

**U.S. Fish and Wildlife Service
Tualatin River National Wildlife Refuge**

**Wildlife and Habitat Management Review
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I. Introduction

The U.S. Fish and Wildlife Service (Service) is the principle Federal agency responsible for conserving, protecting and enhancing fish, wildlife and plants, and their habitats for the continuing benefit of the American people.

The mission of the Service is "*...working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people*" (NPI 99-01). In order to address the mission and its extensive array of statutory responsibilities, the Service implemented an ecosystem approach to fish and wildlife management. The goal of the Service's ecosystem approach is "*...as the Service, working closely with others, carries out its mission and mandates, it will constantly strive to contribute to: the effective conservation of natural biological diversity through perpetuation of dynamic, healthy ecosystems*" (052 FW1.3B{1}).

The Service manages the 150-million-acre National Wildlife Refuge System, which encompasses 550 national wildlife refuges and more than 3,000 waterfowl production areas. The National Wildlife Refuge System Improvement Act (Refuge Improvement Act) of 1997 states that "The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

In support of the Service's mission, the National Wildlife Refuge System Administration Act of 1966, as amended (16 U.S.C. 668 dd-668ee), was recently amended by the National Wildlife Refuge System Improvement Act of 1997 – Refuge Improvement Act specifically mandates "*...each refuge shall be managed to fulfill the mission of the System, as well as the specific purposes for which that refuge was established...provide for the conservation of fish, wildlife, and plants and their habitats within the System; ensure that the biological integrity, diversity, and environmental health of the System are maintained for the benefit of present and future generations of Americans...monitor the status and trends of fish, wildlife, and plants in each refuge...*". In addition, each refuge should support the following System goals (601 FW 1):

- A. Conserve a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered.
- B. Develop and maintain a network of habitats for migratory birds, anadromous and interjurisdictional fish, and marine mammal populations that is strategically distributed and carefully managed to meet important life history needs of these species across their ranges.
- C. Conserve those ecosystems, plant communities, wetlands of national or international significance, and landscapes and seascapes that are unique, rare, declining, or underrepresented in existing protection efforts.

- D. Provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and environmental education and interpretation).
- E. Foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, and plants and their habitats.

Section 4(a)(4)(B) of the Refuge Improvement Act requires the maintenance of the biological integrity, diversity, and environmental health of the System. Refuge Manual Chapter 601 FW 3 defines biological integrity as “... *the biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions, including the natural biological processes that shape genomes, organisms, and communities.*” Historic conditions are “...*composition, structure, and functioning of ecosystems resulting from natural processes that we believe, based on sound professional judgment, were present prior to substantial human related changes to the landscape.*” Biological diversity is defined as “*The variety of life and its processes, including the variety of living organisms, the genetic differences among them, and communities and ecosystems in which they occur.*” Environmental health is the “*Composition, structure, and functioning of soil, water, air, and other abiotic features comparable with historic conditions, including the natural abiotic processes that shape the environment.*” Simply stated biological integrity, diversity, and environmental health (BIDEH), are represented by native fish, wildlife, plants, and their habitats as well as those environmental conditions and processes that support them.

II. Purpose of Wildlife and Habitat Review

The Refuge Improvement Act directs that each refuge shall be managed to fulfill the mission of the National Wildlife Refuge System and the specific purposes for which the refuge was established; compatible wildlife-dependent recreation is a legitimate and appropriate public use; and that a comprehensive conservation plan (CCP) will be developed for each refuge.

Each CCP must identify and describe:

- 1) The purpose of the refuge and why it was established,
- 2) The fish, wildlife, and plant populations and their habitats, and the archaeological and cultural values found on the refuge,
- 3) Problems or issues that may adversely affect wildlife populations, habitats, and ways to correct or mitigate them,
- 4) Areas suitable for administrative or visitor facilities, and
- 5) Opportunities for fish and wildlife dependent recreation.

The CCP is required to have adequate public involvement during preparation.

Adjustments are made to refuge wildlife and habitat management programs (adaptive management) based on periodic evaluations. Most refuges annually use an informal approach to adaptive management to make adjustments in programs. However, there is a need to occasionally conduct more formal evaluations to ensure refuge management programs are consistent with national, regional, ecoregional, and administrative policies; and reflect

consideration of current scientific knowledge. These evaluations are needed to provide accountability and feedback and to determine if wildlife and habitat management goals and objectives are being met at all levels. Regional Office biological staff conducts refuge reviews for specific management programs, the overall program, or entire refuge operations. Refuge managers, biologists, and Service personnel from other divisions within Region 1; as well as experts from other agencies; universities; tribes; and the private sector that have expertise regarding the subject(s) of the review assist with conducting these reviews.

Finally, this review was conducted to assess past, current, and future resource management issues and practices. Information from discussions will be used by the planning team to develop recommendations and strategies for consideration during the CCP.

III. Refuge Establishment

Established in 1992 under guidelines of the Service's Urban Refuge Policy, Tualatin River National Wildlife Refuge is one of a handful of urban refuges in the country. The refuge serves a purpose to protect, restore, and manage wetland, riparian, and upland habitats for a variety of migratory birds, fish, *threatened and endangered species*, other resident wildlife, and for the enjoyment of people. Past management has been guided by 5 interim goal statements derived from the original purpose for establishing the refuge. These interim goals are to:

- Protect and restore a diversity of native habitats and associated populations of indigenous fish, wildlife, invertebrate, and plant species of the Tualatin River basin.
- Provide high quality opportunities for wildlands and wildlife-dependent recreation and environmental education to enhance public appreciation, understanding, and enjoyment of the Refuge's fish, wildlife, habitats, and cultural resources, with emphasis towards urban residents.
- Protect, restore, and develop a diversity of habitats for migratory birds such as neotropical songbirds, wading birds, and shorebirds with special emphasis on wintering waterfowl.
- Protect and restore floodplain type benefits associated with the Tualatin River, including water quality, flood storage, and water recharge, and to
- Protect, restore, develop habitats for, and otherwise support recovery of federally listed endangered and threatened species, and help prevent the listing of candidate species and species of management concern.

