%	42%	0
A: 10/2023	Impact	0	45%	55%	0

American YouthWorks- Texas and Louisiana Conservation Corps

Table A1.7. Proportions of beneficial species, target species, other weeds, and bare ground on plots before and in short- and moderate-term after points after treatment.

Before/After	Control/ Impact	Bare Ground	Beneficial Species	Target Invasive	Other Weed
B: 04/2022	Control	14%	23%	63%	0
B: 04/2022	Impact	34%	29%	37%	0
A: 12/2022	Control	2%	17%	81%	0
A: 12/2022	Impact	51%	41%	8%	0
A: 12/2023	Control	2%	23%	75%	0
A: 12/2023	Impact	22%	59%	19%	0

Virginia Service and Conservation Corps

Table A1.8. Proportions of beneficial species, target species, other weeds, and bare ground on plots before and in short- and moderate-term after points after treatment.

Before/After	Control/ Impact	Bare Ground	Beneficial Species	Target Invasive	Other Weed
B: 05/2022	Control	0	76%	23%	1%
B: 05/2022	Impact	15%	53%	4%	28%
A: 09/2022	Control	18%	11%	24%	47%
A: 09/2022	Impact	20%	17%	7%	56%

Fuels Reduction Management

Colorado Youth Corps

Table A1.9. Average litter depth (in.), canopy cover (%), lowest live branch (ft), and tree circumference (in.) on plots before and after treatment.

Before/After	Control/ Impact	Mean Litter	Mean Canopy	Mean LLB	Mean CBH
B: 09/2022	Control	1.49	14.75	3.17	1.96
B: 09/2022	Impact	2.34	15.65	3.78	2.07
A: 07/2023	Control	3.24	17.17	5.29	7.76
A: 07/2023	Impact	1.56	10.95	3.56	5.67

Mt. Adams Corps

Table A1.10. Average litter depth (in.), canopy cover (%), lowest live branch (ft), and tree circumference (in.) on plots before and after treatment.

Before/After	Control/ Impact	Mean Litter	Mean Canopy	Mean LLB	Mean CBH
B: 05/2022	Control	1.10	60.63	3.59	5.44
B: 05/2022	Impact	1.50	67.88	2.04	3.84
A: 10/2022	Control	0.80	59.19	3.23	6.09
A: 10/2022	Impact	0.85	20.94	0.66	1.26
A: 06/2023	Control	0.81	59.19	3.24	6.22
A: 06/2023	Impact	0.81	21.50	0.66	1.26

Rocky Mountain Youth Corps

Table A1.11. Average litter depth (in.), canopy cover (%), lowest live branch (ft), and tree circumference (in.) on plots before and after treatment.

Before/After	Control/ Impact	Mean Litter	Mean Canopy	Mean LLB	Mean CBH
B: 10/31/23	Control	0.7	12.29	1.61	4.06
B: 10/31/23	Impact	8.39	8.89	2.08	4.50
A:	--				
A: 12/01/23	Impact	8.40	9.54	2.13	4.81

Utah Conservation Corps

Table A1.12. Average litter depth (in.), canopy cover (%), lowest live branch (ft), and tree circumference (in.) on plots before and after treatment.

Before/After	Control/ Impact	Mean Litter	Mean Canopy	Mean LLB	Mean CBH
B: 07/2022	Control	1	12	2.00	3.00
B: 07/2022	Impact	1	18	4.00	19.90
A: 11/2022	Control	0	13	6.00	24.22
A: 11/2022	Impact	0	23	7.00	34.00
A: 11/2023	Control	1	19	3.00	4.80
A: 11/2023	Impact	1	23	4.00	8.60

Appendix 2 – Inferential Results of Individual Projects

Invasive Species Management

American Conservation Experience

Table A2.1. T-test results showing statistically significant changes in vegetation cover before and in near- and moderate-term periods after treatment.

