

# Nelson's Checkermallow Recovery Project, Phase III (Coast Range and Portland Recovery Zones)-Web Version



2017

Annual Report to OWEB (#217-3010-12850  
and 217-3010-14133), USFWS (F16AC00616),  
and BLM (L17AC00158)

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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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## ACKNOWLEDGMENTS

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**Cover photograph:** Nelson's checkermallow at Stub Stewart State Park – Banks-Vernonia State Trail, April 2017; *photo by Peter Moore, IAE.*

**Special Note:** This report has been modified from its original format by removing maps and/or appendices that include information on the location of rare and sensitive species.

## EXECUTIVE SUMMARY

This project continues progress towards recovery of Nelson's checkermallow (*Sidalcea nelsoniana*) in the Coast Range and Portland recovery zones through restoration of habitat and reintroduction and augmentation of populations in order to meet delisting goals. Nelson's checkermallow is listed as threatened by the U.S. Fish and Wildlife Service (USFWS) and Oregon Department of Agriculture (ODA) because of its limited distribution and small, fragmented populations.

Project sites include protected areas on public and private land at six locations in the Coast Range zone and seven locations in the Portland zone. Project partners include Bureau of Land Management (BLM), Metro, Oregon Department of Forestry (ODF), Oregon Parks and Recreation Department (OPRD), USFWS (including Tualatin River National Wildlife Refuge), Weyerhaeuser and City of Hillsboro.

In 2017, at the 13 project sites, the Nelson's checkermallow population was quantified and mapped, weeds were mapped, the vegetation community was described, and photo points were established. Restoration needs were identified, and prescriptions for restoration actions at each site were developed. Implementation of restoration actions commenced at Coast Range sites and Stub Stewart State Park in fall, in collaboration with landowners, and other Portland sites were managed by the partner agencies. To prepare for population augmentations and reintroductions after restoration, Nelson's checkermallow seed was collected at several Coast Range sites for establishing a seed increase field at Heritage Seedlings. A checkermallow production field was also established at the Metro nursery.

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# Nelson's checkermallow recovery project, Phase III (Coast Range and Portland Recovery Zones) – Web Version

ANNUAL REPORT 2017

## INTRODUCTION

### Study species and habitat

The Willamette Valley ecoregion once contained vast stretches of open prairies with a diverse assemblage of plants and wildlife. Currently less than 1% of this habitat remains in native condition, due to centuries of conversion of these unique habitats for human uses. Moreover, the prairie that remains is imperiled by invasion of exotic weeds. This habitat loss, fragmentation, and degradation has put many species, including Nelson's checkermallow, at risk of extinction.

The range of Nelson's checkermallow in Oregon consists of highly fragmented, mostly small populations within the Willamette Valley and flanks of the Coast Range. These populations often occur on private lands, roadsides, and other vulnerable sites, further increasing their risk of local extinction. Small, fragmented populations are a problem for this species as restricted gene-flow and population bottlenecks lead to low genetic diversity and the potential for inbreeding depression. Also, seed predation by weevils and the lack of suitable microsites for germination greatly limits recruitment in these small populations. Seedlings appear to be unable to survive in the dense thatch layers that accumulate when exotic pasture grasses invade and fires are suppressed, nor can they compete against established broadleaf weeds. Without direct intervention, extinction risk is very high.

### Recovery Plan Targets

The Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington (USFWS 2010) identifies benchmarks in populations (plant abundance, population distribution, and habitat quality) to remove Nelson's checkermallow from the endangered species list. The objective is to restore and maintain a series of functioning population networks across the species' historic range, which includes seven recovery zones. For delisting to occur, minimum targets were set for the number of populations (exceeding 2000 plants) and total numbers (5000-20,000) of plants per zone (Table 1). For Nelson's checkermallow populations to contribute to recovery of the species, the site supporting them must meet guidelines for prairie

habitat quality (Table 2), be secured (publicly owned or protected by a permanent conservation easement), and managed for conservation of the species.

**Table 1. Distribution and abundance targets outlined for Nelson's checkermallow in the Recovery Plan (USFWS 2010), and progress towards those population targets in 2012-14. Portland and Coast Range recovery zones are highlighted.**

| Recovery Zone                      | Recovery plan targets per zone            |                  | Status in 2012-14                  |                  |
|------------------------------------|---|------------------|------------------------------------|------------------|
|                                    | Minimum no. populations with >2000 plants | Total no. plants | No. populations with > 2000 plants | Total no. plants |
| SW Washington                      | 2   | 10,000           | 0                                  | 2,340            |
| Portland                           | 1   | 5,000            | 0                                  | 866              |
| Coast Range                        | 3   | 15,000           | 2                                  | 8,185            |
| Salem West                         | 4   | 20,000           | 7*                                 | >119,000*        |
| Salem East                         | 2   | 10,000           | 2                                  | 9,543            |
| Corvallis West                     | 4   | 20,000           | 9*                                 | >87000*          |
| Corvallis East                     | 2   | 10,000           | 0                                  | 0                |
| Additional populations in any zone | 2   | 10,000           |                                    |                  |
| Total                              |   | 100,000          | 20                                 | 226,934          |

\* Goals achieved through Nelson's Checkermallow Recovery Phase I and Phase II projects.

**Table 2. Prairie quality and diversity criteria established in the Recovery Plan (USFWS 2010: Appendix D) for a population to contribute toward recovery of the target species.**

**Criteria for prairie quality and diversity**

- a) **Cover of native prairie vegetation:** ≥50% relative cover.
- b) **Cover of woody vegetation:** ≤15% woody species cover.  
Woody species of management concern will have ≤5% cover (or 25% for savanna habitat).  
Examples include oneseed hawthorn (*Crataegus monogyna*), Suksdorf's hawthorn (*Crataegus suksdorfii*), non-native brooms (*Cytisus* spp.), common pear (*Pyrus communis*), sweetbriar rose (*Rosa eglanteria*), multiflora rose (*Rosa multiflora*), Himalayan blackberry *Rubus armeniacus*), cutleaf blackberry (*Rubus laciniatus*), and poison oak (*Toxicodendron diversilobum*).
- c) **Native prairie species richness:** >10 species (measured in 25 m<sup>2</sup> plots), including 7 forbs and one bunchgrass species.
- d) **Non-native vegetation:** No single species will have >50% cover site-wide and no species of concern will have ≥5% cover.  
Examples include tall oatgrass (*Arrhenatherum elatius*), slender false brome (*Brachypodium sylvaticum*), meadow knapweed (*Centaurea x moncktonii*), Scotch broom (*Cytisus scoparius*), reed canarygrass (*Phalaris arundinacea*), common pear, Himalayan blackberry and European blackberry (*Rubus vestitus*).



## Phase I and Phase II Efforts

The Institute for Applied Ecology (IAE), USFWS, and more than a dozen other partners throughout western Oregon and southwest Washington collaborated in recent years to recover Nelson's checkermallow. Phase I and II of IAE's Nelson's checkermallow recovery project (funded by Oregon Watershed Enhancement Board (OWEB) grant # 208-3082 and # 210-3054, as well as USFWS 13420-8-J813 and 13420AJ035) during 2008-2014 focused on two of the most populous recovery zones, Corvallis West and Salem West, and helped achieve significant strides toward stability for the species. The project included collection of diverse genetic material, establishment of seed increase fields and production of plant materials, establishing a network of sites for restoration, and introducing Nelson's checkermallow along with a diverse mix of other native species. The efforts exceeded the recovery goals for Salem West and Corvallis West (Table 1).

## Phase III Project

The objective of this project, Phase III, is to meet Recovery Plan objectives for Nelson's checkermallow (Table 1, Table 2, and Figure 1) in the Coast Range and Portland recovery zones through enhancing prairie habitat and augmenting/introducing populations as needed.

Currently there are 12 known populations in the Coast Range, but only two populations (Tillamook Burn and Walker Flat) met, or almost met, prairie quality and diversity guidelines and exceeded 2000 individuals in 2012-14 (Silvernail 2012; Silvernail *et al.* 2016). Tillamook Burn is not permanently protected and therefore cannot be counted towards recovery of this species. There are seven known populations in the Portland zone, but only one (Quamash Prairie) met prairie quality and diversity guidelines in 2012-14 (Silvernail 2012; Silvernail *et al.* 2016). All populations have fewer than 350 Nelson's checkermallow plants, and the total number of individuals for this recovery zone is fewer than 1,000 plants. IAE is working with partner agencies (USFWS, Metro, OPRD, ODF, City of Hillsboro, Weyerhaeuser and BLM) to restore habitat and augment the Nelson's checkermallow populations. The project is principally funded by OWEB (# 217-3010-12850 and 217-3010-14133), with additional funds from USFWS (F16AC00616), for restoration at three Coast Range sites, and BLM (L17AC00158), for restoration at Walker Flat. Some elements of Nelson's checkermallow seed collection and production are funded by USFWS (F16AC00632, F17AC00629). Partner agencies are contributing in-kind efforts to the project.

Project elements include:

- Assessing the status of the Nelsons' checkermallow population and habitat at each site.
- Collecting Nelson's checkermallow seed and establishing production fields.
- Developing and implanting management prescriptions to improve habitat conditions.
- Planting Nelson's checkermallow and other prairie species.
- Conducting outreach to partners and the public.

This annual report describes the work conducted in 2017.

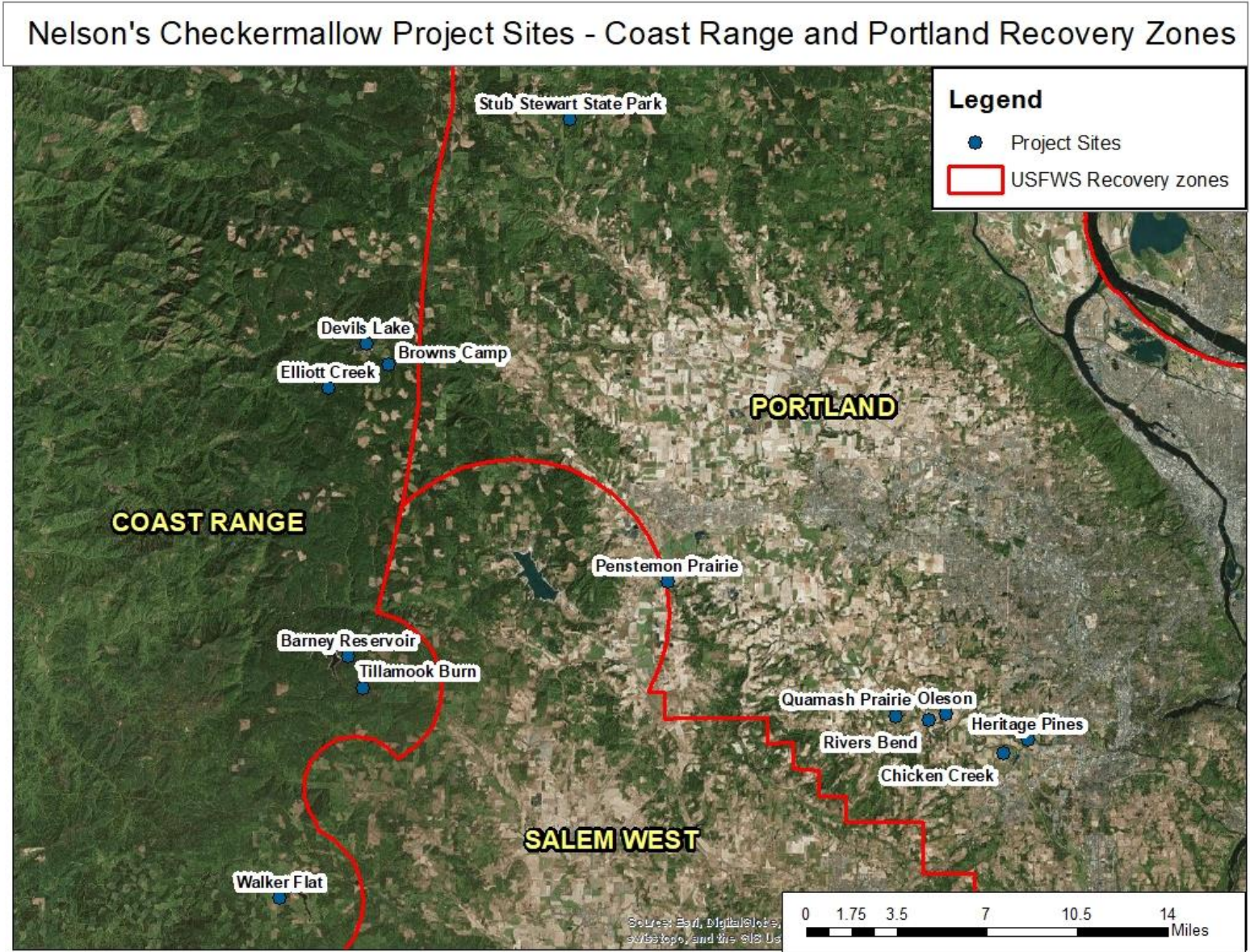


Figure 1. Location of Nelson's checkermallow project sites within the Coast Range and Portland recovery zones (see Appendix 1 for project location detail).

## METHODS

### Nelson's checkermallow population monitoring

At each site existing GIS mapping of Nelson's checkermallow plant patches was evaluated and modified where significant changes had occurred in plant distribution. Updated mapping was integrated into the USFWS geodatabase for Threatened and Endangered Species.

Foliar cover was estimated where individual plants could not be distinguished. Because it is a rhizomatous perennial, Nelson's checkermallow plants arising from the ground more than 30 cm from each other are defined as separate individuals. In some cases, Nelson's checkermallow form dense mats that cover an area larger than what would traditionally be thought of as an individual plant (e.g., >1-2 m<sup>2</sup>). In such cases, square meters of foliar cover were estimated instead of individual plant numbers. Consequently, at some populations, there was a combination of individual counts and foliar cover.

