B O N N E V I L L E   P O W E R   A D M I N I S T R A T I O N

Habitat Evaluation Procedures (HEP) Report;

Sandy River Delta

Technical Report 2000 - 2002 | February 2002 | DOE/BP-00005685-5

This Document should be cited as follows:

Rocklage, Ann, John Ratti, "Habitat Evaluation Procedures (HEP) Report;; Sandy River Delta", 2000-2002 Technical Report, Project No. 199902500, 38 electronic pages, (BPA Report DOE/BP -00005685-5)

Bonneville Power Administration
P.O. Box 3621
Portland, OR 97208

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA.

Habitat Evaluation Program (HEP)

HABITAT SUITABILITY INDEX (HSI) MODELS FOR SELECTED AVIAN SPECIES ON THE SANDY RIVER DELTA, OREGON

Submitted to:

Virginia Kelly
U.S. Forest Service
902 Wasco, Suite 200
Hood River, OR 97031

And

Dan Golner
Ducks Unlimited
1101 SE Tech Center Dr
Suite 115
Vancouver, WA 98683

Submitted by:

Ann M. Rocklage and John T. Ratti
Department of Fish and Wildlife Resources
University of Idaho, Moscow, ID 83844-1136

Project Number 1999-025-00
Contract Number 00005685

20 February 2002

TABLE OF CONTENTS

INTRODUCTION 3

OBJECTIVES 6

METHODS 6

MODELS 9

Black-capped Chickadee 9
Marsh Wren 10
Future Scenarios.— *10*
Red-winged Blackbird 11
Future Scenarios.— *12*
Wood Duck 14
Future Scenarios.— *14*
Yellow Warbler 15
Future Scenarios.— *16*
RESULTS 17

Black-capped Chickadee 18
Marsh Wren 19
Red-winged Blackbird 19
Wood Duck 20
Yellow Warbler 20
DISCUSSION 21

ACKNOWLEDGEMENTS 23

LITERATURE CITED 24

TABLES 28

FIGURES 35

INTRODUCTION

Land managers are often challenged with the mandate to control exotic and invasive plant species. Reed canarygrass (*Phalaris arundinacea*) and Himalayan blackberry (*Rubus discolor*) are 2 such species that are currently threatening natural areas in western United States. Reed canarygrass may be native to the inland northwest (Antieau 2000), but it has invaded many wetland areas as dense, monoculture stands. Spread of this plant species is largely attributed to human disturbances, e.g., draining, farming (Antieau 2000). Reed canarygrass often dominates other emergent vegetation such as cattail (*Typha* spp.) and bulrush (*Scirpus* spp.) (Whitson et al. 1996, Apfelbaum and Sams 1987), and the resulting habitat is largely unsuitable for wetland birds. Himalayan blackberry was introduced to the United States as a garden shrub and was planted at wildlife-management areas for food and cover. It easily colonizes disturbed places, such as roadsides, ditches, and flood plains (Hoshovsky 2000). Once established, it forms a thick, impenetrable stand, which excludes native shrub species. Although Himalayan blackberry does provide food and cover for wildlife, particularly during fall and winter, it decreases habitat diversity, and therefore, may decrease wildlife diversity. Furthermore, patterns of avian nest predation may be altered in some exotic-shrub communities (Schmidt and Whelan 1999).

For land managers to make sound decisions regarding invasive-plant control, it is useful to obtain information on current plant distributions in relation to targeted wildlife species, and then use models to predict how those species may respond to changes in vegetation. The Habitat Evaluations Program was developed by the U.S. Fish and Wildlife Service to evaluate current and future habitat conditions for fish and wildlife

(Stiehl 1994). The program is based on Habitat Suitability Index (HSI) models for specific wildlife species. Each model contains several variables that represent life requisites (e.g., food and nesting cover) for that species. These variables are evaluated with vegetation sampling, and/or through the interpretation of aerial photographs and the like. Variable values are assigned a numerical score. The score may be based on a categorical rating (e.g., different vegetation types receive different scores based on their importance for that species) or may be the result of a linear relationship (e.g., the score increases with the variable value; Figure 1). Variable scores are then input into a mathematical formula, which results in an HSI score. The HSI score ranges from 0-1, with 0 representing poor-quality habitat and 1 optimal habitat. HSI models assume a positive, linear relationship between wildlife-species density and the HSI score. For example, with an HSI score of 1, we assume that a species will be present at its highest density. Models can be projected into the future by changing variable values and observing the corresponding changes in HSI scores. Most models are relatively simple, but some are complex.