When acquisition is complete, the Refuge will consist of 7,370 acres of primarily floodplain habitats including 4,310 acres for the Wapato Lake Unit. High-priority areas of management emphasize conservation through land acquisition and restoration of native habitat types associated with the Tualatin River floodplain. Also among these management priorities is providing wildlife-dependent recreational uses, emphasizing environmental education and *interpretation*. As a result, management of the visitor services program closely mirrors national efforts to implement one of the six highest priorities of the Service, namely the "Connecting People with Nature" initiative.

The Wapato Lake Unit was established in 2007. This unit serves a similar refuge purpose for establishment and supports many of the same types of habitat types found on other units of the

Refuge. Managing wetland habitats for migratory waterfowl is also an interim goal, but special emphasis is placed on wintering tundra swan populations of the Pacific Flyway.

IV. Background Information

The Refuge and its satellite Wapato Lake Unit are both located within the mid-section of the Tualatin River basin at the northern portion of the Willamette Valley, Washington and Yamhill Counties, Oregon. The Refuge is made up of six management units: Riverboat (363 acres); Tualatin River (237 acres); Atfalati' (564 acres); Onion Flats (126 acres); Rock Creek (79 acres); and Wapato Lake (751 acres).

The Refuge's landscape is predominately flat bottomland bordered by uplands. Habitats consist of rivers and streams, seasonal, scrub-shrub, and forested wetlands, riparian forests, stream side riparian areas, wet and dry prairies, oak/pine savanna, and mixed forested uplands. Some of these landscapes are among the best representative examples of severely depleted habitats remaining in the Willamette Valley. When flooded in fall and winter, floodplains provide habitat for salmonids as well as migrating and wintering ducks, Canada geese, tundra swan, and a variety of other waterbirds. Common ducks include northern pintail, green-winged teal, mallard, and American wigeon. Canada geese include dusky and cackling sub-species. Habitats also support important breeding populations of wood ducks, and to a lesser extent; hooded mergansers, cinnamon teal, blue-winged teal, and mallards. The Refuge also is a significant breeding area for migratory landbirds.

Over 230 species of wildlife can be found on the Refuge indicating the richness and diversity of species for this area. Diverse habitats of the Refuge support both resident and migratory species including 11 species of fish, 5 species of amphibians, 4 species of reptiles, 24 species of mammals, and at least 184 species of birds. Birds of Conservation Concern (FWS 2008) that have been recorded on the Refuge include the following:

Peregrine falcon	Rufous hummingbird
Short-billed dowitcher	Willow flycatcher
Bald eagle	Olive-sided flycatcher
Short-eared owl	Solitary sandpiper
Long-billed curlew	Marbled godwit

Federally listed species, candidate species, species of concern, and delisted species of the area include the following:

- Listed Species
 - Nelson's checker-mallow, *Sidalcea nelsoniana* (T)
 - Upper Willamette River winter-run steelhead, *Oncorhynchus mykiss* (T)
 - Upper Willamette River Chinook, *Oncorhynchus tshawytscha* (T)
- Candidate Species
 - Streaked horned lark, *Eremophila alpestris strigata*
- Species of Concern
 - Northwestern Pacific pond turtle, *Actinemys marmorata marmorata*
 - Northern red-legged frog, *Rana aurora aurora*
 - Pacific lamprey, *Lampetra tridentate*

- Delisted Species
 - Aleutian cackling Canada goose, *Branta Canadensis leucopareia*
 - Peregrine falcon, *Falco peregrinus anatum*
 - Bald eagle, *Haliaeetus leucocephalus*

The Refuge preserves a wetland ecosystem and provides a wildlife center in the shadow of Oregon's largest metropolitan area, Portland. The concept of creating the refuge originated from local citizenry, cities, and governments. As a result, the Refuge enjoys a tremendous amount of public support. This "local ownership" of the refuge has also resulted in very high expectations of the Service to develop and manage the refuge in an efficient and effective manner.

Refuge outdoor facilities include trails, foot bridges, a river overlook and wetland observation deck, photography blind, five environmental education study sites, a wayside, and numerous interpretive exhibit panels. These facilities complement and act as an anchor for the state-of-the-art administrative office and wildlife center. They also provide a quality working environment for refuge staff as well as a visitor experience which creates an appreciation of our natural world and personal values in stewardship of resources for supporting the National Wildlife Refuge System.

Because of its urban setting, the refuge faces external threats that reflect the urbanization of the surrounding landscape. Sherwood has been cited as one of the fastest growing cities in Oregon with residential and commercial development continuing to expand at an exponential rate. Metropolitan Services District (Metro) has expanded the Urban Growth Boundary (UGB) since refuge establishment to accommodate growth of municipalities. Many of the habitats adjacent to the floodplain are now targeted for construction and development. Floodplain habitat also is being impacted by removing and converting riparian forest plant communities to agriculture. At the Wapato Lake Unit, impacts to riverine and other water dependent habitats are of concern due to potential hydrology alterations of the floodplain. Lastly, wildlife is continually being pressured into occupying smaller areas as habitats become further fragmented and reduced. This fragmentation further eliminates access to remaining travel and migration corridors. In summary, the Refuge must somehow address challenges of urban development contributing to spatial and connectivity issues among refuge units and within the larger landscape.

The effects of climate change to the Refuge and greater ecosystem may be widespread over the next 15 years and beyond. Although these effects remain largely unknown, it will be imperative that the Refuge adopt and implement adaptive management principles as new information becomes available. In the face of climate change, these actions may be the most beneficial conservation strategies when carried out in combination with partner activities at a landscape level.

V. Management Issues

Issue: Seasonal and Scrub-Shrub Wetlands

Providing high quality habitat to support wintering and migrating waterfowl and other migratory birds (e.g., shorebirds) is a major emphasis for refuge management. As a result, considerable resources are expended in managing wetland communities for the benefit of these guilds, particularly northern pintails, dusky and cackling Canada geese which have regional and Pacific flyway importance. Primary wetland management actions consist of mimicking historic wetland hydrology on an annual basis using water control structures (WCSs) to produce desirable food and cover plant species, and provide wetland features during appropriate times of the year for resting, foraging, or breeding of wetland-dependent wildlife. Maintaining and operating WCSs requires continual funding and refuge staff time. In recent years, some wetland basins on the Refuge have experienced heavy encroachment from noxious weeds and invasive species including cocklebur, velvetleaf, reed canary grass, and Bermuda grass. Mechanical removal (e.g., mowing, disking), herbicides, and water management have controlled these species with varying degrees of success. These techniques are often labor intensive and expensive to implement.