Population abundance survey protocol followed those outlined by Silvernail *et al.* (2016). Populations or patches expected to contain fewer than 1000 individuals were inventoried via direct census, whereas large, or densely vegetated populations, were sub-sampled (Silvernail *et al.* 2016). Each method is described below.

#### Direct Census

For counting the number of individuals, the following protocol was used:

- 1) The population was divided into appropriate survey units, depending on the distribution and density, to aid in the systematic search for individuals. Maps and GPS polygons from the previous surveys were used as a guide for plant locations.
- 2) The survey unit was walked and pin flags used to mark individual plants, patches (for small populations), or the population perimeter (for larger populations).
- 3) Tape measures were used to mark out 1-2m wide transects to divide up the population for counting purposes (Figure 2).
- 4) Plants were assigned to three life history categories:
  - a. seedlings (plants with leaves <2.5 cm in diameter),
  - b. vegetative plants, with no sign of flowering, and
  - c. reproductive plants in any stage of development (Figure 3).

#### Sub-Sample

For sampling a population, the following protocol was used:

- 1) A macroplot was established to encompass the entire population, apart from outlying plants which were counted separately. In the case of Elliott Creek South, the only population which was sampled in 2017, the macroplot was a rectangle, with the dimensions defined by the maximum length (the baseline) and width of the meadow.
- 2) One meter wide sampling quadrats (belt transects) were delineated by running out two parallel tape measures.
- 3) The direction of the sampling quadrats was designed to maximize variability in plant distribution within the quadrat, while minimizing the variation in total plant number between

quadrats. At Elliott Creek South the quadrats ran in parallel across the meadow and were oriented with a compass.

- 4) 10 sampling quadrats were chosen at random along the macroplot baseline.
- 5) Within each quadrat, the number of plants was counted, or foliar cover estimated, in each of the life history stages.
- 6) After counting all individuals, a field calculation sheet (Silvernail *et al.* 2016: Appendix 2) was used to establish how many quadrats were sufficient to sample the population within a margin of error of 30% or less. If needed, additional quadrats were randomly assigned along the baseline and counted. At Elliott Creek South 25 quadrats were required.



**Figure 2. Surveying Nelson's checkermallow; (Left) Anna Ramthun at Oleson; (Center) Jessie Brothers and Stacy Moore at Rivers Bend; (Right) Ashley Ottombrino-Haworth surveying a community plot at Stub Stewart State Park.**



**Figure 3. Nelson's checkermallow: (a) seedling; (b) vegetative plant; (c) reproductive plant.**

## Habitat Monitoring

### Invasive and woody species mapping

The following areas or species were mapped using aerial photos on ArcGIS, or in the field with a hand-held Nautiz GPS:

- Treatment area – the likely area of weed control surrounding the current or proposed Nelson's checkermallow distribution.

- Invasive species (Table 2d) and other non-native species of management concern, such as lesser hawkbit (*Leontodon taraxacoides*) and Fuller's teasel (*Dipsacus fullonum*).
- Native trees and shrubs: Oregon ash (*Fraxinus latifolia*), Oregon grape (*Mahonia aquifolium*), Pacific ninebark (*Physocarpus capitatus*), Nootka rose, (*Rosa nutkana*), willow (*Salix sp.*), Douglas spiraea (*Spiraea douglasii*) and snowberry (*Symphoricarpos albus*).
- Woody species of management concern (Table 2), including Douglas-fir (*Pseudotsuga menziesii*) trees (generally <10 inch diameter, or 5-10 years old) that are encroaching on the prairies.

The mapping was broad-scale and focused on larger infestations, rather than more dispersed weeds. These data were used to assess habitat quality (per USFWS Recovery Plan criteria, Table 2) and to help to plan for restoration actions.

### **Plant community composition**

Plant cover (%) by species was recorded at one to three 25 m<sup>2</sup> (5 x 5 m) plots (Figure 2), either randomly located (for large sites), or in a representative location (for small sites) within Nelson's checkermallow populations and potential introduction sites. Regardless of size of an area, a single plot was recorded if the vegetation appeared to be relatively uniform in community composition. Multiple plots were recorded if there were distinct patches of Nelson's checkermallow, or if the habitat appeared to be different across the site.

Relative cover was calculated for plant functional groups (native or introduced, perennial or annual, forb or graminoid), by dividing the absolute cover by the summed total percent cover of all plant categories, including woody perennials.

### **Photo points**

One or more photo points were established or repeated at each project site, and their position recorded with a hand-held GPS. At each point, photos were taken in the four cardinal directions, unless an alternative direction was needed to capture specific habitat features, or when repeating photo points that were taken in 2012-14 (Silvernail 2012; Silvernail *et al.* 2016).

## **Habitat Restoration**

### **Restoration prescriptions**

Field data describing invasive and woody species location and extent and plant community composition were evaluated to identify common invasive plants and encroaching woody species for treatment. Restoration prescriptions were then developed based on guidelines in the PROJECTS Biological Opinion (USFWS 2015) and requirements of individual landowner/managers. Restoration prescriptions are included in Appendix 5.

### **Restoration actions**

Restoration prescription (above) were used to plan restoration actions in the treatment area at each site, with work commencing in fall 2017.

Metro and USFWS are conducting restoration treatments at their properties in the Portland recovery zone. IAE is coordinating and implementing restoration treatments at all other sites.

Principal actions in the Coast Range sites and Stub Stewart State Park included clearing meadows of encroaching trees and shrubs, combined with herbicide treatments of stumps and stems.

## **Plant materials production**

Seeds of Nelson's checkermallow and other native plant species were collected from most Coast Range project areas during July-September 2017. Nelson's checkermallow seed was collected previously at Portland recovery zone sites.

Nelson's checkermallow seed increase fields for the Portland and Coast Range recovery zones will be established at the Metro nursery and Heritage Seedlings, respectively. The latter field is funded by the "Willamette Valley Plant and Fender's Blue Butterfly Recovery" grant, funded by USFWS (F17AC00629).

10,500 plugs will be grown for planting out in the Portland recovery zone and 6000 plugs for the Coast Range recovery zone. Plugs will be started in fall 2018 by Metro and IAE for planting in fall 2019.

## **Outreach**

News items were posted on social media and the IAE website.

## **RESULTS**

### **Nelson's checkermallow population and habitat monitoring**

#### **Population survey**

Nelson's checkermallow populations were surveyed between May 23 and June 29, 2017 in the Portland recovery zone and between June 19 and June 23, 2017 in the Coast Range. Results are summarized in Table 3, with more detail provided in Appendix 2.

Most Nelson's checkermallow population estimates in the Coast Range were lower in 2017 than in 2012-2014 (Table 3). Assuming an average of two plants per square meter of ground cover (where there was a combination of direct census and cover estimates), decreases ranged from 14% for Tillamook Burn to 63% for Devils Lake. The exception was Elliott Creek, where almost three times as many plants were present in 2017 than in 2012-14. A valid comparison cannot be made at Walker Flat due to survey area differences (see Table 3 footnote). In the Portland recovery zone, there were decreases of 65-83% at Heritage Pines, Penstemon and Quamash prairies, but increases of 146-2011% at Rivers Bend, Stub Stewart State Park and Oleson.

#### **Invasive and woody species mapping**

Approximate areas of weeds and woody plants are summarized in Table 4 and Table 5 and maps are provided in Appendix 3.

**Table 3. Nelson's checkermallow abundance at Portland and Coast Range sites in 2012-14 and 2017.**

| Recovery zone | Project site                  | Status               | 2012-14 survey <sup>1</sup> |   | 2017 survey |   |
|---------------|-------------------------------|----------------------|-----------------------------|---|-------------|---|
|               |                               |                      | # plants                    | Additional cover (m <sup>2</sup> ) <sup>2</sup> | # plants    | Additional cover (m <sup>2</sup> ) <sup>2</sup> |
| Coast Range   | Barney Reservoir              | Natural              | 91                          | 14  | 64          | 10  |
|               | Browns Camp                   | Natural              | 171                         | 0   | 84          |   |
|               | Devils Lake Fork Wilson River | Natural              | 823                         | 5   | 285         | 10  |
|               | Elliott Creek                 | Natural              | 80                          | 117   | 286         | 467   |
|               | Tillamook Burn                | Natural              | 2055                        | 0   | 1699        | 34  |
|               | Walker Flat <sup>3</sup>      | Natural              | 4359                        | 0   | 502         | 11  |
| Portland      | Heritage Pines <sup>4</sup>   | Introduced           | 86                          | 0   | 30          | 0   |
|               | Penstemon Prairie             | Natural & Introduced | 95                          | 0   | 13          | 0   |
|               | Quamash Prairie               | Introduced           | 96                          | 0   | 16          | 0   |
|               | Rivers Bend                   | Introduced           | 9                           | 0   | 190         | 0   |
|               | Tualatin NWR - Oleson         | Introduced           | 75                          | 0   | 253         | 4   |
|               | Stub Stewart State Park       | Introduced           | 195                         | 0   | 480         | 0   |

<sup>1</sup> Silvernail (2012), Silvernail *et al.* (2016).

<sup>2</sup> Additional cover was estimated where individual plants could not be distinguished.

<sup>3</sup> The 2012-14 survey included the whole meadow (total estimate 4359) and based on acreage, there might have been 1821 plants present on the BLM property. Only the BLM portion of the meadow was surveyed in 2017.

<sup>4</sup> Data for the introduced population only. The nearby "natural population" appears to be meadow checkermallow (*Sidalcea campestris*).

**Table 4. Approximate areas of weeds and woody plants in the treatment area of each project site in the Coast Range recovery zone, 2017.**

| Species name   | Common name  | Area (acres)     |             |             |               |                |             |              |
|--|--|------------------|-------------|-------------|---------------|----------------|-------------|--------------|
|  |  | Barney Reservoir | Browns Camp | Devils Lake | Elliott Creek | Tillamook Burn | Walker Flat | Total        |
| <i>Cirsium arvense</i>   | Canada thistle   | 0.282            | *           | *           | 0.111         | *              |             | <b>0.39</b>  |
| <i>Cirsium vulgare</i>   | Bull thistle   |                  |             | 0.001       |               |                |             | <b>0.00</b>  |
| <i>Crataegus sp.</i>   | Hawthorn   |                  |             | 0.000       |               |                |             | <b>trace</b> |
| <i>Cytisus scoparius</i>   | Scotch broom   | 0.038            | 0.095       | 0.194       |               | *              |             | <b>0.33</b>  |
| <i>Fraxinus latifolia</i> ,<br><i>Mahonia aquifolium</i> ,<br><i>Physocarpus capitatus</i> ,<br><i>Rosa nutkana</i> ,<br><i>Salix sp.</i> ,<br><i>Spiraea douglasii</i> ,<br><i>Symphoricarpos albus</i> | Native trees & shrubs: Oregon ash, Oregon grape, Pacific ninebark, Nootka rose, willow, Douglas spiraea, snowberry | *                | **          | 0.342       | 0.130         | 0.076          | 0.070       | <b>0.62</b>  |
| <i>Prunus sp.</i>  | plum   |                  |             |             | 0.011         |                |             | <b>0.01</b>  |
| <i>Pseudotsuga menziesii</i>   | Douglas-fir  | 0.412            | **          | 0.083       | 0.151         | 0.236          | 0.429       | <b>1.31</b>  |
| <b>Total</b>   |  | <b>0.73</b>      | <b>0.09</b> | <b>0.62</b> | <b>0.40</b>   | <b>0.31</b>    | <b>0.50</b> | <b>2.66</b>  |

\* Present but not mapped, generally because of low density, or \*\* because of difficulty with GPS satellite connection under dense canopy.



**Table 5. Approximate areas of weed and woody plants in the treatment area of each project site in the Portland recovery zone, 2017.**

| Species name                  | Common name          | Area (acres)   |                   |                 |             |                         |                      |                    |             | Total       |
|-------------------------------|----------------------|----------------|-------------------|-----------------|-------------|-------------------------|----------------------|--------------------|-------------|-------------|
|                               |                      | Heritage Pines | Penstemon Prairie | Quamash Prairie | Rivers Bend | Stub Stewart State Park |                      | Tualatin River NWR |             |             |
|                               |                      |                |                   |                 |             | Dairy Creek Camp E      | Banks-Vernonia Trail | Chicken Creek      | Oleson      |             |
| <i>Arrhenatherum elatius</i>  | Tall oatgrass        |                |                   |                 |             |                         |                      |                    | 0.23        | <b>0.23</b> |
| <i>Cirsium arvense</i>        | Canada thistle       | 0.01           |                   |                 |             | 0.19                    | 0.15                 |                    | 0.01        | <b>0.37</b> |
| <i>Cirsium vulgare</i>        | Bull thistle         |                |                   |                 |             |                         | 0.03                 |                    |             | <b>0.03</b> |
| <i>Convolvulus arvensis</i>   | Field bindweed       |                |                   |                 | 0.03        |                         |                      |                    |             | <b>0.03</b> |
| <i>Crataegus sp</i>           | Hawthorn species     | 0.03           |                   | 0.01            | trace       |                         | 0.01                 |                    | 0.04        | <b>0.10</b> |
| <i>Dipsacus fullonum</i>      | Fuller's teasel      |                |                   |                 |             |                         |                      |                    | 0.09        | <b>0.09</b> |
| <i>Malus, Pyrus sp.</i>       | Apple, pear          |                |                   |                 |             |                         |                      |                    |             | <b>0.00</b> |
| <i>Leontodon taraxacoides</i> | Lesser hawkbit       |                |                   | 1.88            | 2.4         |                         |                      |                    |             | <b>4.32</b> |
|                               | Other shrubs         | 1.10           | 0.20              | 0.34            | trace       | 0.42                    | 0.01                 |                    | 0.64        | <b>2.73</b> |
| <i>Phalaris arundinacea</i>   | Reed canarygrass     | 0.05           | 0.05              |                 |             | 0.002                   | 0.00                 | 0.05               |             | <b>0.15</b> |
| <i>Prunus sp.</i>             | Plum                 |                |                   |                 |             |                         | 0.00                 |                    |             | <b>0.00</b> |
| <i>Pseudotsuga menziesii</i>  | Douglas-fir          |                |                   |                 |             | 0.004                   |                      |                    |             | <b>0.00</b> |
| <i>Quercus garryana</i>       | Oregon white oak     |                |                   | 0.07            | 0.01        |                         |                      |                    |             | <b>0.08</b> |
| <i>Rosa multiflora</i>        | Multiflora rose      | 0.01           |                   | 0.003           |             |                         |                      |                    |             | <b>0.02</b> |
| <i>Rubus armeniacus</i>       | Himalayan blackberry | 0.23           |                   |                 |             |                         | 0.08                 | 0.09               | 0.005       | <b>0.40</b> |
| <i>Senecio jacobaea</i>       | Tansy ragwort        |                |                   |                 |             |                         |                      |                    | 0.01        | <b>0.01</b> |
| <b>Total</b>                  |                      | <b>1.43</b>    | <b>0.26</b>       | <b>2.30</b>     | <b>2.49</b> | <b>0.61</b>             | <b>0.29</b>          | <b>0.13</b>        | <b>1.04</b> | <b>8.56</b> |

## Plant community composition

Community monitoring data are summarized in Table 6, with a general assessment of whether project areas meet recovery plan criteria provided in Table 7.