These models have come under considerable scrutiny in the last several years, particularly concerning the validity of model assumptions (Van Horne 1983, Laymon and Barrett 1986, Hobbs and Hanley 1990, Kellner et al. 1992). Regardless of criticisms, these models may be used with success when there is an understanding and acceptance of model limitations. Each model should be evaluated as to its applicability in a given situation. Model validation, where results have on-the-ground verification, is highly recommended.

Within this framework, we evaluated the current and future potential vegetation and corresponding wildlife responses at the Sandy River Delta, located at the confluence of the Sandy and Columbia Rivers in Oregon, within the Columbian River Gorge National Scenic Area (Figure 2). Wetland-habitat conditions have been degraded by dense stands of reed canarygrass. Because water levels are not maintained during the summer (which enhances reed canarygrass growth), dense monoculture stands of grass have eliminated most native emergent vegetation, such as cattail, rushes (*Juncus* spp.), and sedges (*Carex* spp.).

Historically, Sandy River Delta was a wooded-riparian wetland with components of ponds, sloughs, bottomland forest, oak woodland, prairie, and low- and high-elevation floodplain. The area has been greatly altered by past agricultural practices and the Columbia River hydropower system. Restoration of historic landscape components is a primary goal, and the current focus is restoration of riparian forest and wetlands. Restoration would enhance habitat for a variety of species, including migratory and wintering waterfowl, forest-dependent neotropical birds, and amphibians and reptiles.

Himalayan blackberry is also prevalent on the Sandy River Delta, where it has largely replaced native shrubs in the understory of the black cottonwood (*Populus balsamifera trichocarpa*) forest. Native shrubs likely included willows (*Salix* spp.), red-osier dogwood (*Cornus stolonifera*), black hawthorn (*Crataegus douglasii*), elderberries (*Sambucus* spp.), snowberry (*Symphoricarpos albus*), trailing blackberry (*R. ursinus*) and blackcap (*R. leucodermis*) (unpublished data, personal communication, V. Kelly, U.S. Forest Service). Himalayan blackberry and reed canarygrass have also invaded the native upland-herbaceous vegetation.

OBJECTIVES

Specific objectives of this project were to 1) conduct avian surveys and measure the present vegetation at the Sandy River Delta, 2) input the vegetation data into HSI models for 5 avian species, 3) evaluate the current habitat suitability for these species, and 4) predict species responses to potential changes in vegetation, resulting from the removal of reed canarygrass and/or Himalayan blackberry. We selected 5 avian species that were observed on the Sandy River Delta (from previous surveys), but which may be found in reduced numbers because of the invasion of reed canarygrass and Himalayan blackberry. These species were black-capped chickadee (*Poecile atricapilla*), marsh wren (*Cistothorus palustris*), red-winged blackbird (*Agelaius phoeniceus*), wood duck (*Aix sponsa*), and yellow warbler (*Dendroica petechia*). Models for each of these species have been published by the U.S. Fish and Wildlife Service as a part of their HIS-model series (Schroeder 1982, 1983; Sousa and Farmer 1983; Short 1985; Gutzwiller and Anderson 1987). Due to funding and time limitations for this project, we evaluated *only* species that were present on Sandy River Delta *and* had previously published models. Few winter-habitat models have been published; wood duck is 1 notable exception. Much of the wetland management on Sandy River Delta is directed at winter habitat, thus, we evaluated winter habitat for wood duck and breeding habitat for the other species.