Much of the management effort has been focused on wetland basins on the Steinborn parcel of the Atfálati' Unit that were restored during 1997. Past and current management actions have sought to deter woody encroachment into these seasonal basins and conduct basin manipulations such as mowing or disking to enhance and promote diversity of annual moist-soil plants. Ability to successfully achieve production of desirable wetland plants on an annual basis is limited by basin topography, soil types, and duration and timing of flooding. If these habitat manipulations were to cease, many of the wetland basins would naturally revert to other habitat types such as riparian forest, scrub shrub wetland, or possibly wet prairie. Allowing this habitat succession to occur would likely diminish use by waterfowl and shorebirds, but benefit other migratory bird guilds such as landbirds, rails, and soras. Cessation of active management could also result in pioneering of invasive species such as reed canary grass as these habitat types transition.

Management Recommendations

1. Continue to intensively manage seasonal wetlands providing the best moist-soil plant communities utilized by wintering waterfowl. A select number of seasonal wetlands should be converted to scrub-shrub, riparian forest, or wet prairie as identified under #2.
2. Allow succession of select intensively managed seasonal wetlands to scrub-shrub wetlands, riparian forest, or wet prairie. Succession or conversion should be based upon the following factors: pervasive and extensive infestations of invasive plants (e.g., Bermuda grass, cocklebur); subject to disturbance from uncontrollable, off-refuge activities (e.g., waterfowl hunting) that reduce migratory bird use; soil types; and unit elevation/bottom morphometry which are not conducive to producing mudflats for migrating shorebirds or moist soil production.
3. For units to be maintained as seasonal wetlands, continue to use mechanical techniques (e.g., mowing, hand cutting) to remove encroaching woody species.

4. Avoid drawdowns before late June in selected wetlands that support key habitat for red-legged frogs in the absence of abundant invasive plant species.
5. Where feasible to control reed canary grass, implement water management strategies utilizing extended flooding to kill RCG and delay drawdown to prevent germination.
6. Use mechanical techniques (e.g., disking) to control canary grass infested wetlands. Disking mimics the natural process of flood-induced scouring that occurred before the hydrology of the Tualatin River basin was altered by agriculture and urbanization.
7. Evaluate the use of herbicide applications in combination with prescribed fire or disking as additional IPM techniques to control canary grass.
8. In scrub-shrub wetlands plant cuttings of woody species in moist areas that would likely survive without the need for extensive watering to help combat infestations of reed canary grass.
9. Continue utilizing mechanical removal (mowing, disking), water level management, and herbicides as an IPM approach to control noxious weeds and invasive species (e.g., cocklebur, velvetleaf) in seasonal and scrubshrub wetland habitats.
10. Continue the use of mowing and disking along with water level management to promote moist-soil annuals in seasonal wetlands. Conduct disking in wetlands on 4-5 year rotations to promote moist-soil annuals while reducing invasive plants and woody species.
11. Where possible, continue the use of staggered drawdown schedules in seasonal wetlands that maximize the availability of mudflats for migrating shorebirds. Staggered drawdowns should not be used in wetlands with previous history of invasive plants issues like cocklebur.
12. If purple loosestrife is present in refuge wetlands, then eradicate as quickly as possible. Conduct wetland monitoring to detect presence of loosestrife as well as infestations of other invasive plants (e.g., cocklebur, knotgrass).
13. Coordinate with Water Resources Branch to ensure that existing water rights provide maximum flexibility to use water allocations for wildlife management purposes and timing of water use is best suited to achieve habitat objectives.
14. Construct a visible screen (row) of Oregon ash that is offset from the levee bordering the Dennis wetland, adjacent to the private duck club. This woody screen would likely reduce disturbance to waterfowl using the wetland caused by hunting on the private duck club. Offsetting from the levee would prevent the trees from compromising the structural integrity of the levee.

Issue: Perennial Streams and Floodplains

The Refuge contains several perennial streams as well as seasonally flooded habitat types that potentially support listed salmonid species and other native fish and wildlife species. Chicken Creek and other perennial streams entering the Refuge have been severely altered by channelization for agriculture and other purposes over the past decades. As stream and river levels naturally rise during winter, some off-channel areas are inundated and may provide protection and foraging areas for salmonid species; however, there are currently no data to indicate whether or not salmonids are using these areas or at what time of year salmonids may be present in the refuge portion of the Tualatin River Basin. It is possible that flooding of some off-channel areas may pose an entrapment issue for listed salmonid species as flooding recedes. Refuge staff have worked with NOAA-Fisheries biologists to allow passage from managed wetland basins back into the main stem of the Tualatin River through design modifications of

wetland outlet structures. A water diversion and fish passage structure on Chicken Creek is maintained to provide water for several wetland basins. The structure is designed to divert some water from Chicken Creek for wetland use and pass the remaining water down the creek. The diversion is screened to prevent fish from entering the wetland system, and weirs are in place to assist fish in passing the diversion point. The fish ladder and screen system were designed and installed prior to listing of salmonids in the Tualatin River basin.

Management Recommendations

1. There was agreement among the review participants that restoring perennial streams (e.g., Chicken and Rock creeks) to their historic meandering courses on the Refuge that have been severely altered by channelization for agriculture (before refuge establishment) would be beneficial to native fish (including salmonids) and wildlife, where feasible.
2. Creek restoration projects on the Refuge should be prioritized considering factors such as potential to re-activate floodplain functionality; vulnerability to high, flash flows during winter months that would require new or modified in-channel structures; existing water rights tied to diversion points for wetland management; benefit to salmonids such as off channel refugia for juvenile salmonids; and benefits to other native species like brook and Pacific lampreys.
3. Conduct a topographic relief/hydrology assessment to determine surface water interactions between river levels and floodplain elevations with an outcome of frequency and duration of flooding inundation, including off-channel backwater areas near the river.
4. To protect restored creek segments, maintain, where necessary, existing channelized sections to act as spillways for high flash flows during storm events. Restored creek segments also would provide storm water retention so the Refuge can help address flood control.
5. Contact Water Resources Branch to conduct a water resource inventory and assessment to address refuge-wide water quality and water rights issues associated with habitat management. Where needed, change the place and time of use of existing water rights for wildlife habitat so there is maximum flexibility to use water for resource management on the Refuge.
6. Assess whether the Refuge is diverting adequate quantities of water to maintain existing surface water rights tied to streams.
7. Coordinate with NOAA-Fisheries during development of the CCP about the effects of management actions (e.g., restoring creeks to historic channels, re-activation of floodplain, creating swales). Incorporate effects into the CCP (environmental consequences) so these analyses can be used by NOAA-Fisheries to prepare an interagency consultation accounting for effects from the full range of habitat management and restoration activities that would provide overall benefits to listed salmonids. There was agreement among the review participants that salmonids could become entrapped in re-activated floodplain so there would be “take”; however, the overall benefits to salmonid populations are likely to far outweigh negative impacts from possible entrapment/loss of a small number of individual fish.
8. Develop additional swales along the Tualatin River corridor to promote connectivity of in-stream and backwater habitats for salmonids. Because review participants found existing swales appropriately designed for fish, creation of additional swales in the future should be based upon the same construction principles.