## Photo points

A summary of photo points established to illustrate the 2017 (pre-restoration) conditions at Nelson's checkermallow project sites is provided in Appendix 4.

## General habitat descriptions

### Barney Reservoir (City of Hillsboro)

Three small meadows with populations of previously introduced Nelson's checkermallow are located near the shoreline of Barney Reservoir. They are heavily encroached by Douglas-fir seedlings and saplings (Figure 4a), with heavy shading by branches of older trees at the perimeter of the meadows. Native shrubs including rose spirea (*Spiraea douglasii*) and willows (*Salix* sp.), are also filling in the openings, and there are small infestations of Scotch broom (one of which is shown in Appendix 3). Prairie vegetation is dominated by introduced species (e.g., creeping buttercup (*Ranunculus repens*), birdsfoot trefoil (*Lotus corniculatus*) and creeping bentgrass (*Agrostis stolonifera*)) which out-compete native species. Problem weeds such as Canada thistle (*Cirsium arvense*) infest the stream flats between the populations and there is a large infestation in the eastern meadow (Appendix 3).

### Browns Camp (ODF)

Small natural populations of Nelson's checkermallow alongside the Devils Lake Fork Wilson River, near Browns Camp in Tillamook State Forest, are heavily encroached by Douglas-fir trees and seedlings, as well as native shrubs, such as rose spirea and common snowberry (*Symphoricarpos albus*)(Figure 4b). Patches of Scotch broom comprise 5-10% in cover over the whole site and Canada thistle is scattered through the area. Overall, woody vegetation dominates the site, and of the native prairie species that persist, woodland strawberry (*Fragaria vesca*) is common.

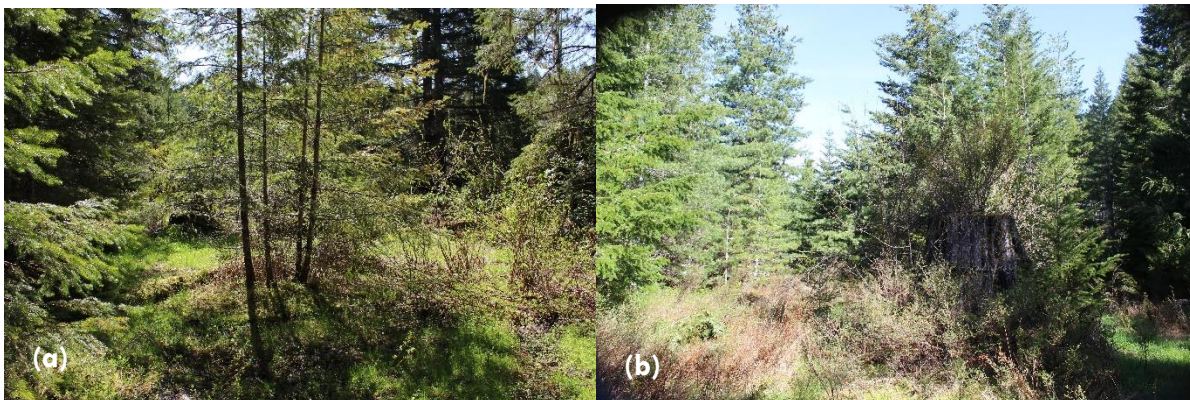


Figure 4. Encroachment of Douglas-fir and native shrubs at (a) Barney Reservoir and (b) Browns Camp.

**Table 6. Plant community characteristics at Nelson's checkermallow project sites in the Coast Range and Portland recovery zones, 2017.**

| Site name                                | Plots |                         | % Relative Cover ± standard error |             |             |            |               |                    |             |           |             | Absolute Cover   |             |             |
|--|-------|-------------------------|-----------------------------------|-------------|-------------|------------|---------------|--------------------|-------------|-----------|-------------|------------------|-------------|-------------|
|  | #     | Native species per plot | Native Species                    |             |             |            |               | Introduced Species |             |           |             | Woody perennials | Bare ground | Thatch      |
|  |       |                         | Perennials                        |             | Annuals     |            | Total Natives | Perennials         |             | Annuals   |             |                  |             |             |
|  |       |                         | Forbs                             | Graminoids  | Forbs       | Graminoids |               | Forbs              | Graminoids  | Forbs     | Graminoids  |                  |             |             |
| Barney Reservoir                         | 1     | 6                       | 13.1                              | 3.0         | 0           | 0          | 16.1          | 62.7               | 21.0        | 0         | 0           | 0.5              | 1.0         | 80.0        |
| Browns Camp                              | 1     | 9                       | 29.5                              | 2.0         | 0           | 0          | 31.5          | 2.9                | 0.3         | 0         | 0           | 114.1            | 0.1         | 65.0        |
| Devils Lake Fork<br>Wilson River (N & S) | 2     | 14.0 ± 0                | 50.3 ± 5.3                        | 11.7 ± 0.8  | 0           | 0          | 62.0 ± 4.5    | 5.5 ± 3.6          | 4.5 ± 3.6   | 0.8 ± 0.4 | 0           | 25.8 ± 0.8       | 5.0 ± 5.0   | 7.5 ± 2.5   |
| Elliott Creek (N & S)                    | 2     | 13.0 ± 1.0              | 63.9 ± 5.6                        | 27.3 ± 3.8  | 0.2 ± 0.2   | 0          | 91.4 ± 2.0    | 3.8 ± 3.4          | 4.2 ± 0.9   | 4.2 ± 0.9 | 0           | 0.3 ± 0.3        | 3.0 ± 2.0   | 10.0 ± 10.0 |
| Tillamook Burn                           | 4     | 13.5 ± 1.0              | 27.8 ± 8.1                        | 55.5 ± 14.5 | 4.4 ± 3.3   | 0          | 87.8 ± 8.0    | 1.2 ± 0.7          | 3.8 ± 2.3   | 0.9 ± 0.8 | 0           | 11.9 ± 11.2      | 4.5 ± 2.0   | 42.5 ± 10.1 |
| Walker Flat                              | 2     | 11.5 ± 0.5              | 37.4 ± 8.4                        | 8.2 ± 0.2   | 0           | 0          | 45.6 ± 8.6    | 15.1 ± 11.1        | 33.3 ± 2.6  | 2.4 ± 1.9 | 0           | 6.8 ± 3.8        | 0.6 ± 0.5   | 80.0 ± 0    |
| Heritage Pines                           | 1     | 2                       | 1.2                               | 0           | 0           | 0          | 1.2           | 10.0               | 41.6        | 0.4       | 0.8         | 57.5             | 0           | 30.0        |
| Penstemon Prairie - natural              | 1     | 2                       | 1.8                               | 0           | 0           | 0          | 1.8           | 0                  | 73.2        | 0.6       | 0           | 20.0             | 20.0        | 80.0        |
| Penstemon Prairie - introduced           | 2     | 5.5 ± 1.5               | 1.0 ± 0.1                         | 12.4 ± 12.4 | 67.2 ± 25.9 | 0          | 80.6 ± 13.7   | 2.2 ± 1.2          | 0.5 ± 0.5   | 1.0 ± 0.1 | 13.8 ± 13.8 | 0.3 ± 0.3        | 55.0 ± 5.0  | 0           |
| Quamash Prairie                          | 3     | 7.7 ± 2.7               | 36.5 ± 26.7                       | 2.4 ± 1.9   | 42.9 ± 20.9 | 0          | 81.8 ± 12.9   | 13.8 ± 12.0        | 0.2 ± 0.2   | 1.7 ± 0.7 | 0.8 ± 0.8   | 0.8 ± 0.6        | 8.3 ± 4.4   | 6.8 ± 6.6   |
| Rivers Bend                              | 2     | 11.5 ± 1.5              | 42.0 ± 17.8                       | 37.6 ± 13.4 | 5.5 ± 0.8   | 0.3 ± 0.3  | 85.4 ± 4.8    | 9.0 ± 7.8          | 0.6 ± 0     | 3.0 ± 1.0 | 0.6 ± 0.6   | 1.3 ± 1.3        | 30.0 ± 5.0  | 12.5 ± 2.5  |
| Stub Stewart - Dairy Creek Camp East     | 3     | 12.0 ± 4.7              | 19.4 ± 11.8                       | 18.2 ± 9.2  | 2.0 ± 1.1   | 0          | 39.7 ± 20.1   | 9.2 ± 3.8          | 47.8 ± 17.6 | 1.3 ± 0.5 | 0           | 1.7 ± 0.2        | 16.8 ± 8.7  | 15.7 ± 9.9  |
| Stub Stewart - Banks-Vernonia            | 2     | 1.0 ± 1.0               | 1.0 ± 1.0                         | 0           | 0           | 0          | 1.0 ± 1.0     | 1.4 ± 0.7          | 96.7 ± 1.2  | 0.3 ± 0.3 | 0           | 0                | 27.5 ± 2.5  | 20.0 ± 5.0  |
| Tualatin River NWR - Chicken Creek       | 1     | 4                       | 2.2                               | 5.5         | 0           | 0          | 7.7           | 3.3                | 7.7         | 2.2       | 78.1        | 0.5              | 15.0        | 1.0         |
| Tualatin River NWR - Oleson              | 2     | 1.0 ± 0                 | 0                                 | 3.4 ± 2.8   | 0           | 0          | 3.4 ± 2.8     | 25.1 ± 22.7        | 57.5 ± 28.9 | 6.3 ± 1.4 | 7.4 ± 5.0   | 0.3 ± 0.3        | 10.0 ± 0    | 22.5 ± 2.5  |

**Table 7. General assessment of Nelson's checkermallow site habitat quality relative to Recovery Plan criteria; yes indicates a site meets a criterion, no indicates a site does not meet a criterion.**

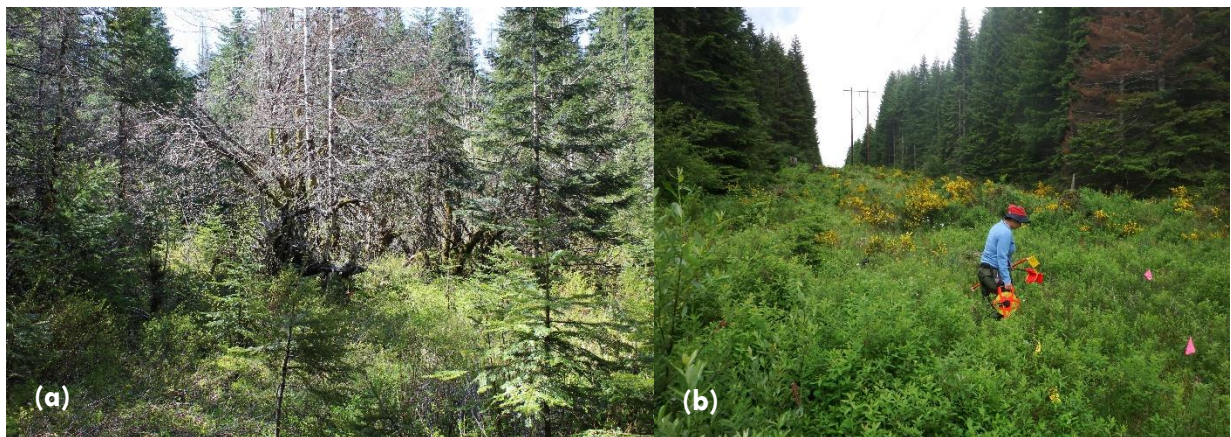
|  | Recovery Plan Criteria for Native Prairie Species Richness |             |       | Recovery Plan Criteria for Plant Community Composition (% cover) |                  |                               |                       |                    |
|--|--|-------------|-------|--|------------------|-------------------------------|-----------------------|--------------------|
|  | Forbs  | Bunch-grass | Total | Native prairie vegetation  | Woody vegetation |                               | Non-native vegetation |                    |
|  |  |             |       |  | Total            | Species of management concern | Single species        | Species of concern |
| Recovery Plan threshold                              | 7  | 1           | >10   | >50%   | <15%             | <5%                           | ≤ 50%                 | ≤5%                |
| Barney Reservoir                                     | No   | No          | No    | No   | No               | Yes                           | Yes                   | Yes                |
| Browns Camp  | No   | No          | No    | No   | No               | No                            | Yes                   | No                 |
| Devils Lake Fork Wilson River (North & South)        | Yes  | Yes         | Yes   | Yes  | No               | Yes                           | Yes                   | Yes                |
| Elliott Creek (North)                                | Yes  | Yes         | Yes   | Yes  | No               | Yes                           | Yes                   | Yes                |
| Elliott Creek (South)                                | Yes  | Yes         | Yes   | Yes  | Yes              | Yes                           | Yes                   | Yes                |
| Tillamook Burn (E and W)                             | Yes  | Yes         | Yes   | Yes  | Yes              | Yes                           | Yes                   | Yes                |
| Tillamook Burn (South Woods)                         | Yes  | Yes         | Yes   | Yes  | No               | Yes                           | Yes                   | Yes                |
| Walker Flat  | Yes  | Yes         | Yes   | Close  | No               | Yes                           | Yes                   | Yes                |
| Heritage Pines (introduced)                          | No   | No          | No    | No   | No               | No                            | Yes                   | Yes                |
| Penstemon Prairie - natural & augmentation           | No   | No          | No    | No   | No               | Yes                           | No                    | No                 |
| Penstemon Prairie - introduced & augmentation        | No   | Yes         | No    | Yes  | Yes              | Yes                           | Yes                   | Yes                |
| Quamash Prairie                                      | No   | Yes         | N     | Yes  | Yes              | Yes                           | Yes                   | Yes                |
| Rivers Bend  | Yes  | Yes         | Yes   | Yes  | Yes              | Yes                           | Yes                   | Yes                |
| Stub Stewart State Park - Dairy Creek Camp East      | Yes  | Yes         | Yes   | No   | No               | Yes                           | Yes                   | Yes                |
| Stub Stewart State Park - Banks-Vernonia State Trail | No   | No          | No    | No   | Yes              | Yes                           | No                    | Yes                |
| Tualatin River NWR - Chicken Creek                   | No   | No          | No    | No   | Yes              | Yes                           | No                    | Yes                |
| Tualatin River NWR - Oleson N                        | No   | No          | No    | No   | Yes              | Yes                           | Yes                   | Yes                |
| Tualatin River NWR - Oleson S                        | No   | No          | No    | No   | Yes              | Yes                           | No                    | Yes                |