METHODS

Twenty-one sampling sites (Figure 2) were established at the Sandy River Delta and selected to represent the range of vegetation present. Sites were located in cottonwood forests, upland vegetation, and wetland areas. We conducted bird surveys on 8 June 2000 at the Sandy River Delta so that we could evaluate species presence and habitat use to facilitate choice of appropriate habitat models. We used the point count method (Ralph et al. 1993) and recorded all birds heard and seen within 50-m in a 10-minute period. Bird counts were conducted at 19 sites, and 2 additional sites were added in August 2000 for vegetation surveys (at the recommendation of V. Kelly, U.S. Forest Service).

Vegetation and habitat data were collected at all 21 sites in August 2000, when wetland areas were drained and relatively dry (site 3 was adjacent to the only inundated pond). Each vegetation plot consisted of an 11.3-m-radius circle, surrounded by 3 satellite plots of the same size. Satellite plots were located 30 m from the center circle and were oriented at 120° intervals with a random start. Data were collected within the 4 circles and at the 3 30-m transects between the center and satellite plots. Within each 11.3-m-radius circle, we collected the following data:

- Percent tree canopy cover, measured with a densiometer at the center point and 1 randomly located point 11.3 m from the center.
- Average tree height, measured with a clinometer.
- Diameter at breast height (dbh) of all snags.
- Mean water depth.
- Recorded information pertinent to the red-winged blackbird model, such as the emergent-vegetation class, water regime, the proportion of emergent-herbaceous vegetation, suitable upland-nesting habitat, and disturbance.

We estimated cover values in a 1x1 m plot, located every 5 m along each 30-m transect. We visually estimate the percent cover of:

- Deciduous shrubs.
- Hydrophitic shrubs (e.g., *Salix* spp.).
- Himalayan blackberry.
- Emergent-herbaceous vegetation.
- Cattail and bulrush.
- Reed canarygrass.
- Upland-herbaceous vegetation.

At each 1x1 m plot we also measured:

- Average height of shrubs.
- Average height of Himalayan blackberry.

Winter cover for wood duck was evaluated at 5 ponds at the Sandy River Delta in January 2001. We visually estimated the percent of water surface that was covered by shrubs, over-hanging tree crowns, woody downfall, and/or winter-persistent herbaceous species. The percent cover of reed canarygrass was also estimated.

We averaged values for each of the 21 sites (and 5 ponds for wood duck) and means were input to each species model. The result was an HSI score at each site for each species. We examined several future management and vegetation-response scenarios for each species. Scenarios were based on the removal or reduction in reed canarygrass or Himalayan blackberry, and the subsequent regrowth of native plant species (Note: this project was not designed to analyze or advocate any eradication methods or restoration techniques). Future vegetation values were input to each species HSI model.

MODELS

Black-capped Chickadee

Three vegetation variables were evaluated in the black-capped chickadee HSI model: percent tree canopy cover, average height of overstory trees, and number of snags (Schroeder 1983). Food value was represented by tree-canopy cover and height of overstory trees. The model assumed that insect abundance increased with increased canopy cover and tree height. Optimal canopy cover was 50-75%, with values increasing linearly up to 50% and decreasing above 75%. The suitability value for tree height was an increasing function with optimal habitat having an overstory at least 15 m tall. Black-capped chickadees are cavity nesters; therefore, the presence of snags was evaluated for breeding habitat. Suitable nesting snags were 10-25 cm dbh and optimal habitat would have at least 2 snags per 0.4 ha. The variable equations and HSI formula were:

- V1: For 0-50%, V1 = 0.020 (% canopy cover); for 50-75%, V1 = 1.00; for 75-100%, V1 = 2.195 - 0.016 (% canopy cover).
- V2 = 0.067 (tree height).
- V3 = 0.004 + 0.509 (number of snags)
- HSI = The lower of either: $(V1*V2)^{1/2}$ or V3.

Because model variables were not influenced by Himalayan blackberry or reed canarygrass, we did not evaluate future-potential conditions for black-capped chickadee.

