

# Enhancement of Taylor's checkerspot butterfly habitat at Beazell Memorial Forest: 2018 annual report (web version)



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Annual report to Benton County Natural Areas and Parks

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## PREFACE

IAE is a non-profit organization whose mission is conservation of native ecosystems through restoration, research and education. IAE provides services to public and private agencies and individuals through development and communication of information on ecosystems, species, and effective management strategies. Restoration of habitats, with a concentration on rare and invasive species, is a primary focus. IAE conducts its work through partnerships with a diverse group of agencies, organizations and the private sector. IAE aims to link its community with native habitats through education and outreach.



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**Cover photographs:** View of a Taylor's checkerspot butterfly habitat patch in the North meadow in spring 2018 (main photo) and a photo inset of Taylor's checkerspot on Scotch broom.

All photos by Andy Neill unless otherwise noted.

## SUGGESTED CITATION

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## ANNUAL REPORT TO BENTON COUNTY NATURAL AREAS AND PARKS

### 1. EXECUTIVE SUMMARY

In 2018, the Institute for Applied Ecology (IAE) worked with Benton County Natural Areas and Parks Department (Benton County) staff to continue implementation of habitat restoration activities at Beazell Memorial Forest (Beazell) to support the recovery of the federally listed Taylor's checkerspot butterfly (TCB, *Euphydryas editha taylori*, Figure 1). Restoration efforts at Beazell focused on expansion and enhancement of TCB habitat by identifying and treating invasive species, clearing trees, limbs and slash, and creating four TCB habitat patches planted and seeded with a high density of TCB nectar and larval host food plants. Funding for work at Beazell was provided by Benton County and a U.S. Fish and Wildlife Service (USFWS) State Wildlife Grant (SWG).

### 2. INTRODUCTION

Taylor's checkerspot butterfly (Figure 1) was once abundant in native prairies of the Willamette Valley. Land conversion to agriculture and forestry, urban development, encroachment of shrubs and trees and invasion of non-native plants have severely diminished the size and quality of available TCB habitat. Beazell Memorial Forest (Beazell, Figure 2) is one of two locations in Oregon still occupied by TCB.

The primary threats to TCB habitat at Beazell are tree and shrub encroachment into the meadows, increased dominance of non-native plant species, and declining abundance of TCB host and nectar plants (Table 1). Although Washington populations of TCB use the federally listed golden paintbrush (*Castilleja levisecta*) as their host, this species was extirpated in Oregon, and the two remaining Oregon TCB populations use English plantain (*Plantago lanceolata*), a common non-native species found in the meadows at Beazell and throughout the Willamette Valley, as their primary host plant. However, in the absence of periodic burning, native and non-native grasses have become dominant in the TCB meadows, excluding English plantain and TCB nectar species. Maintaining habitat connectivity, controlling invasive species, and limiting encroachment of trees and shrubs into occupied and potential habitats are critical to maintain viable populations of TCB. Although there is no management plan for the meadow and TCB habitat enhancement at Beazell, the Benton County Prairie Species Habitat Conservation Plan (HCP)



**Figure 1.** Taylor's checkerspot butterfly (*Euphydryas editha taylori*) nectaring on rosy plectritis (*Plectritis congesta*) in the North meadow in May 2017.

provides guidance for restoration of TCB-occupied habitat such as the meadows at Beazell (Benton County 2010). The HCP provides details on how to minimize negative impacts to TCB populations resulting from management actions (e.g., herbicide applications, mowing, and planting).

The project area at Beazell includes five meadows – North, Middle, Summit, Steep and South (not shown), as well as a corridor created by Benton County staff in the winter of 2016. The corridor was created by removing mature Douglas-fir (*Pseudotsuga menziesii*) and linking the North and Middle meadows (Figure 2). The South and Steep meadows are also included in the project area but no work was completed there during 2018.

Non-native grasses are the predominant species in the meadows. They out-compete native upland prairie forbs and grasses and create a dense thatch layer that can prevent TCB from accessing plant resources during their flight period. Although non-native grasses clearly reduce the quality of TCB habitat at Beazell, little management has been done to address this problem, primarily because Benton County does not want to directly and negatively impact the TCB population.

## Beazell Memorial Forest Project Map



This map has been removed to protect  
the location of sensitive species

**Figure 2.** Map of Beazell Memorial Forest with treatment areas and habitat patches created since 2016.

IAE began working with Benton County to enhance TCB habitat in the meadows in 2014. Since then, IAE has conducted extensive weed treatments and tree removal in the meadows and created 11 habitat patches in the North, Middle and Summit meadows comprised of a high density of TCB nectar and host species (Table 1). This report summarizes work completed in 2018 at Beazell that was funded by Benton County as well as by a State Wildlife Grant (SWG). Work included weed treatments and planting and seeding of upland prairie species that included TCB nectar and host food plants (Table 1). All TCB habitat enhancement activities occurred in the North, Middle and Summit meadows, as well as in the corridor linking the North and Middle meadows (Figure 2).