### Devils Lake Fork Wilson River – North (ODF)

This small meadow in Tillamook State Forest has been heavily encroached by Douglas-fir, some large willows, and other native shrubs such as prickly currant (*Ribes lacustre*) (Figure 5a). Shading appears to have impacted the flowering of the remnant Nelson's checkermallow population. Despite the impact of the woody vegetation, the native prairie vegetation is diverse and is >50% in cover. Native species include California oatgrass (*Danthonia californica*), white insideout flower (*Vancouveria hexandra*), small camas (*Camassia quamash*) and largeleaf avens (*Geum macrophyllum*).

### Devils Lake Fork Wilson River – South (ODF)

On this power line corridor in Tillamook State Forest, small remnant populations of Nelson's checkermallow are influenced by the hydrology, with the central area being too wet and the west being too dry (Appendix 3). A small patch of checkermallow about 30 m south of the corridor is almost completely enclosed and shaded by tall Douglas-fir and hardwood trees. The corridor has been mowed in the past, but native shrubs, particularly rose spirea and willows, are encroaching on the available habitat (Figure 5b). The drier western and eastern ends of the habitat are dominated by introduced grasses, such as velvet grass (*Holcus lanatus*), Canada thistle, and Scotch broom, with one large patch of broom comprising >30% cover in that sector of the treatment area (Appendix 3). The core habitat for Nelson's checkermallow is dominated by a diverse assemblage of native species including *Carex* sp., bigleaf lupine (*Lupinus polyphyllus*), largeleaf avens and goldenrod (*Solidago* sp.).



**Figure 5. (a) Encroachment of Douglas-fir and native shrubs at Devils Lake North; (b) Native and invasive shrubs encroaching on Nelson's checkermallow habitat at the powerline corridor at Devils Lake South.**

### Elliott Creek – North (ODF)

A small remnant population of Nelson's checkermallow occurs in a meadow adjacent to a tributary of Elliott Creek. There is extensive encroachment of native shrubs, particularly willows, and Douglas-fir and white alder (*Alnus rhombifolia*) surround the edges of the clearing (Figure 6a). A dense infestation of Canada thistle on the north side of the stream is a threat to the Nelson's checkermallow habitat. Remnant prairie species are mostly native, including goldenrod and panicked bulrush (*Scirpus microcarpus*).

### Elliott Creek – South (ODF)

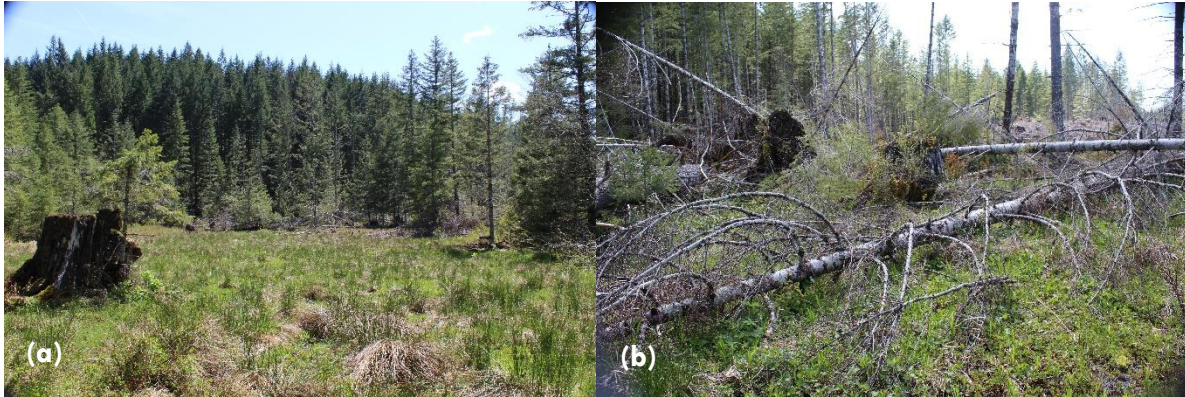
A dense natural population of Nelson's checkermallow occurs in this relatively large and open meadow. Although Douglas-fir, alders and willows are encroaching on the margins, especially on the eastern side of the meadow, there is much less threat from colonization by native shrubs compared with the other project sites in Tillamook State Forest (Figure 6b). Native prairie vegetation dominates, with water parsley (*Oenanthe sarmentosa*), shiny rush (*Juncus lacustris*) and goldenrod being principal components. However, there are scattered weeds such as Canada thistle, tansy ragwort (*Senecia jacobaea*) and velvetgrass, and a 10 m<sup>2</sup> dense patch of reed canarygrass (*Phalaris arundinacea*) at the south end of the meadow.



**Figure 6. (a) Small meadow being encroached by trees and willows at Elliott Creek North; (b) Douglas-fir trees encroaching on the meadow at Elliott Creek South.**

### Tillamook Burn (Weyerhaeuser)

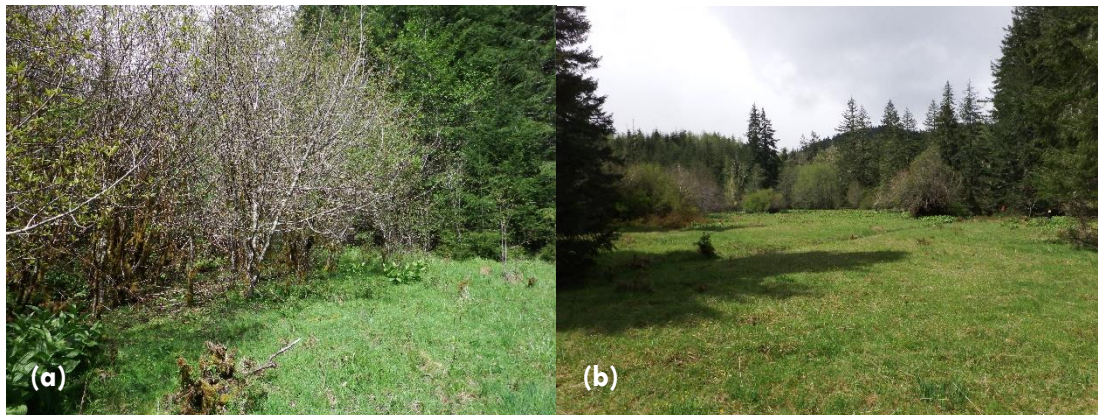
Two almost contiguous meadows are home to a large population of Nelson's checkermallow at this site (Figure 7a). The Douglas-fir forest to the west was recently logged and several large trees along the margin have since fallen into occupied habitat, particularly in the southern ends of the meadows (Figure 7b). Although much of the meadow habitat remains open, there is encroachment by Douglas-fir, with a particularly wide (10-15 m) encroaching area of young trees into Nelson's checkermallow habitat in the east side of the eastern meadow (Appendix 3). Native shrubs, such as Nootka rose (*Rosa nutkana*), California blackberry (*Rubus ursinus*) and salal (*Gaultheria shallon*) are encroaching. Native prairie vegetation dominates the meadow, including sedges and rushes, woodland strawberry, largeleaf avens, monkeyflower (*Mimulus sp.*), lance selfheal (*Prunella vulgaris ssp. lanceolata*), white insideout flower, skullcap speedwell (*Veronica scutellata*), and denseflower willowherb (*Epilobium densiflorum*). The most common invasive grass species is creeping bentgrass, and there are scattered patches of Canada thistle and Scotch broom.



**Figure 7. Tillamook Burn: (a) Open meadow habitat; (b) Fallen Douglas-fir trees in the southern part of meadows.**

### **Walker Flat (BLM portion)**

Walker Flat is a wet prairie meadow near a tributary of Walker Creek (Appendix 1), with ownership split between BLM and McMinnville Water and Light. The meadow is home to the largest Nelson's checkermallow population in the Coast Range, however, only the northern portion (owned by BLM) was surveyed in 2017 (Figure 8), due to access limitations. There is native tree and shrub encroachment in the eastern arm of the meadow (Figure 8a, Appendix 3), particularly by Douglas-fir and cascara buckthorn (*Frangula purshiana*), and to a lesser extent, black hawthorn (*Crataegus douglasii*), common snowberry and Pacific serviceberry (*Amelanchier alnifolia*). The native prairie vegetation (Figure 8b) is diverse and nearly satisfies the recovery plan threshold of 50% native cover because of species such as woodland strawberry, violet (*Viola sp.*) and California oatgrass (*Danthonia californica*). Creeping bentgrass is the dominant invasive grass, followed by tall fescue (*Festuca arundinacea*), orchardgrass (*Dactylus glomerata*), sweet vernalgrass (*Anthoxanthum odoratum*) and velvetgrass. Invasive forbs of note include oxeye daisy (*Leucanthemum vulgare*), Canada thistle, and some bull thistle (*Cirsium vulgare*), common St. Johnswort (*Hypericum perforatum*) and creeping buttercup.



**Figure 8. Walker Flat: (a) Native shrub encroachment in the eastern meadow; (b) More open meadow habitat in the main meadow, looking from the BLM property south-east into the McMinnville Water and Light property.**

### **Heritage Pines – “natural population” (Metro)**

The checkermallow occurring at a small woodland meadow in the north-east of Heritage Pines was previously thought to be Nelson's checkermallow (Silvernail *et al.* 2016), but is now thought to be meadow checkermallow (*Sidalcea campestris*), based on examination of flowering plants observed in 2017. As a result, this area will not be considered further for treatment as part of this project.

### **Heritage Pines – introduced population (Metro)**

Few native prairie components are present where Nelson's checkermallow was previously planted, and the habitat is dominated by woody vegetation, mainly ponderosa pine (*Pinus ponderosa*)(Figure 9a) with an understory of Himalayan blackberry and a ground cover of creeping bentgrass and birdsfoot trefoil (*Lotus corniculatus*). Nelson's checkermallow distribution is determined by the hydrology, as there is only a narrow band of suitable habitat that is not too wet or too dry for the species. A few individual plants have survived in three planting rows along the eastern edge of the pine plantation.

### **Penstemon Prairie – natural population (Metro)**

A small remnant population of Nelson's checkermallow occurs along a wooded drainage on the east side of Penstemon Prairie, alongside the rare Rydberg's penstemon (*Penstemon rydbergii*). Ground cover is dominated by reed canarygrass and the meadow opening is heavily shaded by willows, rose spirea and rose (Figure 9b). Metro has maintained habitat by mowing, hand-weeding and herbicide treatments.

### **Penstemon Prairie – potential augmentation (Metro)**

Metro is planning to expand the available habitat for Nelson's checkermallow along the wooded drainage to the west of the natural population. The species composition in this area is similar to that described above, but the habitat has a closed woody canopy.

### **Penstemon Prairie – introduced population (Metro)**

This prairie restoration area was seeded with native prairie species in fall 2015. When surveyed in 2017, the habitat had very recently been fully inundated, so there was a lot of bare ground and although very small seedlings were establishing, species richness was probably lower than would be apparent later in the season (Figure 9c). Native vegetation, particularly Scouler's popcornflower (*Plagiobothrys scouleri*), dominated the community, although the drier flanks of the prairie also included the introduced annual bluegrass (*Poa annua*). Previous plantings of Nelson's checkermallow have mostly failed, potentially due to the overly wet nature of the habitat.





**Figure 9. (a) Edge of ponderosa pine plantation at Heritage Pines; (b) Habitat for the natural population of Nelson's checkermallow at Penstemon Prairie; (c) Penstemon Prairie introduced habitat.**

### Quamash Prairie (Metro)

Restoration and establishment of native vegetation have been very successful at Quamash Prairie, yet previous plantings of Nelson's checkermallow have been in decline, potentially because the habitat is flooded for too long over the winter, combined with competition by other native plants. Native plant diversity is patchy, with some areas dominated by tarweed (*Madia sp.*) and bigleaf lupine (*Lupinus polyphyllus*) (Figure 10a). Other potential reintroduction sites, on higher ground, can be found in the center of the property where vegetation is currently almost entirely bigleaf lupine (Figure 10b). The southern flanks of the prairie are less dominated by native species (although still >50% cover), as there is a large component of lesser hawkbit (*Leontodon taraxacoides*) (Figure 10c). Recent habitat management has included herbicide spot spraying and hand digging of weeds, and hawkbit control has been attempted by disking.