Marsh Wren

Four wetland variables were evaluated for breeding habitat of marsh wren (Gutzwiller and Anderson 1987). Optimal-nesting habitat is a deep-water marsh with dense cover of cattail and/or bulrush. The first variable ranked the vegetation growth form, with emergent vegetation scoring highest. Variable 2 was percent cover of emergent vegetation, with optimal cover >80%. Optimal-water depth for Variable 3 was >15 cm. Variable 4 was percent cover of woody vegetation, which is an undesirable feature for marsh-wren habitat. The variable equations and HSI formula were:

- V1: V1 = 1.00 for cattail, bulrush; V1 = 0.50 for reedgrasses (*Calamagrostis* spp.), reed canarygrass, sedges (*Carex* spp.); V1 = 0.10 for buttonbush (*Cephalanthus occidentalis*), mangroves (*Rhizophora* spp.); V1 = 0.00 for any other habitat.
- V2: For 0-50%, V2 = 0.002(% cover emergents); for 50-80%, V2 = -1.40 + 0.030(% cover emergents); for >80%, V2 = 1.00.
- V3: For 0-15 cm, V3 = 0.010 + 0.067(water depth); for >15 cm, V3 = 1.00.
- V4 = 1.00 – 0.010(% cover woody vegetation).
- HSI = $(V1*V2*V3)^{1/3}(V4)$.

Future Scenarios.—

Two sites (Sites 3 and 11) were evaluated for future habitat conditions for marsh wrens. These sites currently hold water during winter, and if water levels were maintained throughout the breeding season, they may provide habitat for marsh wrens. We selected 4 future management and vegetation-response scenarios. For all scenarios we assumed that water levels would remain adequate (>15 cm) for marsh wrens throughout the breeding season and that percent cover of woody vegetation would remain near 0%. Variable scores for V3 and V4 were, therefore, 1.00. The 4 scenarios were:

Scenario 1: Reed canarygrass is not removed, V1 = 0.50; reed canarygrass remains at current coverages for V2.

Scenario 2: All reed canarygrass is removed and replaced by cattail and/or bulrush, V1 = 1.00; cattail/bulrush cover is 50%, V2 = 0.10.

Scenario 3: All reed canarygrass is removed and replaced by cattail and/or bulrush, V1 = 1.00; cattail/bulrush cover is >80%, V2 = 1.00.

Scenario 4: All reed canarygrass is removed but is not replace by any emergent vegetation, V1 = 0.00; emergent vegetation cover is near 0%, V2 = 0.00.

Future scenario values were input to the marsh wren HSI formula.

Red-winged Blackbird

The red-winged blackbird model (Short 1985) evaluated 3 habitat types: Condition A wetlands are permanent to semi-permanent wetlands with emergent vegetation interspersed with open water and has aquatic insects, but no carp (*Cyprinus carpio*); Condition B wetlands are those which do not meet the Condition A wetland qualifications; Condition C habitats are uplands sites. Because wetland areas at the Sandy River Delta do not contain water during the breeding season, most habitats were considered Condition C habitats. One site was adjacent to a small pond, and was hence evaluated as a Condition B wetland. Condition B wetlands are not suitable for nesting red-winged blackbirds, but their value may be increased by their proximity to suitable foraging areas, such as a Condition A wetland. Only 1 variable was used in the assessment of Condition B wetlands. Variable values and HSI formula for Condition B wetlands were:

- V6: V6 = 0.10 if foraging substrate is an understory, herbaceous layer; V6 = 0.40 if foraging area includes shrubs and trees; V6 = 0.90 if a Condition A wetland is nearby.
- HSI (Condition B wetlands) = $(0.1*V6)^{1/2}$.

Red-winged blackbirds will nest in upland habitats, although this condition is not preferred. Two variables were measured for Condition C habitats. Variable 7 evaluated the available nesting cover. Local disturbances, such as grazing and haying, were evaluated for Variable 8. Variable values and HSI formula for Condition C habitats were:

- V7: V7 = 0.10 if upland habitat has dense, tall herbaceous vegetation for nesting cover; V7 = 0.00 if any other vegetation.
- V8: V8 = 0.10 if disturbances are not present; V8 = 0.00 if disturbances are present.
- HSI (Condition C habitats) = $(V7*V8)^{1/2}$.