**Table 1.** Taylor's checkerspot butterfly nectar and larval host food plants.

Scientific Name	Common Name	Nectar (N) or Host (H)
<i>Allium acuminatum</i>	tapertip onion	N
<i>Allium amplexans</i>	narrowleaf onion	N
<i>Calochortus tolmiei</i>	Tolmie star-tulip	N
<i>Castilleja levisecta</i>	golden paintbrush	H
<i>Claytonia sibirica</i>	Siberian miner's lettuce	N
<i>Collinsia grandiflora</i>	giant blue-eyed Mary	H
<i>Collinsia parviflora</i>	small-flowered blue-eyed Mary	H
<i>Fragaria virginiana</i>	Virginia strawberry	N
<i>Lomatium utriculatum</i>	spring gold	N
<i>Plantago lanceolata</i> var. <i>lanceolata</i>	English plantain	H
<i>Plectritis congesta</i>	shortspur seablush	N
<i>Taraxacum officinale</i>	common dandelion	N

Taylor's checkerspot butterflies occupy portions of the North, Middle, and Summit meadows. Egg laying has generally been limited to core TCB habitat that tend to be protected by the wind at higher elevations within each occupied meadow (Figure 2). Core TCB habitat is generally characterized as having sufficient nectar and host plants for the butterflies to complete their life cycle. These locations in each meadow are where the butterflies spend most of the flight period. TCB populations increased in the North, Middle, and Summit meadows since surveys began in 2005 until 2017, where the TCB populations saw a small drop in numbers. In 2018, the population rebounded to pre-2017 levels (Ross 2018). The Steep meadow has not had a viable TCB population since reporting began in 2005 and has not received recent restoration treatments. The TCB population in the South meadow was extirpated for unknown reasons in 2013. TCB have been observed moving through the corridor between the North and Middle meadows during the flight period each year, visiting flowers of Siberian miner's lettuce (*Claytonia sibirica*), which increased in abundance following removal of Douglas-fir (Figure 3). TCB movement through the corridor between the North and Middle meadows highlights the importance of connectivity between meadows for maintaining dispersal of TCB to new or underutilized habitats.

Low abundance of TCB nectar and host plants outside core TCB habitat in meadows at Beazell likely limits range expansion. Tree removal near occupied areas followed by seeding and planting nectar and larval host food plants (Table 1) can expand core habitat. Similarly, increasing the abundance of nectar and host food plants outside of core habitat may provide resources to sustain larger TCB populations in meadows at Beazell. One option that has been utilized at Beazell is to create small habitat patches outside of core habitat that have a high density of TCB nectar and host food plants. Habitat patches created in 2016 and 2017 have expanded TCB habitat and serve as stepping stones for TCB to populate other areas of Beazell and beyond. However, it is likely that multiple factors determine habitat quality, including abundance of food and nectar plants, prevailing winds, and aspect. The reason TCB remains in the same core habitat in each meadow year after year is poorly understood (Benton County 2010). The creation of additional habitat patches at Beazell may answer some of those questions.



**Figure 3.** Taylor's checkerspot butterfly (*Euphydryas editha taylori*) nectaring on Siberian miner's lettuce (*Claytonia sibirica*) in the corridor between North and Middle meadows in May 2017.

### 3. GOALS AND OBJECTIVES

The goal of this project is to assist Benton County to enhance and expand TCB habitat in meadows at Beazell. Restoration activities at Beazell are being completed with the following objectives:

- 1) Reduce target weeds within the vicinity of the Middle, North and Summit meadows by 90%.
- 2) Enhance and expand the core TCB habitat at Beazell by:
  - a. Removing trees and limbs in and around TCB occupied meadows,
  - b. Enhancing core TCB habitat by increasing nectar availability, and
  - c. Creating and maintaining TCB habitat patches planted with a high density of TCB nectar and host food plants adjacent to core TCB habitat.

### 4. 2018 RESTORATION ACTIVITIES

#### Overview

A full list of restoration activities implemented at Beazell Memorial Forest during 2018 is listed in Table 2. For a complete list of project activities to date, see Appendix A. All restoration activities in and around TCB occupied meadows followed the guidelines in the Benton County HCP (Benton County 2010).