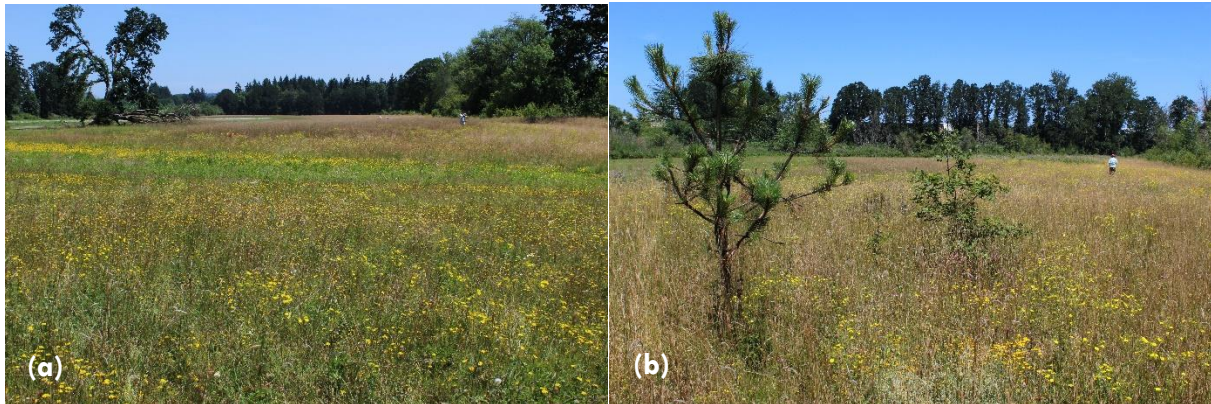


**Figure 10. Quamash Prairie; (a) Habitat where Nelson's checkermallow has previously been introduced; (b) Relatively dry habitat where Nelson's checkermallow could be introduced; (c) Upland transition zone for potential introduction.**

### Rivers Bend (Metro)

Restoration has established diverse and dense native prairie vegetation at the western end of the Rivers Bend site (Figure 11a), including California oatgrass, meadow barley (*Hordeum brachyantherum*), tufted hairgrass (*Deschampsia caespitosa*), slender cinquefoil (*Potentilla gracilis*) and lance selfheal. The most prevalent introduced forb is lesser hawkbit. Small "islands" within the prairie include trees, such as ponderosa pine and Oregon white oak (*Quercus garryana*) (Figure 11b). Previous plantings of Nelson's checkermallow had dwindled to a small number of plants by 2012 (Silvernail *et al.* 2016), but new seeding in fall 2016 has expanded the population, as seen

in 2017 (Appendix 3). Habitat management has included annual mowing, and herbicide spot spraying for broadleaf weeds and introduced grasses.



**Figure 11. Rivers Bend; (a) Open prairie; (b) Ponderosa pine and oak “island” in the prairie.**

### **Stub Stewart State Park – Dairy Creek Camp East (OPRD)**

A small forest meadow lies adjacent to Dairy Creek Camp East. Nelson's checkermallow was introduced to this site on a grassy bank that is now dominated by red fescue (*Festuca rubra*), with scattered Oregon grape (*Mahonia aquifolium*) and an infestation of Canada thistle. The wet prairie meadow has a diverse native community, including common rush (*Juncus effusus*), sedges (*Carex* sp.), bigleaf lupine, and a few scattered Nelson's checkermallow, but there is a large component of weedy grasses, including red fescue, velvetgrass and reed canarygrass, and a scattering of weedy forbs such as oxeye daisy and Canada thistle. Mature Douglas-fir dominate the periphery of the meadow, and some seedlings have established in the meadow. Several large willows dominate the center of the clearing and other native shrubs (e.g., common snowberry and Nootka rose) occupy much of the eastern half of the habitat (Figure 12a). There has been limited management of this area, apart from previous tree thinning in the forest.

### **Stub Stewart State Park – Banks-Vernonia State Trail (OPRD)**

The Nelson's checkermallow introduction site along the west side of the Banks-Vernonia State Trail, near the Manning trailhead, is in vegetation almost completely dominated by tall fescue (*Festuca arundinacea*), which is also the crop on the adjacent fields. Despite this monoculture, there is sufficient space between fescue plants for Nelson's checkermallow to thrive. There are patches of Canada thistle, bull thistle, Himalayan blackberry, and directly along the path edge, Queen Anne's lace (*Daucus carota*) and other broadleaf weeds. There are also a few scattered Oregon ash and hawthorn seedlings. Management at the site has included mowing a narrow 2-3 foot strip at the edge of the path (Figure 12b).



**Figure 12. Stub Stewart State Park; (a) Native shrub encroachment at Dairy Creek Camp East; (b) Nelson's checkermallow amongst non-native grasses alongside the Banks-Vernonia State Trail.**

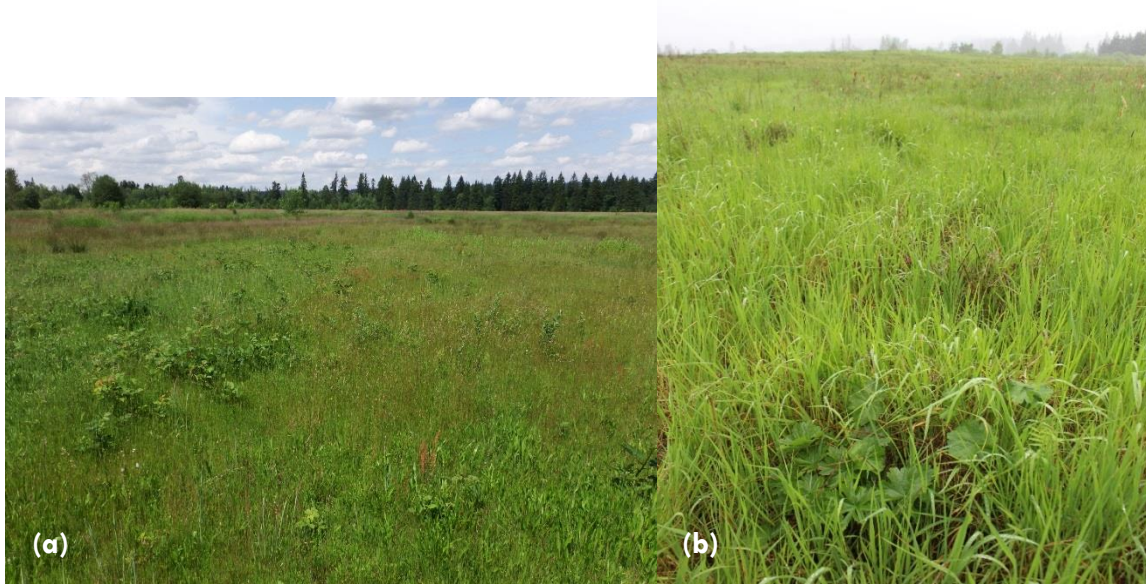
### **Tualatin National Wildlife Refuge – Chicken Creek (USFWS)**

USFWS and partners are engaged in a large-scale restoration project in the Chicken Creek wetlands of the refuge. A small project area was identified for potential introduction of Nelson's checkermallow (Figure 13a). This area has a large component of introduced grasses, particularly soft brome (*Bromus hordeaceus*). Other invasives include Himalayan blackberry and tansy ragwort; reed canarygrass is also abundant outside the proposed introduction area. Management has included mowing and broadcast and spot spray herbicide treatments. Potential effects of planned re-engineering of the Chicken Creek channel on the hydrology of this part of the wetland complex are unclear at this time.

### **Tualatin National Wildlife Refuge – Oleson (USFWS)**

Two introduced patches of Nelson's checkermallow occur in grassland adjacent to a large wet prairie/wetland on the refuge. Other previous introductions of the species failed to establish plants, potentially due to the areas being too wet for too long in the winter.

Both Oleson North and South have abundant introduced grasses (e.g., velvetgrass and tall oatgrass (*Arrhenatherum elatius*)), tansy ragwort, teasel and Himalayan blackberry. The vegetation in 2017 was tall and thick, and may be out-competing the Nelson's checkermallow (Figure 13b), particularly in Oleson South. Management has included annual mowing (although not in 2016) and herbicide spot spraying, although most invasive species management occurs outside the checkermallow areas.



**Figure 13. Tualatin River National Wildlife Refuge: (a) Chicken Creek; (b) Nelson's checkermallow growing among introduced grasses at Oleson North.**

## Habitat Restoration

The primary objective of habitat restoration is to improve habitat quality in currently occupied Nelson's checkermallow habitat, and adjacent potential Nelson's checkermallow habitat, through reducing the abundance of invasive plants; and decreasing encroachment by native and invasive woody shrub species. Both of these parameters must be addressed to move sites closer to Recovery Plan habitat quality benchmarks, and provide space and conditions suitable to maintain and increase Nelson's checkermallow abundance, again, to meet benchmarks for species recovery.

Habitat restoration in areas with threatened and endangered species on public lands requires Endangered Species Act permit coverage and reporting. The sites with USFWS-funded work (Devil's Lake, Barney Reservoir and Tillamook Burn) has ESA coverage under the PROJECTS Biological Opinion (USFWS 2015) or the National Marine Fisheries Service's PROJECTS BO (NMFS 2013). The BLM has specific compliance requirements for work on its lands at Walker Flat. Where no other restrictions apply, the USFWS PROJECTS BO guidelines were followed, using the general project design criteria (PDC) and conservation measures for Nelson's checkermallow (USFWS 2015). Some landowners have additional herbicide notification requirements, for example, herbicide work in 2017 on ODF property was approved through the Forest Activity Electronic Reporting and Notification System.

## Restoration Prescriptions

Treatments included manual, mechanical and chemical techniques. Herbicides and surfactants used this year, or planned for future use are included in Table 8. These herbicides were chosen in part because of their minimal buffer distances from waterways, as required by the PROJECTS Biological Opinion (USFWS 2015). With the exception of foam application for rosette species

(e.g., thistles) and stump/stem treatments, all herbicide application will be spot sprayed. Spray operators will be experienced in identification of Nelson’s checkermallow, and extra care will be taken to avoid spray contact when working close to Nelson’s checkermallow plants, using buckets as shields as needed. Any significant areas of bare ground created during treatments will be seeded with native species, as appropriate and depending on availability.

Treatments prescribed for control of each invasive plant and woody species are described in Appendix 5. IAE will coordinate with each landowner/manager to approve treatments prior to implementation.

**Table 8. Herbicides to be used in restoration treatments, singly or in combination, at Nelson’s checkermallow restoration sites.**

| Method                                | Herbicide  | Buffer width from water (feet) | Surfactants     |
|---------------------------------------|--|--------------------------------|-----------------|
| Spot spraying                         | Glyphosate (e.g., Rodeo)*                                | 0                              | Agridex         |
|                                       | Triclopyr (e.g., Renovate, Garlon 3a)                    | 15                             | Competitor      |
|                                       | Clopyralid (e.g., Stinger)                               | 15                             | Superspread MSO |
|                                       | Metsulphuron-methyl (e.g., Escort)                       | 15                             |                 |
|                                       | Sethoxydim (e.g., Poast) or Clethodim (e.g., Select Max) | 50-100                         |                 |
| Foam applicator (for rosette species) | Glyphosate (e.g., Rodeo)                                 | 0                              |                 |
| Stump or stem treatments              | Glyphosate (e.g., Rodeo)                                 | 0                              |                 |
|                                       | Triclopyr (e.g., Garlon 3a)                              | 0                              |                 |

\*Only glyphosate is proposed for use at Walker Flat, depending on approval by BLM.

**Restoration Actions**

A summary of restoration actions implemented in 2017 is provided in Table 9 and approximate treatment areas are included in Table 10. The focus of 2017 work in the Coast Range (with the exception of Walker Flat), was to clear encroaching trees and shrubs (Figure 14). Some of the larger trees were girdled (Figure 15). Work at Walker Flat was deferred at the direction of BLM, until 2018, when a newly hired BLM botanist would be available to collaborate and guide the NEPA compliance processes.

In most cases, when hardwoods and native and invasive shrubs were cut, the cut surface of trunks and stems were treated with a 50% solution of Garlon 3A to control re-sprouting. Stems were not treated at most of Browns Camp, because IAE staff were not present, and parts of other areas, when shrub stems were too numerous for practical or thorough treatment. Limited foliar spraying of shrubs occurred at Tillamook Burn, and spot spraying of broadleaf weeds and reed canarygrass at Stub Stewart State Park. Success of woody species control will be evaluated in 2018, and repeated as feasible, along with herbaceous vegetation control (e.g., invasive grasses, thistles, and forbs).