Because Condition B and C habitats are largely unsuitable for nesting red-winged blackbirds, formulas were devised such that the HSI scores were inherently low.

Future Scenarios.—

Seven sites were evaluated for future conditions for nesting habitat for red-winged blackbirds. Two of these sites hold water during winter (Sites 3 and 11), and if they were managed to maintain water during the breeding season, these sites could be upgraded to Condition A wetlands. We chose 4 management and vegetation-response scenarios for the new Condition A wetlands. Five variables were evaluated for Condition A wetlands. All scenarios assumed that 1) water levels would be maintained throughout the breeding season (V2 = 1.00), 2) no carp were present (V3 = 1.00), and 3) aquatic insects were present (V4 = 1.00).

Scenario 1: Reed canarygrass is not removed, V1 = 0.10; reed canarygrass remains on the wetland as a dense stand of emergents, V5 = 0.30.

Scenario 2: Reed canarygrass is removed and replaced by cattail and/or bulrush, V1 = 1.00; cattail and bulrush are present in an equal mix of emergent vegetation and water, V5 = 1.00.

Scenario 3: Reed canarygrass is removed and replaced by cattail and/or bulrush, V1 = 1.00; cattail and bulrush are present as a dense stand, V5 = 0.30.

Scenario 4: Reed canarygrass is removed, but is not replace by cattail or bulrush, V1 = 0.10; wetland is mostly open water, V5 = 0.10.

The HSI formula for Condition A wetlands was:

- HSI (Condition A wetlands) = (V1*V2*V3*V4*V5).

Because of their proximity to the new Condition A wetlands, 5 sites were upgraded to Condition B wetlands. Two future scenarios for Condition B wetlands were evaluated. We assumed the nearby Condition A wetlands were suitable for foraging; therefore, the score for Variable 6 was 0.90.

Scenario 5: No modifications to the site were made.

- HSI (Condition B wetland with reed canarygrass) = $(0.10 \cdot V6)^{1/2}$.

Scenario 6: Reed canarygrass as removed and replaced by sturdy, upland-herbaceous vegetation.

HSI (Condition B wetland without reed canarygrass) = $(0.20 * V6)^{1/2}$.

The remaining 14 sites were not evaluated for future conditions. Nine sites would remain either reed canarygrass or upland sites, mainly due to larger distances from water. Five sites were located in cottonwood forests, and were not considered suitable for red-winged blackbirds under any conditions.

Wood Duck

Winter habitat for wood duck was represented by one variable, the percent of the water surface covered by protective cover (Sousa and Farmer 1983). Suitable winter cover included shrubs, over-hanging tree crowns, woody downfall, and winter-persistent herbaceous species (e.g., cattail, bulrush, *Sparganium* spp, *Phragmites* spp). We did not consider reed canarygrass suitable winter cover. Optimal cover was 50-75%, with values increasing linearly below 50% and decreasing above 75%. The model assumed that available food was correlated with cover. The variable equations were:

- V1: For 0-50% cover, V1 = 0.020(% winter cover); for 50-75%, V1 = 1.00; for 75-100% cover, V1 = 4.00-0.040(% winter cover).

The HSI value is equal to the value of this variable.

Future Scenarios.—

We evaluated 5 future habitat conditions for wood duck at the 5 ponds. All future scenarios assumed that any methods that removed reed canarygrass will also remove the current cover for wood duck. Current suitable wood duck cover largely consisted of winter-persistent herbaceous species and we assumed that the same would apply for future conditions. In other words, we assumed that habitat alterations would not increase shrub, tree, or woody-downfall cover.

Scenario 1: All reed canarygrass is removed, but no suitable wood duck cover replaces it.

Scenario 2: All reed canarygrass is removed. Suitable wood duck cover replaces it at current coverages of reed canarygrass.

Scenario 3: All reed canarygrass is removed. Suitable wood duck cover replaces it at 50% of current reed canarygrass cover.