Issue: Wetland and Water Delivery Infrastructure

Management Recommendations

1. Evaluate water control structures for refuge wetlands to determine if they should remain or be removed to meet priority management objectives such as for wetland dependent wildlife species or passage for salmonids. .
2. In the absence of restoring Chicken Creek to its original channel evaluate major diversions (e.g., Chicken Creek) to assess the capacity to handle progressively larger flash flows during winter months. In recent years, flows >1200 cfs have been recorded and higher discharges are expected in future years with more development within the Urban Growth Boundary encompassing the refuge watershed.
3. Evaluate water control structures to determine if modification is required to allow complete dewatering of surface-connected waters within wetland basins.
4. For restoration/reconfiguration of streams with legal diversion points (e.g., Chicken Creek), coordinate with Water Resources Branch on the legal process to change the point of diversion associated with management of wetlands.
5. Utilize water allocations for wetland management that are tied to water rights. For example, there is a water right associated with the Dennis wetland's water control structures.

Issue: Riparian Forest

Riparian and mixed coniferous/deciduous forest communities provide important habitat within the Refuge for migrating landbird species and other wildlife. Although much of the remaining habitat is narrow and fragmented, it may be providing a migration corridor among larger blocks, some of which exist on private land. Restoring and expanding existing habitat to improve connectivity is a high priority for refuge management.

Management Recommendations

1. Identify priorities for riparian and mixed coniferous/deciduous forest restoration across the refuge considering connectivity with existing forest habitats on and off-refuge lands. At a landscape level, seek to achieve connectivity of riparian habitats that are functional (not sinks) for migrating and breeding landbirds.
2. Plant over story, native trees as the first step in re-establishing structural components of riparian forest. Conduct tree plantings during the fall and water at least 2 times during the first year to ensure survival.
3. After native trees are established (#2), then plant native shrubs underneath trees that would survive better in shaded conditions compared to areas of exposed sunlight.
4. Where feasible, mulch around woody plantings to promote survival, health, and growth through conservation of water and mycorrhiza introduction. This management strategy also will reduce herbicide use for invasive plant control over time.
5. With over story and under story development, plantings of herbaceous species likely will not be necessary because they likely will naturally recruit/regenerate.

6. Conduct forest stand assessments to evaluate current conditions and develop restoration options so these habitats serve as fully functioning systems meeting biological requirements of high-priority landbird species.
7. Allow natural succession through woody recruitment to convert select seasonal wetlands to riparian forest. See *Issue: Seasonal and Scrub-shrub Wetlands*.

Issue: Wet and Upland Prairies

Wet meadow prairies are among the rarest plant communities in the Willamette Valley with less than 1% remaining since European settlement. Prairies are characterized by native grasses and forbs with almost no trees or shrubs. These plant communities were maintained by Native Americans through the use of fire to provide valuable food plants and hunting opportunities. In the absence of fire, these communities are difficult to maintain as a result of encroachment from trees and shrubs as well as invasive plant species such as reed canary grass. Current management actions consist of mowing and herbicide treatments to maintain these communities. As previously noted, some seasonal wetland communities may naturally move toward wet prairie plant species, but it is unknown how many acres of habitat is necessary to be of benefit to guilds such as migratory landbirds. In early 2008, refuge staff re-introduced federally threatened Nelson's checker-mallow to the Refuge as an experimental population in an effort to help with recovery of this species. To date, the listed plants are thriving and more plantings may be undertaken to enhance populations.

Management Recommendations

1. There was consensus among review participants that maintaining existing and restoring prairie habitats should be considered a management priority for the Refuge. These habitats have been severely degraded or lost throughout the Willamette Valley. As rare, unique native habitats, they represent biological integrity on the Refuge, and provide habitat for birds, rare plants and invertebrates.
2. For restoration projects, be cognizant that a long-term commitment is necessary to ensure successful restoration. Carefully select restoration areas considering presence of native grasses and/or forbs, large blocks available (especially those that would be connected with existing prairie), and capability to use all management strategies (including prescribed fire).
3. As the first step to prairie restoration, conduct extensive, multiple year treatments of invasive plants to exhaust their seed bank.
4. After invasive plant treatments (#4), seed native grasses and forbs during the fall using an appropriate seeding rate (lbs/acre). Contact Kathy Pendergrass (Natural Resources Conservation Service [NRCS]) and Kurt Zonic (Metro) for specific recommendations regarding appropriate seeding rates for native grasses and forbs.
5. Utilize available local seed sources with the appropriate genotypes of native prairie grasses and forbs for restoration activities. Where possible, conduct seed collections and propagations of native grasses and forbs from the refuge and/or nearby restored partner projects as a source of restoration projects in the future.
6. Where feasible, utilize prescribed fire to promote establishment and cover of native grasses and forbs as well as remove thatch build up. For use of prescribed fire, consider smoke management, fuels preparation, containing fire risk, and haying before conducting burns.