**Figure 14. (a) Crew from R. Franco Restoration felling a Douglas-fir at Tillamook Burn; (b) Crew from South Forks Forest Camp hauling cut trunks and branches into the surrounding forest.**



**Figure 15. (a) Some larger Douglas-fir were girdled and/or limbed. (b) Some areas of thick shrubs were cut with scrub-cutters before the stems were treated with herbicide.**

**Table 9. Summary of restoration actions implemented at Nelson's checkermallow sites in the Coast Range recovery zone and Stub Stewart State Park in 2017.**

| Location                                  | Activity  | Date                      | Who                                   |
|---|---|---------------------------|---------------------------------------|
| Barney Reservoir                          | Marked perimeter of treatment areas.  | 9/8/2017                  | IAE                                   |
| Barney Reservoir                          | Tree/shrub clearing and stump herbicide treatment.  | 10/10, 10/11 & 10/17/2017 | IAE                                   |
| Browns Camp, Devils Lake, Elliott Creek   | Marked perimeter of treatment areas.  | 9/7/2017                  | IAE, ODF                              |
| Browns Camp                               | Tree/shrub clearing and stump herbicide treatment.  | 10/9, 10/10 & 10/11/2017  | ODF, South Fork Forest Camp crew      |
| Devils Lake N & S                         | Tree/shrub clearing and stump herbicide treatment.  | 10/4 & 10/5/2017          | IAE, ODF, South Fork Forest Camp crew |
| Devils Lake South                         | Tree/shrub clearing and stump herbicide treatment.  | 10/25 & 10/26/2017        | IAE                                   |
| Elliott Creek North                       | Tree/shrub clearing and stump herbicide treatment.  | 10/3 & 10/9/2017          | IAE, ODF, South Fork Forest Camp crew |
| Elliott Creek South                       | Tree/shrub clearing and stump herbicide treatment.  | 10/2 & 10/3/2017          | IAE, ODF, South Fork Forest Camp crew |
| Stub Stewart Park - Dairy Creek Camp East | Tree/shrub clearing, stump herbicide treatment, spot spray thistles (Garlon 3A + Competitor) and reed canarygrass (Rodeo + Competitor). | 10/13, 10/23 & 10/24/2017 | IAE                                   |
| Stub Stewart Park - Banks Vernonia Trail  | Shrub clearing and spot spray broadleaf weeds & blackberry (Garlon 3A + Competitor) and reed canarygrass (Rodeo + Competitor).          | 10/24/2017                | IAE                                   |
| Tillamook Burn                            | Marked perimeter of treatment areas.  | 9/8/2017                  | IAE                                   |
| Tillamook Burn                            | Tree/shrub clearing & stump treatment.  | 9/21/2017                 | IAE, R. Franco Restoration crew       |
| Tillamook Burn                            | Tree/shrub clearing, and stump herbicide treatment of shrubs, spot spray shrubs (Garlon 3A + Competitor).                               | 9/26 & 9/27/2017          | IAE                                   |

**Table 10. Approximate restoration action extent at Coast Range Stub-Stewart State Park Nelson's checkermallow sites in 2017.**

| Area   | Overall treatment area | Approximate area (acres) treated in 2017 |                 |                      |
|--|------------------------|--|-----------------|----------------------|
|  |                        | Tree-shrub clearing                      | Stump herbicide | Spot spray herbicide |
| Barney Reservoir                                     | 0.71                   | 0.71                                     | 0.34            | 0                    |
| Browns Camp  | 0.89                   | 0.89                                     | 0.12            | 0                    |
| Devils Lake North                                    | 0.43                   | 0.43                                     | 0.43            | 0                    |
| Devils Lake South                                    | 1.25                   | 0.86                                     | 0.86            | 0                    |
| Elliott Creek North                                  | 0.29                   | 0.29                                     | 0.29            | 0                    |
| Elliott Creek South                                  | 1.37                   | 1.37                                     | 1.37            | 0                    |
| Tillamook Burn                                       | 2.94                   | 2.94                                     | 2               | 0.18                 |
| Walker Flat  | 1.08                   | 0  | 0               | 0                    |
| Stub Stewart State Park - Dairy Creek Camp East      | 1.45                   | 1.45                                     | 0.26            | 0.16                 |
| Stub Stewart State Park - Banks Vernonia State Trail | 1.3                    | 0.03                                     | 0.03            | 1.3                  |
| <b>Total</b>   | <b>11.71</b>           | <b>8.97</b>                              | <b>5.7</b>      | <b>1.64</b>          |

### Plant materials production

Nelson's checkermallow seeds were collected at Devils Lake, Elliott Creek, Tillamook Burn and Walker Flat between 08/1 and 08/16/2017. Additional seeds from a variety of native plants were collected from these sites between 07/26 and 09/07/2017. Seed is currently being cleaned, so a full set of seed weights will be available in late winter 2018.

With the objective of seed increase, 345 Nelson's checkermallow plants were planted out in a 0.1 acre field at the Metro nursery on November 9, 2017.

Nelson's checkermallow seed was supplied to Heritage Seedlings in December 2017. Plugs will be started in order to be ready for transplanting to a 0.05 acre field in fall 2018.

Other potential native species to be seeded on bare ground created during restoration treatments are listed in Table 11.



**Table 11. Potential native species to be seeded on bare ground created during treatments at Nelson's checkermallow sites.**

| Type      | Common name            | Species name                             |
|-----------|------------------------|--|
| Forb      | denseflower willowherb | <i>Epilobium densiflorum</i>             |
|           | largeleaf avens        | <i>Geum macrophyllum</i>                 |
|           | slender cinquefoil     | <i>Potentilla gracilis</i>               |
|           | lance selfheal         | <i>Prunella vulgaris ssp. lanceolata</i> |
| Graminoid | spike bentgrass        | <i>Agrostis exarata</i>                  |
|           | California brome       | <i>Bromus carinatus</i>                  |
|           | dense sedge            | <i>Carex densa</i>                       |
|           | slough sedge           | <i>Carex obupta</i>                      |
|           | California oatgrass    | <i>Danthonia californica</i>             |
|           | slender hairgrass      | <i>Deschampsia elongata</i>              |
|           | fowl mannagrass        | <i>Glyceria striata</i>                  |

## Introduction of Nelsons checkermallow

Recent introductions of Nelson's checkermallow have been undertaken in Portland recovery zone sites by Metro, and have included:

- Approximately one pound of Nelson's checkermallow seed was included with native prairie mixes sowed at 11 acres of Rivers Bend in fall 2016 (Jeff Merrill, Metro, pers. comm., August 2017).
- 5.6 pounds of Nelson's checkermallow seed was hand sown at Penstemon Prairie on 11/30/2017 (Elaine Stewart, Metro, pers. comm., December 2017).

Additional introductions will occur in 2019 as plant materials are available and habitat restoration has progressed.

## Outreach

IAE integrated this project into our organizational communication and outreach presence, with social media posts, website blogs, and highlights in our e-newsletter. One can see here "Clearing Meadows for Nelson's checkermallow" (<https://appliedeco.org/clearing-meadows-for-nelsons-checkermallow/>). We encourage partners to be social with us!

## FIRST YEAR CONCLUSIONS

### Coast Range

In the Coast Range, most populations of Nelson's checkermallow appear to be decreasing in size, potentially due to parallel declines in habitat quality. Though many of the Coast Range sites satisfy recovery criteria for native prairie species richness and cover (except for Barney Reservoir and Browns Camp), most have a high level of encroachment of trees and shrubs. This encroachment is reducing available open habitat and competition for space is causing excessive shading of Nelson's checkermallow plants, decreasing the fecundity of the populations. Elliott Creek South was an exception, where there were large mats of Nelson's checkermallow in relatively open habitat, with much less encroachment of trees and shrubs than other nearby meadows. Similarly, much of Tillamook Burn remains open habitat, and the decrease in population was relatively small (14%). Control of tree and shrub encroachment in the Coast Range is the highest priority for helping improve habitat in the Coast Range sites.

### Portland

In the Portland Recovery Zone there were a mix of decreases and increases. Substantial decreases occurred in the introduced populations at Heritage Pines, Penstemon Prairie and Quamash Prairie. These appear to be related, at least in part, to the hydrology of the sites, with habitat being flooded for too long in the winter in most years. There is also competition with native or non-native vegetation. New introductions at these sites should focus on areas that are least prone to flooding.

The increase at Rivers Bend is a reflection of new seeding of Nelson's checkermallow in 2016. This habitat already satisfies recovery criteria, and is a good site for further reintroduction of the species. Despite the poor richness and quality of native prairie habitat at the Banks-Vernonia State Trail (Stub Stewart State Park), the Nelson's checkermallow population has thrived and increased. Strategies for improving the native species component should be investigated. Conversely, numbers decreased at Dairy Creek Camp (Stub Stewart State Park), where encroachment of trees and shrubs has reduced the available habitat.

The Nelson's checkermallow population increased at Oleson North and South (Tualatin National Wildlife Refuge) since 2012-14, despite the poor quality habitat. However, since numbers are fewer than the original number planted (186 and 154 respectively; USFWS data), this indicates that the population has struggled at this site. Introductions of >1500 Nelson's checkermallow plants (USFWS data) at the neighboring Oleson wetland have failed. Ongoing control of invasive species at this site are required.

Restoration by IAE and partners at the project sites in the Coast Range and Portland recovery zones will help reverse declines in habitat. Augmentation of populations through addition of Nelson's checkermallow seed and plugs is also planned to help boost the number of sites that contribute to recovery of the species.

## NEXT STEPS

Work in 2018 will:

- Develop a specific schedule for the second round of restoration actions at individual sites.
- Plan and commence restoration actions at Walker Flat, in collaboration with BLM and hopefully McMinnville Water and Light.
- Conduct spring, summer and fall treatments at Coast Range and Stub Stewart State Park.
  - Herbicide spot spray targeting shrub regrowth, broadleaf weeds and invasive grasses.
  - Hand weeding/pulling.
  - Continue tree/shrub control in areas where coverage was not complete, or where re-sprouting is evident.
- Liaise with Metro and USFWS about restoration activities at Portland sites.
- Repeat photo points at all sites.
- Purchase native seed.
- Continue to establish Nelson's checkermallow seed increase fields.
- Start grow-out of Nelson's checkermallow plugs in fall 2018 (for planting in fall 2019).
- Annual report and partner meeting (early 2019).

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## APPENDIX 1. LOCATION MAPS OF NELSON'S CHECKERMALLOW PROJECT AREAS.

**Maps have been removed from this web version of the report.**

APPENDIX 2: NELSON'S CHECKERMALLOW POPULATION SURVEY SUMMARY

Appendix 2a: Coast Range Recovery Zone

| Project Site      | Subpopulation or sector <sup>2</sup> | Status  | 2012-14 surveys <sup>1</sup> |              |                                      | 2017 survey    |           |            |              |              |                                      |                 |
|-------------------|--------------------------------------|---------|------------------------------|--------------|--------------------------------------|----------------|-----------|------------|--------------|--------------|--------------------------------------|-----------------|
|                   |                                      |         | Year                         | Total Plants | Cover (m <sup>2</sup> ) <sup>3</sup> | Date surveyed  | Seedlings | Vegetative | Reproductive | Total plants | Cover (m <sup>2</sup> ) <sup>3</sup> | CI <sup>4</sup> |
| Barney Reservoir  | 1                                    | Natural | 2012                         | 54           |                                      | 6/20/2017      | 0         | 8          | 5            | 13           |                                      |                 |
|                   | 2                                    | Natural | 2012                         | 37           | 11.0                                 | 6/20/2017      | 0         | 23         | 22           | 45           | 1.3                                  |                 |
|                   | 3                                    | Natural | 2012                         |              | 3.1                                  | 6/20/2017      | 0         | 1          | 5            | 6            | 8.4                                  |                 |
|                   | <b>Total</b>                         |         | <b>2012</b>                  | <b>91</b>    | <b>14.0</b>                          | <b>2017</b>    | <b>0</b>  | <b>32</b>  | <b>32</b>    | <b>64</b>    | <b>9.7</b>                           |                 |
| Browns Camp       | E1                                   | Natural | 2013                         | 51           |                                      | 6/23/2017      | 0         | 12         | 7            | 19           |                                      |                 |
|                   | E2                                   | Natural | 2013                         | 33           |                                      | 6/23/2017      | 0         | 8          | 1            | 9            |                                      |                 |
|                   | E3                                   | Natural | 2013                         | 21           |                                      | 6/23/2017      | 0         | 4          | 18           | 22           |                                      |                 |
|                   | E4                                   | Natural | 2013                         | 39           |                                      | 6/23/2017      | 0         | 1          | 31           | 32           |                                      |                 |
|                   | Dispersed                            | Natural | 2013                         | 27           |                                      | 6/23/2017      | 0         | 0          | 2            | 2            |                                      |                 |
|                   | <b>Total</b>                         |         |                              | <b>171</b>   | <b>0.0</b>                           | <b>2017</b>    | <b>0</b>  | <b>25</b>  | <b>59</b>    | <b>84</b>    | <b>0.0</b>                           |                 |
| Devils Lake North | East                                 | Natural | 2014                         | 519          | 5.4                                  | 6/20/2017      | 10        | 96         | 37           | 143          | 6.0                                  |                 |
|                   | West                                 | Natural | 2014                         | 61           | 0.0                                  | 6/20/2017      | 1         | 7          | 5            | 13           | 0.1                                  |                 |
|                   | <b>Total</b>                         | Natural | <b>2014</b>                  | <b>580</b>   | <b>5.5</b>                           | <b>2017</b>    | <b>11</b> | <b>103</b> | <b>42</b>    | <b>156</b>   | <b>6.1</b>                           |                 |
| Devils Lake South | 1                                    | Natural | 2014                         | 121          |                                      | 6/20/2017      | 1         | 6          | 53           | 60           | 2.1                                  |                 |
|                   | 2                                    | Natural | 2014                         | 29           |                                      | 6/20/2017      | 0         | 2          | 5            | 7            | 0.2                                  |                 |
|                   | 3                                    | Natural | 2014                         | 37           |                                      | 6/20/2017      |           | 6          | 7            | 13           | 1.7                                  |                 |
|                   | 4                                    | Natural | 2014                         | 56           |                                      | 6/20/2017      | 1         | 42         | 6            | 49           |                                      |                 |
|                   | <b>Total</b>                         |         | <b>2014</b>                  | <b>243</b>   | <b>0</b>                             | <b>2017</b>    | <b>2</b>  | <b>56</b>  | <b>71</b>    | <b>129</b>   | <b>4.0</b>                           |                 |
| Elliott Creek     | North                                | Natural | 2013                         | 62           |                                      | 6/21/2017      | 27        | 86         | 113          | 226          |                                      |                 |
|                   | South                                | Natural | 2014                         | 18           | 116.5                                | 6/21-6/22/2017 |           | 30         | 30           | 60           | 467.0                                | 113             |