**Table 2.** Detailed list of management activities at Beazell Memorial Forest in 2018.

Date	Activity	Notes
Apr-2018	Site visit and weed treatment	<ul style="list-style-type: none"> <li>• Met with A. Stebbins to discuss work at Beazell and creation of four habitat patches in the North meadow.</li> <li>• Spot sprayed glyphosate to existing habitat patches targeting thistles and oxeye daisy, and false brome.</li> <li>• Spot sprayed clethodim on existing habitat patches targeting non-native grasses.</li> </ul>
May-2018	Site assessment, habitat patch layout and weed treatment	<ul style="list-style-type: none"> <li>• Collected photopoints and conducted habitat assessments in North, Middle, and Summit meadows.</li> <li>• Installed stakes at corners of four habitat patches in the North meadow.</li> <li>• Sprayed habitat patches with glyphosate.</li> <li>• Spot sprayed false brome in North and Middle meadows with glyphosate.</li> </ul>
June-2018	Mowing	<ul style="list-style-type: none"> <li>• Used string trimmer to mow habitat patches sprayed in May and tall oatgrass in the North meadow.</li> <li>• Used a leaf blower and rakes to remove thatch from the four new habitat patches in the North meadow.</li> </ul>
Sept-2018	Site visit	<ul style="list-style-type: none"> <li>• Assessed weed growth in the North and Middle meadows.</li> <li>• Assessed the fall green-up on the four new habitat patches to determine need for fall herbicide treatment</li> </ul>
Oct-2018	Planting	<ul style="list-style-type: none"> <li>• Hosted nine volunteers to plant ~4,100 plants in the four new habitat patches in the North meadow, corridor between the North and Middle meadows, and in core TCB habitat in the North meadow.</li> </ul>
Nov-2018	Seeding	<ul style="list-style-type: none"> <li>• Broadcast TCB seed mix to the habitat patches and areas in the Corridor and Middle and North meadows.</li> <li>• Cut limbs of several Douglas-fir trees at the top of the North meadow near the parking area to expand core TCB habitat.</li> <li>• Piled limbs in the forest and broadcast seed TCB seed mix to exposed areas.</li> </ul>

## Vegetation management

Vegetation management to expand and enhance TCB habitat in 2018 included weed treatments and tree and limb removal. Weed treatments included mowing with a string trimmer and spot spray herbicide treatments in the North, Middle, and Summit meadows, as well as in the corridor between the North and Middle meadows. Attention was given to patches of targeted weeds identified in the early detection weed surveys (Neill 2017), areas cleared of trees in fall 2015 and 2016 (Figure 2), and habitat patches created in 2016 and 2017. Tree removal focused on clearing trees and limbs from the North meadow to expand core TCB habitat (Figure 2).

### **Weed treatments**

Herbicide treatments in core TCB habitat were avoided to prevent negative impacts to butterflies and larvae, but IAE staff did conduct cursory spot spray treatments in unoccupied areas of the North, Summit, and Middle meadows during the TCB flight period in May. Spot spray treatments targeting high-priority weeds appear to be successful at reducing abundance, but repeated treatments over multiple years will likely be necessary to control target weed populations across the project area at Beazell. In 2018, spot spray treatments extended into adjacent forest. In particular, areas that will eventually be cleared of trees were targeted to prevent false brome seed production and dispersal prior to and after tree clearing activities that are likely to disturb the seed bed (Figure 4).



**Figure 4.** Institute for Applied Ecology staff conducting spot spray herbicide treatments in an area of the North meadow cleared of Douglas-fir (*Pseudotsuga menziesii*) trees and limbs. (Photo: Anna Ramthun, April 9, 2018)

Spot spray applications of glyphosate effectively killed treated false brome in the corridor and in and around the North, Middle, and Summit meadows. However, false brome continues to be

a threat to TCB habitat at Beazell due to its persistence under forest canopies. Dispersal of false brome seed from these areas into the meadows at Beazell is likely facilitated by animals. Until the large patches of false brome in adjacent forests can be controlled, repeated spot spray treatments in the meadows at Beazell will be needed to prevent false brome from expanding into the meadows and core TCB habitat. As false brome has become less abundant in the meadows, spot spray treatments can expand into the adjacent forest. However, control of large false brome patches in the forest understory will require substantial and repeated herbicide treatments to significantly reduce the threat of this weed.

In 2018, areas previously cleared of trees and habitat patches that were planted and seeded in 2016 and 2017 received spot spray treatments of glyphosate to reduce the abundance of thistles, oxeye daisy (*Leucanthemum vulgare*), false brome and velvet grass (*Holcus lanatus*). Spot spray treatments of clethodim (Select Max) to the same areas targeted other non-native grasses that are more susceptible to grass specific herbicides (e.g., tall oatgrass [*Arrhenatherum elatius*] and orchard grass [*Dactylis glomerata*]). The opportunity to use grass specific herbicides in the habitat patches was maintained by excluding native grasses from the original seed and planting mix (Neill 2017). Roemer's fescue was included in the seed mix because it is resistant to grass specific herbicides.



**Figure 5.** Scotch broom (*Cytisus scoparius*) pulled Benton County work crew and piled in the North meadow (April 4, 2018).