			Summary stats		t-test			
Time	**Measure**		**Mean** (change over time)	**SD**	**t-value**	**Df**	**P-value**	
Before to near-term after	Bare ground	Control	-0.01	0	1.00	1.00	0.50	
		Impact	-0.04	0.04				
	Target species	Control	0.05	0.01	8.08	1.63	0.03	*
		Impact	-0.03	0.01				
	Beneficial species	Control	-0.06	0.02	-5.20	1.57	0.06	
		Impact	0.06	0.03				
	Other weeds	Control	0.02	0.02	1.00	1.00	0.50	
		Impact	0	0				
Before to moderate-term after	Bare ground	Control	-0.01	0	-0.33	1.00	0.79	
		Impact	0.004	0.05				
	Target species	Control	0.03	0.01	7.17	1.56	0.04	*
		Impact	-0.03	0.01				
	Beneficial species	Control	-0.03	0.01	-1.25	1.18	0.41	
		Impact	0	0.04				
	Other weeds	Control	0.01	0	-2.00	1.00	0.30	
		Impact	0.03	0.01				

*Statistically significant

Conservation Legacy

Table A2.2. T-test results showing statistically significant changes in vegetation cover before and in near and moderate-term periods after treatment.

		Summary stats			t-test		
Time	**Measure**		**Mean** (change over time)	**SD**	**t-value**	**Df**	**P-value**
Before to near-term after	Bare ground	Control	-0.07	0.03	-1.38	1.03	0.39
		Impact	0.18	0.26			
	Target species	Control	-0.18	0.07	-1.20	1.11	0.43
		Impact	-0.11	0.02			
	Beneficial species	Control	-0.07	0.05	0.26	1.05	0.84
		Impact	-0.13	0.32			
	Other weeds	Control	0.31	0.05	3.72	1.67	0.09
		Impact	0.06	0.08			
Before to moderate-term after	Bare ground	Control	-0.11	0.02	-0.66	1.03	0.62
		Impact	-0.01	0.20			
	Target species	Control	-0.18	0.07	-1.20	1.11	0.43
		Impact	-0.11	0.02			
	Beneficial species	Control	-0.09	0.04	-0.05	1.02	0.97
		Impact	-0.08	0.34			
	Other weeds	Control	0.38	0.06	1.37	1.26	0.36
		Impact	0.21	0.16			

*Statistically significant

Kupu Conservation Leadership Program

Table A2.3. T-test results showing statistically significant changes in vegetation cover before and in near- and moderate-term periods after treatment.

		Summary stats			t-test		
Time	**Measure**		**Mean** (change over time)	**SD**	**t-value**	**Df**	**P-value**
Before to near-term after	Bare ground	Control	0.01	0.01	-0.51	1.05	0.70
		Impact	0.04	0.08			
	Target species	Control	0.00	0.00	0.34	1.00	0.79
		Impact	-0.004	0.02			
	Beneficial species	Control	0.08	0.03	2.02	1.41	0.23
		Impact	-0.03	0.07			
	Other weeds	Control	-0.10	0.02	-4.01	1.99	0.06
		Impact	-0.01	0.02			
Before to moderate-term after	Bare ground	Control	0.05	0.02	1.53	1.01	0.37
		Impact	0.02	0.00			
	Target species	Control	0.02	0.02	2.11	1.36	0.23
		Impact	-0.05	0.04			
	Beneficial species	Control	-0.07	0.06	-1.36	1.15	0.38
		Impact	-0.01	0.02			
	Other weeds	Control	-0.003	0.01	-1.84	1.67	0.23
		Impact	0.03	0.02			

*Statistically significant

Montana Conservation Corps

Table A2.4. T-test results showing statistically significant changes in vegetation cover before and in near- and moderate-term periods after treatment.