| Project Site             | Subpopulation or sector <sup>2</sup> | Status  | 2012-14 surveys <sup>1</sup> |              |                                      | 2017 survey   |           |            |              |              |                                      |                 |
|--------------------------|--------------------------------------|---------|------------------------------|--------------|--------------------------------------|---------------|-----------|------------|--------------|--------------|--------------------------------------|-----------------|
|                          |                                      |         | Year                         | Total Plants | Cover (m <sup>2</sup> ) <sup>3</sup> | Date surveyed | Seedlings | Vegetative | Reproductive | Total plants | Cover (m <sup>2</sup> ) <sup>3</sup> | CI <sup>4</sup> |
|                          | <b>Total</b>                         |         | <b>2014</b>                  | <b>80</b>    | <b>116.5</b>                         | <b>2017</b>   | <b>27</b> | <b>116</b> | <b>143</b>   | <b>286</b>   | <b>467.0</b>                         | <b>113</b>      |
| Tillamook Burn           | East Meadow                          | Natural | 2012                         | 454          |                                      | 6/20/2017     | 0         | 104        | 748          | 852          | 10.7                                 |                 |
|                          | South Woods                          | Natural | 2012                         | 703          |                                      | 6/20/2017     | 0         | 49         | 234          | 283          | 17.8                                 |                 |
|                          | West Meadow                          | Natural | 2012                         | 898          |                                      | 6/21/2017     | 0         | 33         | 531          | 564          | 5.7                                  |                 |
|                          | <b>Total</b>                         |         | <b>2012</b>                  | <b>2055</b>  | <b>0.0</b>                           | <b>2017</b>   | <b>0</b>  | <b>186</b> | <b>1513</b>  | <b>1699</b>  | <b>34.2</b>                          |                 |
| Walker Flat <sup>5</sup> | BLM West Meadow                      | Natural | 2012                         | 3969         |                                      | 6/19/2017     | 1         | 150        | 143          | 294          | 5.7                                  |                 |
|                          | City West Meadow                     | Natural |                              |              |                                      | NA            | NA        | NA         | NA           | NA           | NA                                   |                 |
|                          | BLM East Meadow                      | Natural | 2012                         | 390          | 40.8                                 | 6/19/2017     | 1         | 116        | 91           | 208          | 5.2                                  |                 |
|                          | City East Meadow                     | Natural |                              |              |                                      | NA            | NA        | NA         | NA           | NA           | NA                                   |                 |
|                          | <b>Total</b>                         |         | <b>2012</b>                  | <b>4359</b>  | <b>40.8</b>                          | <b>2017</b>   | <b>2</b>  | <b>266</b> | <b>234</b>   | <b>502</b>   | <b>10.8</b>                          |                 |

<sup>1</sup> Silvernail (2012), Silvernail et al. (2016).

<sup>2</sup> Sectors as identified in 2012-14 surveys.

<sup>3</sup> Additional cover was estimated where individual plants could not be distinguished.

<sup>4</sup> 95% confidence interval for the cover estimate from the sampled population at Elliott Creek.

<sup>5</sup> In 2017 the BLM portion of the meadows were surveyed, whereas in 2012 the surveys provided estimates for the west and east meadows without dividing between BLM and City of McMinnville ownerships. As a rough guide, the BLM portion of the population may have been about 1821, if density was even across the meadows.

**Appendix 2b: Portland Recovery Zone**

| Project Site            | Subpopulation or sector <sup>2</sup> | Status     | 2010-16 surveys <sup>1</sup> |              |                                      | 2017 survey   |           |            |              |              |                                      |
|-------------------------|--------------------------------------|------------|------------------------------|--------------|--------------------------------------|---------------|-----------|------------|--------------|--------------|--------------------------------------|
|                         |                                      |            | Year                         | Total Plants | Cover (m <sup>2</sup> ) <sup>3</sup> | Date surveyed | Seedlings | Vegetative | Reproductive | Total plants | Cover (m <sup>2</sup> ) <sup>3</sup> |
| Heritage Pines          | Natural <sup>4</sup>                 | Natural    | 2014                         | 52           |                                      | 6/1/2017      | 1         | 29         | 3            | 33           | 13.1                                 |
|                         | Pine plantation                      | Introduced | 2014                         | 86           |                                      | 6/1/2017      |           | 15         | 15           | 30           |                                      |
|                         |                                      |            | 2016                         | 29           |                                      |               |           |            |              |              |                                      |
|                         | <b>Total</b>                         |            | <b>2014</b>                  | <b>138</b>   | <b>0</b>                             | <b>2017</b>   | <b>1</b>  | <b>44</b>  | <b>18</b>    | <b>63</b>    | <b>13.1</b>                          |
| Penstemon Prairie       | Natural                              | Natural    | 2012                         | 13           |                                      | 5/23/2017     | 6         |            |              | 6            |                                      |
|                         | 1                                    | Introduced | 2012                         | 23           |                                      | 5/23/2017     | 0         |            |              | 0            |                                      |
|                         | 2                                    | Introduced | 2012                         | 48           |                                      | 5/23/2017     | 2         | 5          |              | 7            |                                      |
|                         | 3                                    | Introduced | 2012                         | 24           |                                      | 5/23/2017     | 0         |            |              | 0            |                                      |
|                         | <b>Total</b>                         |            |                              | <b>108</b>   | <b>0</b>                             | <b>2017</b>   | <b>8</b>  | <b>5</b>   | <b>0</b>     | <b>13</b>    |                                      |
| Quamash Prairie         | <b>Total</b>                         |            | 2012                         | <b>96</b>    |                                      | 5/31/2017     | <b>1</b>  | <b>12</b>  | <b>3</b>     | <b>16</b>    |                                      |
| Rivers Bend             | 1                                    | Introduced |                              |              |                                      | 6/29/2017     | 3         | 16         | 34           | 53           |                                      |
|                         | 2                                    | Introduced |                              |              |                                      | 6/29/2017     | 9         | 17         | 25           | 51           |                                      |
|                         | 3                                    | Introduced | 2012                         | 9            |                                      | 6/29/2017     | 5         | 30         | 51           | 86           |                                      |
|                         | <b>Total</b>                         |            | <b>2012</b>                  | <b>9</b>     | <b>0</b>                             | <b>2017</b>   | <b>17</b> | <b>63</b>  | <b>110</b>   | <b>190</b>   |                                      |
| Stub Stewart State Park | Dairy Creek Camp East                | Introduced | 2010 <sup>5</sup>            | 65           |                                      | 5/22/2017     |           | 17         | 2            | 19           |                                      |
|                         | Banks-Vernonia State Trail (Manning) | Introduced | 2010 <sup>5</sup>            | 125          |                                      | 5/22/2017     | Abundant  | 317        | 144          | 461          |                                      |
|                         | Banks-Vernonia State Trail (Banks)   | Introduced | 2010 <sup>5</sup>            | 5            |                                      | NA            | NA        | NA         | NA           | NA           |                                      |
|                         | <b>Total</b>                         |            | <b>2010</b>                  | <b>195</b>   | <b>0</b>                             | <b>2017</b>   | <b>0</b>  | <b>334</b> | <b>146</b>   | <b>480</b>   | <b>0</b>                             |



| Project Site                               | Subpopulation or sector <sup>2</sup> | Status     | 2010-16 surveys <sup>1</sup> |              |                                      | 2017 survey   |             |            |              |              |                                      |
|--|--------------------------------------|------------|------------------------------|--------------|--------------------------------------|---------------|-------------|------------|--------------|--------------|--------------------------------------|
|  |                                      |            | Year                         | Total Plants | Cover (m <sup>2</sup> ) <sup>3</sup> | Date surveyed | Seedlings   | Vegetative | Reproductive | Total plants | Cover (m <sup>2</sup> ) <sup>3</sup> |
| Tualatin National Wildlife Refuge - Oleson | North                                | Introduced | 2012                         | 64           |                                      | 5/30/2017     | 11          | 91         | 39           | 141          | 4.0                                  |
|  |                                      |            | 2016                         | 128          |                                      |               |             |            |              |              |                                      |
|  | South                                | Introduced | 2012                         | 11           |                                      | 5/30/2017     | 5           | 55         | 52           | 112          |                                      |
|  |                                      |            | 2016                         | 41           |                                      |               |             |            |              |              |                                      |
|  | <b>Total</b>                         |            |                              | <b>2012</b>  | <b>75</b>                            | <b>0</b>      | <b>2017</b> | <b>16</b>  | <b>146</b>   | <b>91</b>    | <b>253</b>                           |

<sup>1</sup> Silvernail (2012), Silvernail et al. (2016), USFWS (unpubl. data 2010, 2016)

<sup>2</sup> As identified in 2012-14 surveys.

<sup>3</sup> Additional cover was estimated where individual plants could not be distinguished.

<sup>4</sup> The “natural population” appears to be meadow checkermallow (*Sidalcea campestris*) and not Nelson’s checkermallow.

<sup>5</sup> Original out-planting data.

## APPENDIX 3: INVASIVE AND WOODY SPECIES MAPPING

**Maps have been removed from this web version of the report.**

## APPENDIX 4: PHOTO POINTS

Appendix 4a: Nelson's checkermallow photo point locations in the Portland and Coast Range Recovery Zones (Projection is NAD 1983 UTM Zone 10N).

**Table has been removed from this web version of the report.**

Appendix 4b: Maps of photo point locations

**Maps have been removed from this web version of the report.**

## **Appendix 4c: Photographs at photopoints**

Photographs are provided below at each photopoint. In general, photos were taken in the four cardinal directions (North = 0 degrees, East = 90 degrees, South = 180 degrees and West = 270 degrees), unless a photo was taken from the edge of a meadow to repeat a previous photo point direction. Sample photographs are provided below which are taken in the directions that are most likely to illustrate restoration changes.

**Coast Range Recovery Zone**



Barney Reservoir BR1 – 90 degrees.



Barney Reservoir BR1 – 140 degrees. Repeat of 2002 and 2012 photo.



Barney Reservoir BR2 – 354 degrees. Repeat of 2012 photo



Barney Reservoir BR2 – 90 degrees.



Barney Reservoir BR3 – 180 degrees.



Barney Reservoir BR3 – 257 degrees. Repeat of 2012 photo



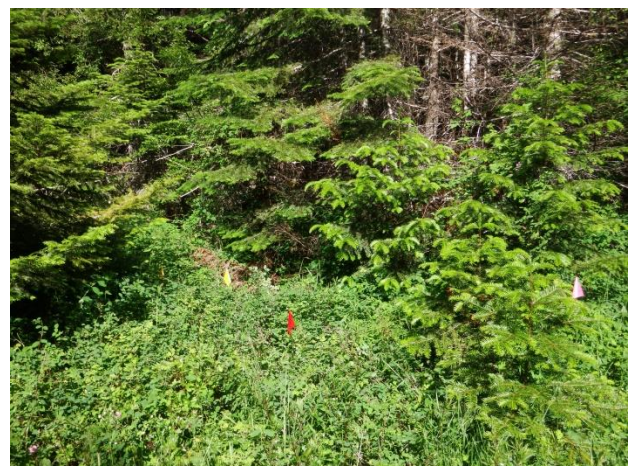
Browns Camp BC9 – 90 degrees.



Browns Camp BC10 – 270 degrees.



Browns Camp BC9 – 286 degrees. Repeat of 2014 photo.



Devils Lake North DLN1 – 90 degrees.



Browns Camp BC10 – 120 degrees. Repeat of 2014 photo.



Devils Lake North DLN11 – 357 degrees. Repeat of 2014 photo.



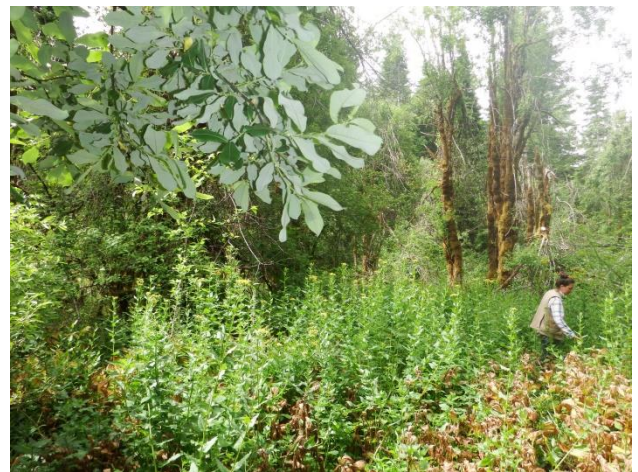
Devils Lake North DLN12 – 0 degrees.



Devils Lake South DLS2 – 0 degrees.



Devils Lake North DLN12 – 90 degrees.



Devils Lake South DLS2 – 190 degrees. Repeat of 2014 photo.



Devils Lake South DLS1 – 260 degrees. Repeat of 2014 photo.



Devils Lake South DLS3 – 90 degrees.



Devils Lake South DLS3 – 270 degrees.



Elliott Creek South ECS44 – 170 degrees.  
Repeat of 2013 photo.



Elliott Creek North ECN1 – 180 degrees.



Elliott Creek South ECS1 – 90 degrees.



Elliott Creek North ECN1 – 270 degrees.



Elliott Creek South ECS1 – 180 degrees.





Elliott Creek South ECS2 – 0 degrees.



Tillamook Burn TB1 – 0 degrees.



Elliott Creek South ECS2 – 180 degrees.



Tillamook Burn TB1 – 90 degrees. Repeat of 2012 photo.



Elliott Creek South ECS14 – 0 degrees. Repeat of 2013 photo.



Tillamook Burn TB2 – 198 degrees. Repeat of 2012 photo.