Efforts by IAE staff and volunteers and Benton County work crews to pull or treat Scotch broom in 2016 and 2017 in areas outside of core TCB habitat in the Middle and North meadow has reduced the abundance of Scotch broom (Neill 2017). In 2018, Benton County work crews have continued to pull Scotch broom in the North and Middle meadows in and around core TCB occupied habitat (Figure 5). This invasive species continues to persist because of long-lived seeds that remain in the soil seedbank. In particular, core TCB habitat that extends from the top of the North meadow to the corridor leading to the Middle meadow has a large amount of immature Scotch broom that should be

pulled or treated before it becomes large enough to flower and produce seed. This area is sensitive TCB habitat and special care needs to be taken to minimize negative impacts on TCB larva, butterflies, and nectar and host plants. Repeated pulling and herbicide treatments over many years will be required to prevent Scotch broom from eventually dominating these meadows.

Past treatments of thistles in the North, Middle and Summit meadows, as well as the corridor between the North and Middle meadows, were successful and remaining patches were targeted in 2018. Weed treatments in the corridor between the North and Middle meadows focused on false brome, thistles and oxeye daisy. This area was highly disturbed when it was logged in 2016 and weeds will continue to be a problem until natives become established. Other weeds that were targeted with glyphosate include St. Johnswort (*Hypericum perforatum*) and velvet grass. Bull thistle (*Cirsium vulgare*), a biennial, was most abundant in exposed soils in areas recently disturbed by tree clearing and in the corridor. Spot spray treatments with clopyralid effectively reduced the abundance of bull thistle but repeated applications will be needed until the seed bank is depleted and native species that were seeded and planted in these areas become established. Canada thistle (*Cirsium arvense*) had lower abundance in the disturbed areas but has the potential of invading by seed and surviving rhizomes of nearby plants. Triclopyr was applied to control trailing blackberry (*Rubus ursinus*) that has increased in abundance in the corridor in dense patches that inhibit establishment of seeded natives. Although trailing blackberry is native,



**Figure 6.** View from the North meadow through the corridor to the Middle meadow (October, 2018).

its dominance inhibits establishment of nectar and host species preferred by TCB.

**Tree removal**

Douglas-fir encroachment into meadows has reduced the size of and cut off connections between meadows (Figure 7). IAE and Benton County have been removing trees from the meadows for several years to expand and maintain open meadows to benefit TCB and establish a corridor between the North and Middle meadows (Figure 6). The movement of TCB through the corridor created in winter 2016 suggests TCB at Bezell would likely benefit from additional tree removal. Small trees and limbs from large Douglas-fir were cleared from the upper portion of the North meadow (Figures 2 and 8) and then seeded with a TCB prairie seed mix (Table 3). In 2019, more trees and limbs will be removed followed with seeding and planting in 2019 to expand TCB habitat in the North and Middle meadows.



**Figure 7.** View from just inside the forest edge from the North meadow with many small diameter Douglas-fir cleared in 2018 (October 2018).



**Figure 8.** View from the top of the North meadow before (left) and after (right) Douglas-fir (*Pseudotsuga menziesii*) tree and limb removal in October 2018.

Tree removal within the project area was paid for with funds from the SWG grant with the goal of expanding TCB habitat. Trees were felled, limbed, and bucked using chainsaws and all the material was removed from the meadows and piled in the surrounding forest by IAE staff. After the trees and limbs were removed the exposed ground was seeded with a native seed mix using belly seeders (Table 3). The species included in all seeding and planting schemes were upland prairie species, with emphasis given to TCB nectar and host food plants (Tables 1, 3 and 4). Additional tree removal in this areas by IAE staff and volunteers is planned for early 2019.

Disturbance associated with the logging operation to create the corridor between the North and Middle meadows in 2016 created bare ground and left a large amount of Douglas-fir slash on the ground (Figure 6). Benton County staff will pile the remaining limbs and logs in the corridor and burn the pile in early 2019. This area will need to be seeded, planted and monitored for weed invasions during and after 2019.

**Table 3.** Native species seed mix and broadcast rates to new habitat patches and areas cleared of trees in North meadows and the corridor between North and Middle meadows, at Bezell Memorial Forest in fall 2018.