7. As an alternative to fire for removing thatch build up, use mowing and grazing as management strategies, where feasible.
8. Conduct small-scale use of prescribed fire to evaluate habitat response in prairies; this can be implemented as a demonstration project. If there are issues with availability of fire crews during summer months, conduct fall burns during wetter days. Although 100% consumption may not be achieved with these burns, the available window for burning can be extended for prairie habitats.
9. Implement a rotational prescribed fire regime on the prairie habitats that reduces woody vegetation and thatch, and stimulates native forb growth. Burn prairie units on a variable schedule (2-4 years) providing a mosaic to ensure leaving some unburned units each year to benefit grassland birds, invertebrates, and other wildlife.
10. Use disking to stimulate early successional plant communities and/or control invasive plants such as reed canary grass in wet prairie areas not occupied by listed plants.
11. Conduct soil surveys and topographic relief/hydrology assessment to determine surface water interactions between river levels and floodplain elevations with an outcome of frequency and duration of flooding or perching of seasonal sheet water to support saturation requirements of wet meadow habitats.
12. To diversify and improve conditions for the wet prairie plant community, use grading and alter hydrology to create heterogeneity in water depth and duration of soil saturation and inundation (e.g. emulate vernal pools) based on topographic and hydrologic assessments.
13. For restoration projects, establish tolerable thresholds for invasive plants as a basis for conducting IPM treatments.
14. Utilize IPM techniques (e.g., mowing, herbicides) to control invasive grass and forb species within prairies.
15. Use mechanical treatments to remove encroaching woody species from prairie habitats.
16. Given the success of establishing the experimental population of Nelson's check mallow on the refuge, evaluate other prairie sites that would be suitable to establish additional experimental populations of this and other listed plant species.
17. Coordinate with RO-Fire Branch regarding need for and use of prescribed fire to manage prairie habitats.
18. Implement inventory and monitoring protocols of restored prairies to gather baseline life history data on use of areas by benefiting species to determine if spatial size is sufficient for sustainable populations of plants and wildlife.

Issue: Oak and Oak/Pine Savanna

Oak and oak/pine savanna communities are important habitat types that have been severely reduced in the Willamette Valley since European settlement. These habitat types were maintained by Native Americans with the use of fire to remove shrub species, stimulate desired herbaceous species, and maintain minimum density of trees. Many grassland landbirds, raptors, mammals, and oak specialists (e.g., white-breasted nuthatch) use these habitat types. The Refuge staff has undertaken restoration activities on several areas with varying degrees of success. The refuge has stands approaching 10 years of age. Tree components of these areas are robust and thrive with minimal maintenance after the first three to five years. However, native grass and forb components have had generally poor success. Non-native grasses and forbs typically dominate the landscape and are difficult to purge prior to introducing native species, and often

out-compete native species. Once established, some form of disturbance is necessary to control non-native species and stimulate growth of desired species. When forbs are included in the planting mix, herbicides are no longer an option for control of invasive broadleaf species. Mowing is often used to help control unwanted species, but control is generally marginal and may negatively affect desired species. These are fire dependent habitat types and the use of fire should be considered as a management practice.

Management Recommendations

1. There was consensus among review participants that oak and oak/pine savanna are high priority habitats to manage and, where feasible, restore on the Refuge. Because they are rare, unique habitats throughout the Willamette Valley, they are representative of biological integrity.
2. Integrate prescribe fire as a management strategy to maintain existing habitat and restore appropriate areas of the Refuge to oak and oak/pine savanna. Conduct experimental trials to evaluate timing of burning to best promote herbaceous cover while controlling invasive plants and reducing thatch buildup.
3. Continue to utilize mowing and herbicide applications for oak and oak/pine savanna habitats to promote herbaceous cover while controlling invasive plants and reducing thatch buildup.
4. Where necessary, reduce the density of oak trees using hand/mechanical cutting to a spacing of 100-300 feet across the upland prairie sites. Oak removal should be limited to trees <15 inch dbh. Trees should be moved off the native prairie for another beneficial use such as habitat structures, biomass, or another forest product including donation to community organizations, or disposed of through pile burning.
5. In the absence of prescribed fire, conduct mowing on a rotational basis to suppress encroaching woody vegetation.
6. Protect an adequate number of regenerating oaks to allow for stand perpetuation over time. Oaks may be marked for retention when thinning or protected with water/foam during prescribed burning if at risk from fire intensity.
7. Outplant bare root or container stock of seedling oaks during late fall/winter at a spacing of 50-300 feet. Supplemental watering twice during the summer growing season (July-Sept) to ensure early (first-year) survival. Monitor survival in the second growing season and replant, as necessary. Tubing or other protection from rodents or herbivores may be needed.
8. Implement measures (e.g., seed collection and redistribution, grow-out and outplanting, or no-till drilling) to supplement existing populations or establish new populations of native grass and forb species.
9. Fall seeding with native species using a no-till drill is preferred; broadcast seeding and following with a cultipacker is an optional strategy. Use different seed mixes to permit follow-up treatments during Year 1 such as: seed grasses only to allow subsequent applications of broadleaf herbicides; seed forbs only to allow subsequent applications of grass-specific herbicides; seed diverse mixes and spot treat undesirable vegetation; or seed diverse mixes and conduct frequent low mowing for the first two years after establishment.
10. For restored sites, prescribed fire may be used on a 3-5 year rotation to reduce thatch buildup and stimulate forb growth; however, protection of seedling oaks likely will be necessary for the first 15-25 years.

11. Coordinate with RO-Fire Branch about the need for prescribed fire to manage oak and oak/pine savanna habitats.

Issue: Water Quality

As an urban refuge, there are external threats likely impacting water quality and quantity to refuge wetlands and streams from the surrounding watershed. There is concern that refuge wetland basins may be acting as sinks for pesticides and heavy metals received from urban storm water runoff, or adjacent agricultural practices, but no data are currently available. However, ongoing urban development in the watershed has caused a change in water flow regimes in both perennial streams entering the refuge and into the Tualatin River. During winter months, perennial streams (Rock and Chicken creeks) experience high flash flows due to increased non-pervious surfaces from buildings and roads in the upper watershed. Chicken Creek is the primary source of water used to manage wetland basins on the Steinborn parcel. The creek is fed by Cedar Creek, which runs through the majority of the City of Sherwood. In the last several years, flow rates have consistently increased, impacting the water diversion structure on the Steinborn parcel and causing thousands of dollars worth of damage. A recent repair and enhancement project was completed to make the structure more resilient to flood events, but it is unknown at this time if this will be the long term solution to the problem. A major portion of the Refuge and the entire Wapato Lake Unit lie within active agricultural areas where farming practices may be impacting wetlands from pesticide and sediment loading of the wetland system.