Tillamook Burn TB3 – 0 degrees. Repeat of 2012 photo.



Walker Flat WF1 – 230 degrees. Repeat of 2012 photo.



Tillamook Burn TB4 – 0 degrees.



Walker Flat WF2 – 82 degrees. Repeat of 2012 photo.



Tillamook Burn TB4 – 270 degrees.



Walker Flat WF2 – 270 degrees.



Walker Flat WF3 – 0 degrees.



Walker Flat WF3 – 90 degrees.

**Portland Recovery Zone**



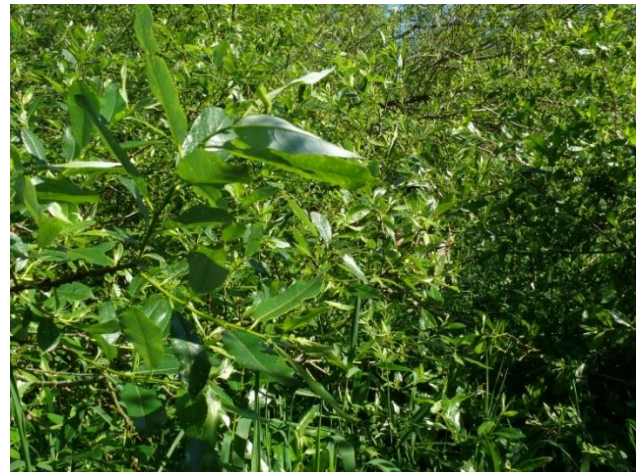
Heritage Pines HP1 – 198 degrees. Repeat of 2014 photo.



Penstemon Prairie P1 – 270 degrees.



Heritage Pines HP3 – 0 degrees.



Penstemon Prairie P2 – 0 degrees.



Heritage Pines HP3 – 90 degrees.



Penstemon Prairie P3 – 0 degrees.



Penstemon Prairie P3 – 90 degrees.



Quamash Prairie Q3 – 90 degrees.



Quamash Prairie Q1 – 302 degrees. Repeat of 2012 photo.



Quamash prairie Q4 – 90 degrees.



Quamash Prairie Q2 – 180 degrees.



Quamash prairie Q4 – 180 degrees.



Rivers Bend RB1 – 8 degrees. Repeat of 2012 photo.



Rivers Bend RB2 – 90 degrees.



Rivers Bend RB1 – 180 degrees.



Stub Stewart Dairy Creek Camp East SS1 – 13 degrees.



Rivers Bend RB2 – 0 degrees.



Stub Stewart Dairy Creek Camp East SS2 – 0 degrees.



Stub Stewart Dairy Creek Camp East SS2 – 90 degrees.



Chicken Creek CC1 – 0 degrees.



Stub Stewart Banks-Vernonia Trail SS3 – 330 degrees.



Chicken Creek CC1 – 180 degrees.



Stub Stewart Banks-Vernonia Trail SS4 – 330 degrees.



Oleson North ON2 – 0 degrees.



Oleson South OS1 – 270 degrees.



Oleson North ON2 – 180 degrees.



Oleson South OS5 – 195 degrees. Repeat of 2014 photo.



Oleson North ON6 – 290 degrees. Repeat of 2014 photo.



APPENDIX 5: RESTORATION PRESCRIPTIONS FOR WEEDS AND WOODY SPECIES OF CONCERN IN NELSON'S CHECKERMALLOW AREAS.

| Scientific name                | Common name    | Method     | Detail   | Timing          | Description  | Source |
|--------------------------------|----------------|------------|--|-----------------|--|--------|
| <i>Arrhenatherum elatius</i>   | Tall oat grass | Mechanical | Hand pulling   | June            | May be used for small infestations or close to waterways where spot spraying not possible. Pull before seed set.   | 1      |
|                                |                | Chemical   | Sethoxydim (e.g., Poast), Clethodim (e.g., Select Max), Glyphosate (e.g., Rodeo) | April; May-June | Grass-specific herbicide in early spring, Glyphosate applications can be made later but is broad spectrum and can create bare ground if spraying large patches. Note that Nelson's checkermallow plants must be buffered, shielded or protected from broad spectrum or broadleaf herbicides but this is not necessary for grass-specific herbicides. | 1      |
|                                |                | Chemical   | Glyphosate   | May-June        | Later herbicide control may be possible with Glyphosate, but more likely to affect non-target species than with the grass-specific herbicide   | 1      |
| <i>Brachypodium sylvaticum</i> | False brome    | Mechanical | Digging or hand pulling  | April-May       | Small infestations can be controlled by digging or hand pulling, to remove the whole root system, when the ground is soft, but this disturbs the soil and activates the seed bank. This can be counteracted to some extent by seeding the  | 1      |

| Scientific name        | Common name    | Method     | Detail  | Timing                          | Description   | Source  |
|------------------------|----------------|------------|---|---------------------------------|---|---------|
|                        |                |            |   |                                 | disturbed area with natives after control.  |         |
|                        |                | Chemical   | Glyphosate  | May-June;<br>July to<br>October | Glyphosate is the most effective chemical for pure stands of false brome. Grass-specific herbicide is also an option but will take 2-3 years. Spring treatment for seedlings and summer-fall for adults.  | 1, 2    |
| <i>Cirsium arvense</i> | Canada thistle | Chemical   | Clopyralid (e.g., Stinger), Triclopyr (e.g., Garlon 3A), Glyphosate (e.g., Rodeo) | May-June                        | Post emergence before the bud stage is the most effective time. IAE experience at some sites suggests that later summer spray times may be effective in combination with dead-heading the thistle flowers or seed heads to ensure that seed is not set. Fall applications are also effective. Clopyralid targets asters and affects lupines, and has residual soil activity so may affect any follow up seeding. Triclopyr has no residual soil activity. | 1, 2, 4 |
| <i>Cirsium vulgare</i> | Bull thistle   | Mechanical | Dig by hand   | May-July                        | Hand pulling is effective prior to seed production  | 2       |
|                        |                | Chemical   | Clopyralid,<br>Triclopyr,<br>Glyphosate   | May-June                        | Post emergence before the bud stage is the most effective time when plants are rapidly  | 1, 2    |

| Scientific name             | Common name                      | Method          | Detail  | Timing             | Description   | Source  |
|-----------------------------|----------------------------------|-----------------|---|--------------------|---|---------|
|                             |                                  |                 |   |                    | growing. Fall applications are also effective.  |         |
| <i>Convolvulus arvensis</i> | Field bindweed                   | Chemical        | Triclopyr   | June-August        | Careful spot spraying is required if mixed with other forbs. Retreatment is needed for effective control, because of the deep root system.  | 1, 2    |
| <i>Crataegus sp</i>         | Hawthorn (native and non-native) | Mechanical      | Cutting with chainsaws and hand tools                   | September-November | Annual cutting may be effective at maintaining an open prairie, but stems will resprout.  | 1       |
|                             |                                  | Hack and squirt | Hack with machete and spray Triclopyr (e.g., Garlon 3A) | September-October  | Make two cuts on the stem with a machete and squirt concentrated herbicide into the cut. This can be useful if wanting to limit cutting or soil disturbance.                      | 1       |
|                             |                                  | Stem treatment  | Cut stem and paint with Triclopyr                       | September-October  | Cut the tree/shrub near the ground and paint stump with concentrated herbicide. Pile the cut material in nearby forest.   | 1, 4    |
|                             |                                  | Chemical        | Foliar spray with Triclopyr                             | May-June           | Spray foliage in spring, especially for regrowth after cut treatments or fall before dormancy.  | 1       |
| <i>Cytisus scoparius</i>    | Scotch broom                     | Mechanical      | Pull by hand or weed wrench                             | May, November      | Pull seedlings and small shrubs by hand, larger shrubs with a weed wrench (generally <1 inch diameter), when soil is moist. The whole root must be extracted. Soil disturbance is | 1, 2, 3 |

| Scientific name   | Common name                                  | Method                            | Detail  | Timing                        | Description   | Source     |
|---|--|-----------------------------------|---|-------------------------------|---|------------|
|   |  |                                   |   |                               | an issue as more seed may be activated.   |            |
|   |  | Mechanical                        | Cut stems   | May-June                      | Cut stems (>1 inch) before flowering or at the beginning of the dry season, to limit resprouting.                       | 2, 3       |
|   |  | Stem treatment                    | Cut stem and paint with Triclopyr (e.g., Garlon 3A)                   | September-October             | Cut the tree/shrub near the ground and paint stump with concentrated herbicide. Pile the cut material in nearby forest. | 1, 2       |
|   |  | Chemical                          | Foliar spray with Triclopyr   | May-June                      | Spray foliage when plants are growing rapidly or at or flowering stage  | 1, 2, 3, 4 |
| <i>Dipsacus fullonum</i>  | common teasel                                | Mechanical                        | Repeated Digging or hand pulling                                      | May-June                      | Before flowering. When digging sever the root below ground level.   | 2          |
|   |  | Chemical                          | Clopyralid , Glyphosate, Triclopyr, Metsulfuron-methyl (e.g., Escort) | May-June, repeated treatments | Spray from rosette to young bolting stage. Clopyralid and Metsulfuron have some residual soil activity.                 | 1, 2, 4    |
| <i>Fraxinus latifolia</i>   | Oregon ash – encroaching on prairie          | Stem treatment                    | Cut stem and paint with Triclopyr                                     | September-October             | Cut the tree/shrub near the ground and paint stump with concentrated herbicide. Pile the cut material in nearby forest. | 1, 2       |
|   |  | Chemical                          | Foliar spray with Triclopyr   | May-June                      | Spray foliage with herbicide  | 1, 2       |
| <i>Mahonia aquifolium</i> ,<br><i>Physocarpus capitatus</i> , <i>Rosa</i> | Native shrubs encroaching on prairie habitat | Stem treatment or hack and squirt | Cut stem and paint with Triclopyr                                     | September-October             | Cut the tree/shrub near the ground and paint stump with concentrated herbicide. Pile the cut material in nearby forest. | 1          |

| Scientific name   | Common name      | Method         | Detail                                   | Timing  | Description  | Source  |
|---|------------------|----------------|--|---|--|---------|
| <i>nutkana</i> , <i>Salix</i><br><i>sp.</i> , <i>Spiraea</i><br><i>douglasii</i> ,<br><i>Symphoricarpos</i><br><i>albus</i> |                  |                |  |   | Alternatively, Make two cuts on the stem with a machete and squirt concentrated herbicide into the cut. This can be useful if wanting to limit cutting or soil disturbance.  |         |
|   |                  | Chemical       | Foliar spray with Triclopyr              | May-June  | Spray foliage with herbicide   | 1       |
| <i>Phalaris arundinacea</i>   | reed canarygrass | Chemical       | Clethodim (e.g., Select Max), Glyphosate | April-June, or September-October, multiple times. | Grass-specific herbicide in early spring, or where Nelson's checkermallow or desirable native forbs are mixed in with the grass. Glyphosate applications are generally more effective and can be made later but it can create bare ground if spraying large patches. | 1, 2, 4 |
| <i>Prunus sp.</i>   | Plum             | Stem treatment | Cut stem and paint with Triclopyr        | September-October                                 | Cut the tree/shrub near the ground and paint stump with concentrated herbicide. Pile the cut material in nearby forest.  | 1       |
| <i>Pseudotsuga menziesii</i>  | Douglas-fir      | Mechanical     | Cut trees and seedlings                  | September-October                                 | Cut down trees and seedlings < 12 inch diameter that have spread into the meadows in the last 5 years, buck and pile woody material in forest the nearby forest to create wildlife habitat.  |         |
|   |                  | Mechanical     | Limb or Girdle                           | September-October                                 | Limb or girdle older trees that are shading Nelson's checkermallow.  |         |

| Scientific name          | Common name          | Method         | Detail   | Timing                      | Description   | Source     |
|--------------------------|----------------------|----------------|--|-----------------------------|---|------------|
| <i>Pyrus communis</i>    | Pear                 | Stem treatment | Cut stem and paint with Triclopyr  | September-October           | Cut the tree/shrub near the ground and paint stump with concentrated herbicide. Pile the cut material in nearby forest. | 1          |
| <i>Ranunculus repens</i> | creeping buttercup   | Chemical       | Foliar spray with Triclopyr  | May-June                    | Spray actively growing plants. Note that successful control may require use of other chemicals.                         | 4, 5       |
| <i>Rosa multiflora</i>   | multiflora rose      | Stem treatment | Cut stem and paint with Triclopyr  | September-October           | Cut the tree/shrub near the ground and paint stump with concentrated herbicide. Pile the cut material in nearby forest. |            |
|                          |                      | Chemical       | Foliar spray with Triclopyr  | May-June                    | Spray foliage when leaves are fully expanded  | 1, 2       |
| <i>Rubus armeniacus</i>  | Himalayan blackberry | Mechanical     | Hand pulling or digging  | All year                    | Only effective for small areas and if canes, roots and root crowns are removed entirely.                                | 2          |
|                          |                      | Chemical       | Foliar spray with Triclopyr  | June-July or August-October | Spray post-emergence when actively growing in mid-summer or early fall after flowering and fruiting                     | 1, 2, 3, 4 |
| <i>Senecio jacobaea</i>  | Tansy ragwort        | Chemical       | Clopyralid (e.g., Stinger), Glyphosate (e.g., Rodeo), Metsulfuron-methyl (e.g., Escort), Triclopyr (e.g., Garlon 3A) | May-June; September-October | Up to flowering stage or in the fall when plants are sending nutrients to the roots.                                    | 1, 2, 3    |
|                          |                      | Manual         | hand pulling   | any time                    | Small infestations can be controlled by digging or hand pulling.  |            |

Source:1 IAE; 2 DiTomoaso *et al.* 2013; 3 Northwest Weed Management Partnership (2009); 4 Prather *et al.* (2016). 5 Cascadia Prairie-Oak Partnership Listserv (2015).