Scientific Name	Common Name	Nectar (N) or Host (H)	Broadcast Rates (lbs/acre)	
			Habitat Patches	All Other Areas
<i>Achillea millefolium</i>	common yarrow		0.12	0.11
<i>Clarkia amoena ssp. lindleyi</i>	farewell-to-spring		0.20	0.15
<i>Clarkia purpurea ssp. quadrivulnera</i>	winecup clarkia		0.05	0.04
<i>Collinsia grandiflora</i>	giant blue-eyed Mary	N/H	0.37	n/a
<i>Eriophyllum lanatum</i>	woolly sunflower		0.15	0.13
<i>Festuca roemerii</i>	Roemer's fescue		1.74	1.55
<i>Gilia capitata</i>	bluehead gilia		0.17	0.15
<i>Leptosiphon bicolor</i>	true babystars	N	0.13	0.07
<i>Madia elegans</i>	showy tarweed		0.41	0.80
<i>Plantago lanceolata</i>	English plantain	H	0.50	0.66
<i>Plectritis congesta</i>	rosy plectritis	N	0.48	0.35
<i>Prunella vulgaris var. lanceolata</i>	self-heal		0.44	0.39
<i>Ranunculus occidentalis</i>	western buttercup	N	1.39	1.39
<i>Sidalcea malviflora ssp. virgata</i>	dwarf checkermallow		0.66	0.70
<b>Total:</b>			<b>6.81</b>	<b>6.50</b>

**Table 4.** Number and location of native plants planted in fall 2018 at Bezell Memorial Forest.

Scientific Name	Common Name	Material	# of Plants		
			Per Habitat area (x 4)	Corridor and North Meadow	Total planted
<i>Allium acuminatum</i>	tapertip onion	Bulb	50	n/a	200
<i>Allium amplexans</i>	narrow-leaf onion	Bulb	50	n/a	200
<i>Calochortus tolmiei</i>	Tolmie's star-tulip	Bulb	44	250	425
<i>Dichelostemma congestum</i>	ookow	Bulb	25	n/a	100
<i>Fragaria virginiana</i>	Virginia strawberry	Bareroot	200	700	1,500
<i>Geranium oreganum</i>	Oregon geranium	Bareroot	13	n/a	50
<i>Iris tenax</i>	toughleaf iris	Bareroot	25	100	200
<i>Lomatium utriculatum</i>	spring gold	Bareroot	125	365	865
<i>Ranunculus occidentalis</i>	western buttercup	Bareroot	25	n/a	100
<i>Wyethia angustifolia</i>	mule ears	Bareroot	13	n/a	50
<i>Sidalcea virgata</i>	dwarf checkermallow	Bareroot	n/a	400	400
<b>Total:</b>			<b>569</b>	<b>1,815</b>	<b>4,090</b>

## Taylor's checkerspot butterfly habitat patches

In 2018, four TCB habitat patches were created by preparing small rectangular patches (20m x 30m) in the North meadow (Figure 2) with a combination of herbicide, blowing and raking to kill vegetation and remove thatch. (Figures 9). These habitat patches are in addition to seven created in 2016 and four in 2017 (Figure 2). The locations of the habitat patches were chosen based on proximity to core TCB habitat, low abundance of existing TCB nectar and host food plants, and the highest potential to expand and enhance TCB habitat. The locations were established outside of core TCB habitat to minimize negative effects of site preparation and planting activities on TCB. Ideally, the habitat patches will contribute to TCB habitat by providing enough resources for the TCB to complete its lifecycle, and the patches will serve as stepping stones to other habitat areas within Bezell and beyond.

In fall 2018 after initial treatments and thatch removal, a follow-up herbicide treatment was planned to target germinating weed seeds prior to planting and seeding of the patches. However, late arrival of fall rains and impending planting dates did not provide sufficient fall green-up to justify another treatment. Instead, perennial weeds that survived the initial treatment were targeted in a fall spot spray herbicide treatment prior to planting and seeding of the habitat patches.

The four habitat patches in the North meadow were each planted with ~569 native prairie species by IAE staff and volunteers in October (Table 4). Remaining plants were planted in the North meadow and the corridor between the North and Middle meadows by IAE staff and a volunteer. Native seed was broadcast to the four habitat areas in November at a rate of 6.81 lbs. per acre (Table 3). Remaining seed was broadcast to habitat patches created in 2016 and 2017 that had low establishment of natives from previous seeding and to areas cleared of trees in 2018 (Table 3).



**Figure 9.** Leaf blower used to remove thatch from a treated and mowed habitat patch (top) and bare ground and moss exposed (bottom) in the North meadow (August 2018, Photos by Anna Ramthun).

Most habitat patches created in 2016 and 2017 have good establishment of natives that were planted and seeded (Figure 10). However, a few habitat patches in the North and Middle meadows did not establish with natives as expected (Figure 11). It is possible that these plots had higher abundances of non-native annual grasses that were missed by herbicide applications increasing competition for



**Figure 10.** Anna Ramthun, IAE Restoration Technician, applying herbicide to a habitat patch in the North meadow in May 2016 (top left) and the results of the herbicide application two months later in July 2016 (top right), many seeded and planted natives growing in May 2017 (bottom left), and established and flowering natives in May 2018 (bottom right).

resources, the weed seedbank was not depleted, residual effects of herbicides used to spot spray weeds, such as clopyralid, could have affected germination of native seed, or the removal of the thatch and duff layers created warmer and dryer conditions not suitable for germinating seeds (Figure 11). These habitat patches received spot spray treatments of glyphosate and clethodim in 2018. These treatments provided some ground preparation for broadcasting the remaining seed to these plots to increase establishment of native species, and TCB host and nectar species in particular (Table 3).