Throughout the Tualatin River Valley, landscape alterations have contributed to higher winter flow rates in the Tualatin River. Extreme flood events have caused damage to refuge infrastructure, and flooding of wildlife habitat has rendered it less suitable for foraging and resting. Flooding of this nature can also contaminate the floodplain by bringing with it oils, pesticides, and other chemicals released from areas upstream. Additionally, Total Maximum Daily Loads (TMDLs) have been established for the Tualatin River by the Oregon Department of Environmental Quality (DEQ). One of the TMDLs affecting refuge water management is temperature. Because of high water temperature in the Tualatin River during summer months, the refuge staff is restricted to dewatering some wetlands by April 30th to prevent further increase in river water temperature. This drawdown can be detrimental for maintaining optimal wetland habitat conditions to benefit wildlife because early drawdowns promote canary grass infestations that displace native and moist-soil annuals. Temperature loggers both in the river and adjacent wetlands have shown higher water temperature in the wetlands, but no discernable, measurable increases in river temperatures at and downstream of refuge outlet structures discharging water have been recorded.

Management Recommendations

1. Assess the contaminant loading associated with storm water run-off for major creeks (e.g., Chicken Creek) supplying refuge wetlands. Utilize the soon-to-be-released handbook prepared by USGS-BRD that assesses contaminant risks associated with storm water run-off.
2. See ***Issue: Onion Flats*** for best management practices (BMPs) associated with farming to reduce/minimize contaminant run-off into channelized Rock Creek.

3. Identify BMPs associated with water management of refuge wetlands that would address concerns about increased water temperatures in the Tualatin River. Conduct a mass-balance study to determine pre- and post-implementation of BMPs to quantify the relative contribution of wetland outputs to water temperatures and nutrient levels in the Tualatin River. Contact Contaminant Specialists at Oregon State Field Office regarding the preparation of an on-refuge contaminant investigation to conduct this study.
4. Discuss with Oregon DEQ the need for the FWS to prepare a TMDL implementation plan to account for refuge habitat management activities (especially wetland drawdowns) relative to 303d impairments (temperature and phosphorus) in the Tualatin River. This plan would describe BMPs that would be feasible for refuge staff to implement to address water quality impairments without compromising the achievement of wetland habitat objectives.

Issue: Onion Flats

Many land parcels purchased by the Refuge have been in agricultural production for decades prior to refuge establishment. Although the emphasis has been to restore native habitat types, cropland management is a viable option as an interim form of management. In many cases initiation of restoration activities may not occur for several years following the time of purchase. This additional time allows the refuge to secure adequate funding, complete necessary planning, and in some cases, secure adjacent lands to facilitate cost effective restoration alternatives. This is the case with the Onion Flats and Wapato Lake Units. As an interim management tool, cropland management provides substantial value to wintering waterfowl while controlling invasive vegetation. Cropland management typically consists of growing small grains such as wheat or barley, or hayed pasture. Cropland management on the Tualatin River Refuge and Wapato lake Unit has historically been managed with cooperative farming agreements arranged with local farmers. Farmers are responsible for all aspects of planting, maintaining, and harvesting with rights to retain a portion of crops harvested in lieu of financial payment to the refuge. In exchange, the refuge retains a portion of the crop as forage for wildlife. Currently, there are 92 acres under agreement on the Onion Flats Unit and 261 acres on the Wapato Lake Unit. The level of interest for local farmers to continue this practice is wavering due to a variety of factors including crop type restriction and crop market value. An alternative to cooperative farming would be to have refuge personnel conduct all farming operations and hence, retain all crops for wildlife. This method would involve a considerable investment in equipment, materials, and labor resources.

Management Recommendations

1. Continue to use cooperative farming as an interim measure to control invasive plants and provide forage (e.g., barley, wheat) for migrating and wintering waterfowl. Also, continue the current share ratio of 70:30.
2. Utilize BMPs (e.g., vegetative buffers) to prevent fertilizers, sediment, and herbicides used in small grain farming from reaching Rock Creek in order to protect water quality.
3. Continue to provide improved pasture for wintering Canada geese. Hay it during the early season with an early September mowing so the browse is <6 inches and palatable for geese by October 1. Providing sustainable browse during the winter would help address off-refuge goose depredation from a rising population of cackling geese.

4. Mow upper bench of the unit (currently reed canary grass) to provide browse for wintering Canada geese.
5. Continue to aggressively pursue acquisition of in-holdings at Onion Flats. Because only 33-50% of lands in this unit are owned in fee title by the Service, restoration cannot be conducted at this time.
6. After acquisition of in-holdings as described under #6, move forward with restoration of the historic Rock Creek including re-activation of natural floodplain. There was agreement among review participants that creating backwater habitat with an active floodplain and shrub-shrub wetlands would be beneficial to salmonids and migratory birds.
7. Conduct a topographic relief/hydrology assessment and other engineering assessments (i.e., geomorphic to identify historic stream meander) to determine surface water interactions between river levels and floodplain elevations to arrive at estimates for frequency and duration of flood inundation to determine what habitats should be prioritized for restoring, (i.e., habitat restoration plan).

Issue: NRCS Restoration

This 220-acre tract is owned by the City of Hillsboro with a Wetland Reserve Program restoration easement currently in progress. Natural hydrology of the tract has been altered by river levees, tile drains, and surface ditching to support previous farming activities. Since 2007, habitat restoration activities on the tract by NRCS have been supported by mitigation funding for pipeline installation. NRCS' goal was to restore riparian forest and prairie habitats on the tract. This restoration has involved herbicide applications to control reed canary grass and no till drilling of seeds for native wet and dry prairie grasses. After establishment of grasses, native forbs were to be planted in prairie areas. The Service could assume long-term habitat management responsibilities on the tract.