		Summary stats			t-test		
Time	**Measure**		**Mean** (change over time)	**SD**	**t-value**	**Df**	**P-value**
Before to near-term after	Bare ground	Control	-0.07	0.12	1.03	1.62	0.43
		Impact	-0.17	0.07			
	Target species	Control	0.01	0.10	1.46	1.56	0.31
		Impact	-0.12	0.06			
	Beneficial species	Control	-0.02	0.01	-1.78	1.48	0.26
		Impact	0.02	0.02			
	Other weeds	Control	0.08	0.03	-2.51	1.12	0.22
		Impact	0.26	0.10			
Before to moderate-term after	Bare ground	Control	-0.40	0.02	0.58	1.12	0.66
		Impact	-0.43	0.07			
	Target species	Control	0.17	0.16	0.74	2.00	0.54
		Impact	0.05	0.17			
	Beneficial species	Control	0.02	0.01	-1.29	1.21	0.39
		Impact	0.06	0.04			
	Other weeds	Control	0.21	0.17	-0.52	1.65	0.67
		Impact	0.33	0.27			

*Statistically significant

Texas YouthWorks- Texas and Louisiana Conservation Corps

Table A2.6. T-test results showing statistically significant changes in vegetation cover before and in near- and moderate-term periods after treatment.

		Summary stats			t-test		
Time	**Measure**		**Mean** (change over time)	**SD**	**t-value**	**df**	**P-value**
Before to near-term after	Bare ground	Control	-0.12	0.12	-2.88	1.69	0.12
		Impact	0.17	0.07			
	Target species	Control	0.18	0.13	5.27	1.00	0.12
		Impact	-0.29	0			
	Beneficial species	Control	-0.06	0.01	-3.35	1.02	0.18
		Impact	0.13	0.08			
	Other weeds	Control	0	0	1.00	1.00	0.50
		Impact	-0.004	0.01			
Before to moderate-term after	Bare ground	Control	-0.12	0.11	0.01	1.01	0.99
		Impact	-0.12	0.01			
	Target species	Control	0.12	0.13	2.72	1.80	0.13
		Impact	-0.18	0.09			
	Beneficial species	Control	0.02	0.02	-4.74	1.06	0.12
		Impact	0.31	0.09			
	Other weeds	Control	0	0	1.00	1.00	0.50
		Impact	-0.004	0.01			

*Statistically significant

Fuels Reduction Management

Mt. Adams Corps

Table A2.5. T-test results showing statistically significant changes in average leaf litter depth, canopy cover, tree circumference at breast height, and height of lowest live branch before & in near/moderate-term periods after treatment.

		Summary stats			t-test			
Time	**Measure**		**Mean** (change over time)	**SD**	**t-value**	**df**	**P-value**	
Before to near-term after	LL	Control	-0.16	0.23	2.97	1.05	0.20	
		Impact	-0.65	0.04				
	CC	Control	-2.22	3.14	9.22	1.49	0.03	*
		Impact	-46.94	6.1				
	CBH	Control	-0.23	0.66	1.07	1.1	0.47	
		Impact	-2.58	3.03				
	LLB	Control	-0.71	1.01	0.62	1.97	0.60	
		Impact	-1.78	1.13				
Before to moderate-term after	LL	Control	-0.15	0.25	3.06	1.01	0.20	
		Impact	-0.69	0.02				
	CC	Control	-2.23	2.96	9.32	1.46	0.03	*
		Impact	-46.38	6.01				
	CBH	Control	-0.1	0.49	1.14	1.05	0.45	
		Impact	-2.58	3.03				
	LLB	Control	-0.7	1.03	0.63	1.98	0.60	
		Impact	-1.38	1.13				

*Statistically significant

Utah Conservation Corps

Table A2.7. T-test results showing statistically significant changes in average leaf litter depth, canopy cover, tree circumference at breast height, and height of lowest live branch before & in near/moderate-term periods after treatment.