**Figure 11.** Habitat patch in the North meadow created in 2017 with low establishment of natives (left) and in the Middle meadow dominated by annual grasses (right) (April 2018).



**Figure 12.** Native species growing in a TCB habitat patch planted in 2017 including Virginia strawberry (*Fragaria virginiana*, left), mule ears (*Wyethia angustifolia*, center-left), Tolmie's star-tulip (*Calochortus tolmiei*, center-right) and Oregon geranium (*Geranium oregonum*, right) in April 2018.

Similar to those species used for nectar plot seeding in 2016 and 2017, upland prairie species, including TCB host or nectar species, were chosen for seeding and planting in prepared areas at Beazell in 2018 (Tables 3 and 4). Despite attempts to purchase seed of rosy plectritis (*Plectritis congesta*) in 2016 and 2017, no seed was available for this project. Rosy plectritis is an important nectar species for TCB (Table 1). In 2018, rosy plectritis seed was available and extra seed was purchased and broadcasted to all habitat patches and areas previously cleared of trees at Beazell. English plantain, the primary host plant for TCB in Oregon, is not commonly grown for seed. In order to augment this important TCB host plant, we hand-collected seed from wild populations at Beazell and other locations in the Willamette Valley in 2017. Additional seed was provided by USFWS as part of TCB recovery efforts in Benton County. Wild-collected seed has been added to the native seed mixes used for seeding TCB habitat patches and other



disturbed areas since 2016. In 2018, TCB were observed visiting flowering plants during the flight season in all areas that were seeded and planted in 2016 and 2017.

Although areas planted and seeded after tree removal are proximal to the habitat patch in the Middle meadow, it is likely that there is a difference in seed bank and soil conditions as a result of being covered by 1-3 inches of Douglas-fir needles. These differing conditions could result in different plant assemblages and should be frequently assessed to address any weed or native species establishment issues that may arise.

All prepared areas were planted and seeded by an AmeriCorps team and IAE staff in fall 2016 and by IAE staff and volunteers in fall 2017 and 2018. Some of the seeded and planted areas were inspected in April 2018 and sown seeds were observed germinating and bareroot plants and bulbs were seen growing (Figure 12). Ground preparation appears to have facilitated germination of seed; however, the removal of duff and thatch can result in seedling mortality due to increased heat and drying out of the soil. Follow-up seeding is intended to supplement these areas when survivorship is low and to add species to increase diversity. The prepared areas created access to bare soil for seeds of golden paintbrush (*Castilleja levisecta*), which has been found to be important to germination and survivorship of this species (Tom Kaye, personal communication September 2016). Golden paintbrush and English plantain seeded into habitat patches and areas cleared of Douglas-fir were observed growing in April 2018.

The typical restoration methods, such as herbicide application and thatch removal to prepare ground, were effective at creating small habitat patches at Beazell Memorial Forest. However, this process would likely be difficult to manage and require significant resources if the process was scaled up to include the entirety of the meadows at Beazell. These methods on a small scale have created easy-to-maintain, high-density patches of TCB nectar and host food plants. It is recommended that these areas continue to be the focus of intense management, such as hand weeding and spot spray herbicide applications.

## 5. RECOMMENDATIONS

Below are recommendations for restoration and management actions in 2019 and beyond:

- Create a five-year management plan for the Taylor's checkerspot butterfly-occupied meadows and/or a Taylor's checkerspot butterfly conservation plan for Benton County properties.
- Maintain and expand open meadow habitat by annually removing trees and limbs followed by seeding and planting of native species in disturbed areas to reduce encroachment of Douglas-fir in the North, Middle and Summit meadows. In particular:
  - Lop Douglas-fir saplings in the Summit meadow
  - Remove limbs and small trees at the top of the North meadow
  - Re-girdle trees in the Middle and Summit meadows that survived prior girdling efforts.
- Conduct spot spray herbicide treatments throughout the year to reduce the abundance of and prevent the spread of priority weeds, including false brome, Canada thistle, and Scotch broom in and around meadows, with focus given to core TCB habit.
- Create additional TCB habitat patches in TCB-occupied meadows.
- Establish and maintain sources of seed, bareroot plants and bulbs of TCB nectar and host food

plants to ensure availability.