Management Recommendations

1. Allow natural breaching of levees over time to re-activate the floodplain and create additional backwater habitat for migratory birds and native fish (especially salmonids).
2. Remove/crush tile drains (especially the main drain to river) to promote/restore natural hydrology.
3. Utilize management actions identified under ***Issue: Riparian Forest***. Conduct riparian forest restoration at appropriate elevations before the dike completely breaches.
4. On slightly higher benches of the tract, restore wet prairie at appropriate sites utilizing management strategies identified under ***Issue: Wet and Upland Prairies***.
5. At the highest elevations on the tract, alternate management between short grass for wintering geese, and unmanaged grasslands for high-priority migratory birds (e.g., nesting meadowlarks). After grassland habitat becomes rank, use prescribed fire (every 2 to 3 years) to produce short-grass (browse) for wintering geese. Use mowing as a management strategy during late summer and early fall to maintain short grass for wintering geese and other waterfowl.
6. See ***Issue: Elk*** for population management of the elk herd that might utilize this tract.

Issue: Wapato Lake

Wapato Lake is known to be the second largest area of Labish soils in Oregon, which indicate historic occurrence of scrub shrub wetlands and other rare habitats (e.g., wet prairie). The lake bed was naturally supplied by backwater from the Tualatin River as well as perennial creeks. The natural hydrology of the historic Wapato Lake bed was altered by agricultural conversion during the mid-1930s. Dikes were built, approximately 5.5 miles, to surround the lake bed to prevent natural drainage and backfilling of river water into the lake basin. These outer dikes also serve to delivery water to irrigate crops during the growing season. To date, dikes and levees have been maintained by the Wapato Irrigation District (WID). The main diversion point from the Tualatin River supplying water to irrigation users is not screened and there are concerns about fishery resources including wintering steelhead, overwintering and spawning Coho, wintering cutthroat trout, and Pacific lamprey.

Currently, there have been fish die-offs in the river adjacent to Wapato Lake documented by Oregon Department of Environmental Quality. These die-offs have been attributed to poor water quality (high temperatures and low dissolved oxygen) during summer months.

During January 2007, the Service completed the *Tualatin River National Wildlife Refuge Wapato Lake Unit Addition, Land Conservation Plan and Environmental Assessment*. This EA described protecting and restoring up to approximately 4,310 acres of fish and wildlife habitat as the Wapato Lake Unit of the Refuge. Wildlife and habitat management priorities selected through the Finding of no Significant Impact for the EA are the following:

- Protect and restore a diversity of rare and native habitats and associated populations of fish, wildlife, invertebrate, and plant species.
- Protect, restore, and develop a diversity of habitats for migratory birds such as landbirds, wading birds, and shorebirds with special emphasis on wintering waterfowl (tundra swans).
- Protect and restore floodplain benefits associated with the Wapato Lake wetland complex and Tualatin River Basin including water quality, flood storage, water recharge, and floodplain habitats.
- Protect, restore, and develop habitats for and otherwise support recovery of federally-listed threatened and endangered species and help prevent the listing of candidate species and species of management concern.

Through successful acquisition of property within the boundary of the WID, the process can begin for habitat restoration of the Wapato Lake bed identified in the EA. Based upon existing WID by-laws, a landowner with 75% controlling interest can dissolve the WID. Therefore, the WID can be dissolved by the Service after it becomes the dominant landowner; this would allow initiation of habitat restoration.

Management Recommendations

1. There was consensus among the review participants to conduct large-scale restoration of a mosaic of native habitat, when feasible. Given the extensive areas of Labish soils, there would be potential to restore substantial areas of scrub-shrub wetlands and large tracts of prairie habitats on upper elevation benches, eventually giving way to Oregon ash riparian

forest. Habitat restoration efforts would improve watershed health and function by protecting and restoring areas of rare remnant native habitat such as scrub shrub wetlands and Oregon ash riparian forest. These plant communities are representative examples of severely depleted habitats of the Willamette Valley. The Oregon Natural Heritage Program has referenced Oregon ash and scrub-shrub habitats as among the rarest which remain in the Valley and suggests they be considered the highest priority for protection because of their former historical status and range of importance for promoting biological diversity on a landscape scale.

2. Restore meandering riverine channels and riparian habitat along stream banks as well as wetlands within the historic Wapato Lake lakebed. This will improve water quality and enhance migration passage functions of the Tualatin River for two federally-listed species, spring-run Chinook salmon and winter-run steelhead. Mainstem and upper tributaries of the Tualatin River historically provided spawning, passage, and rearing habitat.
3. Evaluate hydrological inputs supplied from perennial sources like Wapato and Ayers creeks.
4. Although not identified in the recovery plan, assess the potential to re-introduce Oregon Chub into Wapato Lake. However, any chub introduction should not impact habitat restoration efforts.
5. There was general agreement among the review participants that there would be overall benefits to anadromous fish including those listed and other salmonids associated with restoring natural hydrology and floodplain functionality. As with natural systems, individual fish may be stranded so there will be recognized levels of take associated with habitat restoration in the lake bed.
6. For restoring habitats in the lake bed, utilize natural hydrology and historic channels, where possible, to avoid/minimize restrictions for water releases associated with the river TMDL.
7. Secure LIDAR imagery for determining topographic relief at a detailed scale for modeling with river hydrology information and geomorphic data to determine flood inundation specifics and historic stream meanders for predicting habitat restoration acreage configurations and spatial relationships to guide implementation of habitat restoration.

Issue: Urban Growth Boundary/Land Protection

Under Oregon law, every city or metropolitan area in the state has an UGB. Metro is responsible for managing Portland metropolitan region's UGB. Land inside the UGB supports urban services such as roads, water and sewer systems, parks, schools and fire, and police protection that create thriving urban centers. The UGB protects farms and forests outside the boundary from urban sprawl. At this time, Metro 2040 Growth Concept is re-evaluating delineation and management of the UGB for Portland metropolitan region.

Management Recommendations

1. Coordinate with conservation partners (including public agencies and NGOs) to protect habitats adjacent to the Refuge and outside the UGB. Identify this partnership effort within the refuge's CCP.
2. Explore opportunities to develop an easement or private lands program for the Tualatin River Basin to protect existing and restore floodplain and riparian habitats. Work collaboratively with the Willamette Valley NWRC's in implementation of Great America Outdoors Land Conservation Program to protect important habitat in the upper Willamette Valley ecosystem.

3. To develop an easement and/or private lands program for the refuge as described in #2, it is essential to have a 1.0 FTE dedicated specifically to it.
4. Identify and prioritize lands adjacent to the Refuge and outside the UGB that would be most important to protect over time. Evaluate existing habitat on the refuge as well as potential restoration projects in the context of providing habitat connectivity and functionality at a larger landscape level. This would support conservation and management of trust resources such as migratory birds.