		Summary stats			t-test			
Time	**Measure**		**Mean** (change over time)	**SD**	**t-value**	**df**	**P-value**	
Before to near-term after	LL	Control	-1.33	0.19	-2.18	1.94	0.17	
		Impact	-0.86	0.24				
	CC	Control	0.4%	1.03	-4.30	1.95	0.05	*
		Impact	4%	4.5				
	CBH	Control	1.46	1.37	0.33	1.35	0.78	
		Impact	0.64	3.2				
	LLB	Control	0.47	0.65	0.50	1.99	0.67	
		Impact	0.13	0.7				
Before to moderate-term after	LL	Control	-0.7	0.002	-1.91	1.00	0.31	
		Impact	-0.32	0.28				
	CC	Control	7%	6.67	0.32	1.31	0.79	
		Impact	5%	2.64				
	CBH	Control	-0.66	0.82	1.05	1.35	0.45	
		Impact	-2.22	1.93				
	LLB	Control	0.16	0.08	1.43	1.06	0.38	
		Impact	-0.30	0.46				

*Statistically significant

Appendix 3 – References

Adams, C., & Galatowitsch, S. M. (2008). The transition from invasive species control to native species promotion and its dependence on seed density thresholds. Applied Vegetation Science, 11(1), 131-138.

Barry, J., Maxwell, D., Jennings, S., Walker, D., & Murray, J. (2017). Emon: An R-package to support the design of marine ecological and environmental studies, surveys and monitoring programs. Methods in Ecology and Evolution, 8(10), 1342-1346.

Conner, M. M., Saunders, W. C., Bouwes, N., & Jordan, C. (2016). Evaluating impacts using a BACI design, ratios, and a Bayesian approach with a focus on restoration. Environmental Monitoring and Assessment, 188(10), 555.

Davis, C. (2015). Meadow Smith and Cooney-McKay Restoration and Fuels Reduction Projects: What Did We Learn?

Fisher, R., Shiell, G. R., Sadler, R. J., Inostroza, K., Shedrawi, G., Holmes, T. H., & McGree, J. M. (2019). epower: An r package for power analysis of Before-After-Control-Impact (BACI) designs. Methods in Ecology and Evolution, 10(11), 1843-1853.

Fontaine, J. B., & Kennedy, P. L. (2012). Meta-analysis of avian and small-mammal response to fire severity and fire surrogate treatments in US fire-prone forests. Ecological Applications, 22(5), 1547-1561.

McCreary, A., Seekamp, E., Cerveny, L. K., & Carver, A. D. (2012). Natural resource agencies and their motivations to partner: The Public Lands Partnership Model. Leisure Sciences, 34(5), 470–489.

Naiman-Sessions, J. & Shteir, S. (2019). The Efficacy of AmeriCorps Weed Treatments in Montana State Parks. Montana Fish, Wildlife & Parks - Montana State Parks AmeriCorps, 1-15.

Pilliod, D.S., Bull, E.L., Hayes, J.L., & Wales, B.C. (2008). Wildlife and invertebrate response to fuel reduction treatments in dry coniferous forests of the Western United States: A synthesis. Gen. Tech. Rep. RMRS-GTR-173. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station.

Prior, K. M., Adams, D. C., Klepzig, K. D., & Hulcr, J. (2018). When does invasive species removal lead to ecological recovery? Implications for management success. Biological Invasions, 20(2), 267-283.

Pysek, P., & Richardson, D. M. (2010). Invasive species, environmental change and management, and health. The Annual Review of Environment and Resources, 35, 25–55.

R Core Team (2023). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Rai, P. K., & Singh, J. S. (2020). Invasive alien plant species: Their impact on environment, ecosystem services and human health. Ecological Indicators, 111, 106020.

Stevens, J. T., Safford, H. D., & Latimer, A. M. (2014). Wildfire-contingent effects of fuel treatments can promote ecological resilience in seasonally dry conifer forests. Canadian Journal of Forest Research, 44(8), 843-854.

Tubbesing, C. L., Fry, D. L., Roller, G. B., Collins, B. M., Fedorova, V. A., Stephens, S. L., & Battles, J. J. (2019). Strategically placed landscape fuel treatments decrease fire severity and promote recovery in the northern Sierra Nevada. Forest ecology and management, 436, 45-55.

Appendix 4 – Data Collection Instruments

Project Summary Form

Invasive Species Data Collection Form

Forest Fuels Data Collection Form