- Consider contracting a grower to ensure availability of seed and/or plants of species with no, little, or unpredictable commercial availability (e.g., English plantain and rosy plectritis).
  - To ensure availability of seed at optimal time for seeding, consider purchasing seed the year prior to the targeted seeding date.
  - Collect English plantain seed annually to ensure availability of seed for TCB restoration projects on Benton County properties.
- Devise a plan or experiment with methods to reduce the abundance of non-native grasses and thatch in and around core TCB habitat. Methods or combinations of methods could include:
    - Periodic burning
    - Mowing
    - Brush-cutting
    - Broadcast treatments of grass-specific herbicides
    - Flame weeding

## 6. REFERENCES

Benton County. 2010. Prairie species habitat conservation plan. 160 pp plus appendices.

[www.co.benton.or.us/parks/hcp](http://www.co.benton.or.us/parks/hcp).

Neill, A. 2017. Enhancement of Taylor's checkerspot butterfly habitat at Beazell Memorial Forest: 2018 annual report (web version). Institute for Applied Ecology. 19 pages plus appendices.

Ross, D. 2018. 2018 Population estimates for Taylor's checkerspot in Oregon. A report to Benton County Areas and Parks Department, State of Oregon: Oregon Parks and Recreation Department, and U.S. Fish and Wildlife Service.

## APPENDICES

### Appendix A. Complete list of activities at Beazell Memorial Forest to date.

Date	Activity	Notes
Dec-2014	Scotch broom removal	<ul style="list-style-type: none"> <li>AmeriCorps helped to remove heavy invasion of Scotch broom from 2 acres in North and Middle meadows.</li> </ul>
Dec-2014	Tree removal	<ul style="list-style-type: none"> <li>Cleared Douglas-fir from ~3.25 acres in North meadow. Seeded exposed areas with Roemer's fescue.</li> </ul>
July-2015	Photopoints	<ul style="list-style-type: none"> <li>Established photopoints: one in the Middle meadow, one in the North meadow, and two in the Summit meadow.</li> </ul>
Nov-2015	Tree removal	<ul style="list-style-type: none"> <li>AmeriCorps helped to remove 5-8 Douglas-fir trees from the North meadow and piled slash in the forest.</li> </ul>
Dec-2015	Tree removal	<ul style="list-style-type: none"> <li>AmeriCorps helped to remove Douglas-fir from the Summit meadow and piled in the adjacent forest. Seeded exposed area with Roemer's fescue.</li> </ul>
Jan-2016	Tree removal	<ul style="list-style-type: none"> <li>Benton County staff removed mature Douglas-fir to create a corridor linking the Middle and Summit meadows.</li> </ul>
Mar-2016	Weed survey	<ul style="list-style-type: none"> <li>Surveyed Middle, Steep meadows and corridor for priority weeds.</li> <li>GPS points to be submitted to Adam Stebbins from Benton County.</li> </ul>
Apr-2016	Site assessment, project coordination, and weed pulling	<ul style="list-style-type: none"> <li>Walked site with A. Stebbins and College of Forestry (CoF) students to coordinate Earth Day Volunteer event.</li> <li>Determined location of TCB habitat patches to be sprayed in May.</li> <li>Led ~30 volunteers with OSUs Center for Civic Engagement and College of Forestry to pull Scotch broom in North and Middle meadows.</li> </ul>
May-2016	TCB habitat patch treatments	<ul style="list-style-type: none"> <li>Established corners of seven TCB habitat patches in Summit (1), Middle (2) and North (4) meadows.</li> <li>Sprayed TCB habitat patches with glyphosate.</li> <li>Spot sprayed false brome with glyphosate and thistles with clopyralid in North, Summit, and Middle meadows with glyphosate and clopyralid.</li> </ul>
Jul-2016	Seed collection	<ul style="list-style-type: none"> <li>Collected English plantain (<i>Plantago lanceolata</i>) seed at Finley Wildlife Refuge and Beazell for fall seeding in TCB habitat patches at Beazell.</li> </ul>
Aug-2016	Seed collection and site assessment	<ul style="list-style-type: none"> <li>Collected English plantain seed from Summit, Middle, and North meadows for fall seeding in TCB habitat patches at Beazell.</li> <li>Site visit with A. Stebbins.</li> </ul>