Issue: Non-Native Fauna

Non-native animal populations that occur on refuge lands include nutria, bullfrogs, carp and other non-native fish species, and feral cats. These species degrade habitat and affect native wildlife populations directly or by displacement. Nutria affect habitat by destroying desirable plants such as softstem bulrush and native woody shrubs, and can also have detrimental effects on water management infrastructure by digging dens into levees and wetland banks. Tunnels and dens often cause levees to leak or cause safety hazards to refuge personnel when tunnels and dens collapse under equipment such as tractors or refuge vehicles. Bullfrogs displace native red-legged frogs and eat a myriad of native wildlife species. Common carp eat submerged aquatic vegetation and cause turbidity degrading water quality and reducing photosynthesis in aquatic plants. Other non-native fish include several sunfish species, catfish, and mosquito fish. These species have been shown to impact native fisheries and may negatively affect other wildlife species. Feral cats have been observed on most refuge units and are known predators of native wildlife, including migratory landbirds and small native mammals.

Although beavers are a native species, they cause damage to water control structures and native vegetation. The Refuge is currently experimenting with “beaver levelers” at some water control structures to discourage beavers from clogging and damaging structures. Possible changes in infrastructure and/or recontouring wetland basins may help reduce the presence of some non-native animal species. For example, some wetlands retain water at full drawdown so carp and bullfrogs may survive and reproduce. Complete drawdown of refuge wetlands would reduce or eliminate these species.

Management Recommendations

1. Where possible, completely dewater wetlands on a regular (e.g., annual) basis to control bullfrog and carp populations. Be cognizant that bullfrogs in the area have been found to complete metamorphosis in one year rather than two. If units cannot be completely desiccated, then drawdown wetlands to their lowest levels to maximize the kill of bullfrog tadpoles.
2. Collaborate with USGS to conduct surveys to detect for presence of non-native crayfish within refuge wetlands. If present, investigate treatment and control measures as they are a highly invasive species.
3. To prevent nutria from damaging levees, use riprap or other underlayment options. Also, consider the following levee construction principles to deter nutria: oversized spillways, 8:1 slopes, and little freeboard.
4. Where possible, avoid building levees in floodplains that are highly attractive to nutria.

Issue: Elk

The effect of establishing and conserving refuge lands with respect to wildlife depredation may be twofold depending on circumstances. On one hand, crop depredation can be reduced by providing foraging and cover areas on the refuge for waterfowl and resident species such as black-tailed deer. On the other hand, refuge lands may increase wildlife populations and, therefore, magnify depredation problems on adjacent private lands. Black-tailed deer in the Willamette Valley are largely non-migratory and have a relatively small home range. With an increase in restored natural habitat available on refuge lands, deer populations may expand or simply shift from using adjacent agricultural areas to refuge habitats. To date, there have been no deer depredation complaints received by the refuge staff.

The Willamette Valley is designated an “elk de-emphasis zone” by the Oregon Department of Fish and Wildlife (ODFW). This designation emphasizes removal of elk to prevent depredation issues. Although very few elk have been observed, an increase in elk populations could occur given the Refuge is currently closed to elk hunting. The Wapato Lake Unit is much more rural in nature and populations of elk are less than one mile away. Increased elk use of the Wapato Lake area could cause conflict among private landowners, ODFW, and the Refuge. Options for limited recreational hunting on refuge lands may exist and could possibly be considered as a compatible public use.

Management Recommendations

1. Because the Wapato Lake Unit is situated within the state’s Willamette Game Management Unit, an elk de-emphasis zone, coordinate with ODFW to remove elk that use this unit as refugia. The Service supports elk management by ODFW in order to prevent depredation on private lands as well as promote public safety by minimizing potential for vehicle collisions with animals on highways immediately adjacent to the refuge unit.
2. Coordinate with ODFW to develop a range of hunting opportunities that aggressively remove elk, including special hunts like youth and archery. Hunting options must consider safety issues given the highway immediately adjacent to the refuge unit.
3. Consider opening the refuge to elk hunting by preparing an opening package. Prepare an opening package that includes a hunt plan, concurrence letter from state, appropriate NEPA document (e.g., EA), and other necessary compliance documentation (e.g., CD, Section 7).
4. Consider other means of selective elk population controls that are cost effective and management efficient.

Issue: Mosquitoes

Mosquitoes are native species inhabiting aquatic habitats (e.g., seasonal wetlands) on the refuge, where adults and larvae provide important forage for a variety of migratory birds and bats. Mosquitoes may reproduce in refuge wetlands associated with routine habitat management including dewatering during spring and summer. During the past few years, surveys for mosquito larvae have revealed low numbers of larvae at most monitoring locations. To date, there have been no mosquito-borne disease issues documented near the Refuge, but some nuisance complaints have been filed with the county. There are many horse properties near the

Refuge and concern about West Nile Virus exists among these horse owners. Washington County's Department of Health and Human Services has contacted refuge staff regarding monitoring and treatment of mosquitoes. Refuge staff have conducted monitoring for mosquito larvae, but no treatments have been applied on refuge lands to date. Survey reports prepared by refuge have been sent to the county on an annual basis.

Management Recommendations

1. Because mosquito monitoring and necessary treatments represent a refuge use (603 FW 2), these activities should be conducted by Washington County and not the refuge staff. County staff should be responsible for identifying species-specific thresholds to justify mosquito treatments on refuge lands.
2. Coordinate with Washington County to identify the appropriate locations on the refuge to conduct monitoring for larval and/or adult mosquitoes. Refuge staff should not be responsible to conduct mosquito monitoring larvae or adult surveillance for presence of disease.
3. In cooperation with the county, develop a mosquito monitoring and treatment strategy for the Refuge that is consistent with the Director's guidance for mosquito management on refuges (April 2005). A key component of this strategy is a response matrix that describes use of pesticides (larvicides, pupacides, or adulticides) based upon monitored areas of the refuge exceeding established larval and/or adult thresholds. Moreover, the use of pupacides and adulticides on the Refuge can only occur where public health experts have declared a human health threat or emergency.

VI. Review Participants

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