Date	Activity	Notes
Oct-2016	Flame weeding	<ul style="list-style-type: none"> <li>• Flame weeded TCB habitat patches in North meadow by IAE staff to kill fall germinating plants.</li> </ul>
Nov-2016	Tree removal, hand weeding and planting	<ul style="list-style-type: none"> <li>• IAE staff, volunteers and AmeriCorps Gold 5 NCCC team:               <ul style="list-style-type: none"> <li>○ Felled, limbed, bucked and piled approximately 25 Douglas-fir trees from the Middle meadow, removed limbs from North meadow, and cleared slash from the Corridor;</li> <li>○ Hand pulled Scotch broom in the Middle and North meadows;</li> <li>○ Raked to remove thatch from habitat patches and fir needles from areas where Douglas-fir was removed in the North, Middle and Summit meadows to prepare areas for planting; and</li> <li>○ Planted prepared areas and TCB habitat patches, each with bulbs, bareroot plants, and plugs (Table 3).</li> </ul> </li> </ul>
Dec-2016	Planting, seeding, clearing and hand weeding	<ul style="list-style-type: none"> <li>• IAE staff and a volunteer seeded the seven habitat patches, areas cleared of trees, and Corridor between North and Middle meadows (Table 4).</li> <li>• IAE staff pulled weeds and finished planting in TCB habitat patches in North, Middle, and Summit meadows.</li> <li>• Cleared slash in corridor and Middle and North meadows.</li> </ul>
Mar-2017	Site assessment and trail clearing	<ul style="list-style-type: none"> <li>• Walked North, Middle and Summit meadows to assess seeding and planting success in TCB habitat patches.</li> <li>• Cleared trail to middle of the North meadow for volunteers to pull Scotch broom.</li> </ul>
Apr-2017	Scotch broom pulling event	<ul style="list-style-type: none"> <li>• Worked with 40 volunteers to pull Scotch broom in the middle of the North meadow.</li> </ul>
May-2017	Site assessment and weed treatments	<ul style="list-style-type: none"> <li>• Scouted TCB, TCB habitat patches and problem weeds in North and Middle meadows.</li> <li>• Spot spray false brome, velvet grass and two new habitat patches in the North meadow with glyphosate.</li> <li>• Spot spray false brome, St. John's wort, and velvet grass in corridor between North and Middle meadows.</li> <li>• Sprayed two TCB habitat patches in the Summit meadow with glyphosate.</li> </ul>
Jun-2017	Weed treatment	<ul style="list-style-type: none"> <li>• Spot spray Scotch broom in North meadow with triclopyr.</li> </ul>
July-2017	Seed collection	<ul style="list-style-type: none"> <li>• Plantago seed collection at Finley National Wildlife Refuge and Beazell.</li> <li>• Hand weeding of TCB habitat patches in North and Middle meadows.</li> </ul>
Oct-2017	Weed treatment	<ul style="list-style-type: none"> <li>• Spot spray false brome with glyphosate in Summit meadow.</li> </ul>

Date	Activity	Notes
Nov-2017	Planting and seeding	<ul style="list-style-type: none"> <li>• IAE staff and volunteers planted bulbs and bareroot plants in habitat patches in the North (2) and Summit (2) meadows and open meadow in North and Summit meadows (Table 5).</li> <li>• IAE staff broadcast seed onto TCB habitat patches (Table 6).</li> </ul>
Apr-2018	Site visit and weed treatment	<ul style="list-style-type: none"> <li>• Met with A. Stebbins to discuss work at Beazell and creation of four habitat patches in the North meadow.</li> <li>• Spot sprayed glyphosate to existing habitat patches targeting thistles and oxeye daisy, and false brome.</li> <li>• Spot sprayed clethodim on existing habitat patches targeting non-native grasses.</li> </ul>
May-2018	Site assessment, habitat patch layout and weed treatment	<ul style="list-style-type: none"> <li>• Collected photopoints and conducted habitat assessments in North, Middle, and Summit meadows.</li> <li>• Installed stakes at corners of four habitat patches in the North meadow.</li> <li>• Sprayed habitat patches with glyphosate.</li> <li>• Spot sprayed false brome in North and Middle meadows with glyphosate.</li> </ul>
June-2018	Mowing	<ul style="list-style-type: none"> <li>• Used string trimmer to mow habitat patches sprayed in May and tall oatgrass in the North meadow.</li> <li>• Used a leaf blower and rakes to remove thatch from the four new habitat patches in the North meadow.</li> </ul>
Sept-2018	Site visit	<ul style="list-style-type: none"> <li>• Assessed weed growth in the North and Middle meadows.</li> <li>• Assessed the fall green-up on the four new habitat patches to determine need for fall herbicide treatment</li> </ul>
Oct-2018	Planting	<ul style="list-style-type: none"> <li>• Hosted nine volunteers to plant ~4,100 plants in the four new habitat patches in the North meadow, corridor between the North and Middle meadows, and in core TCB habitat in the North meadow.</li> </ul>
Nov-2018	Seeding	<ul style="list-style-type: none"> <li>• Broadcast TCB seed mix to the habitat patches and areas in the Corridor and Middle and North meadows.</li> <li>• Cut limbs of several Douglas-fir trees at the top of the North meadow near the parking area to expand core TCB habitat.</li> <li>• Piled limbs in the forest and broadcast seed TCB seed mix to exposed areas.</li> </ul>