Scenario 4: 50% of reed canarygrass is removed, and suitable wood duck cover replaces it.

Scenario 5: 50% of reed canarygrass is removed. Suitable wood duck cover replaces only 50% of that removed.

Yellow Warbler

The HSI model for yellow warbler was based on 3 vegetation variables: percent cover of shrubs, average shrub height, and percent cover of hydrophitic shrubs (i.e., *Salix* spp. and *Alnus* spp; Schroeder 1982). These variables represented nesting cover and habitat requirements (i.e., hydrophitic shrubs as an indicator of moist habitats). The optimal shrub cover was 60-80%, with values increasing linearly from 0-60% and decreasing above 80%. Shrubs >2m tall were considered optimal, with suitability values increasing linearly from 0-2 m. Hydrophitic shrub cover was a linearly increasing function with optimal habitats containing nearly 100% hydrophitic shrubs. The variable equations and HSI formula were:

- V1: For 0-60% shrub cover, V1 = 0.009 + 0.016(% shrub cover); for 60-80% shrub cover, V1 = 1.0; for 80-100% shrub cover, V1 = 2.60 – 0.020(% shrub cover).
- V2 = 0.500(shrub height).
- V3 = 0.100 + 0.009(% hydrophitic shrub cover).
- HSI = $(V1*V2*V3)^{1/3}$.

Future Scenarios.—

Future habitat conditions for yellow warbler were evaluated at 5 cottonwood sites. Although some reed canarygrass and upland sites contained Himalayan blackberry and may benefit by its removal, we assumed that any native shrubs that may replace Himalayan blackberry would not be hydrophitic; therefore, the HSI scores would not change. We evaluated 4 future scenarios. For all scenarios we assumed that the average shrub heights would remain the same, and that this reflected site potential. We realize this may not be realistic, and that many native shrubs that replace Himalayan blackberry may reach taller heights than the blackberry (e.g., willows). If shrub heights increased, this would increase the HSI value. Based on potential historic conditions at the Sandy River Delta, we assumed that 75% of the native shrubs that returned would be species such as willows, dogwood, hawthorn (assumption based on unpublished data, personal communication, V. Kelly, U.S. Forest Service). Furthermore, we considered that most removal methods for Himalayan blackberry would not be species specific; thus, native shrubs would be removed in the process.

Scenario 1: All shrub cover is removed. Native shrubs return to current coverages.

Scenario 2: All shrub cover is removed. Native shrubs return at 50% of current coverages.

Scenario 3: Half (50%) of the shrub cover is removed. Himalayan blackberry remains at current proportions. Percent of hydrophitic shrubs is reduced proportionally by the amount of remaining blackberry. Total shrub cover returns to current coverages.

Scenario 4: Half (50%) of the shrub cover is removed. Himalayan blackberry remains at current proportions. Percent of hydrophitic shrubs is reduced proportionally by the amount of remaining blackberry. Total shrub cover returns to 50% of current coverages.

RESULTS

We classified each of the 21 sites into 3 dominant-vegetation types: 8 reed canarygrass, 5 cottonwood, and 8 upland (Tables 1 and 2). Reed canarygrass sites were upland sites or were in areas that hold water during winter. The mean cover of reed canarygrass at these sites was 72%. The cottonwood forests had an average tree canopy of 79%, and typically had an understory dominated by Himalayan blackberry. The average cover of blackberry was 47% in cottonwood forests. The upland sites were not dominated by reed canarygrass, although it was often present with an average cover of 11%. The cover of herbaceous vegetation other than reed canarygrass was 73%. These sites also contained scattered cottonwood and Himalayan blackberry patches. One of the upland sites was adjacent to a pond, which contained water and emergent vegetation.

We detected 37 birds species (Table 3), 4 of which (great blue heron, mallard, Vaux's swift, and wood duck) were only detected flying over the area. We observed all of our model species. Black-capped chickadee and yellow warbler were most abundant at cottonwood sites, but were also detected at upland sites. Red-winged blackbird and marsh wren were detected only at upland sites. We observed 3 wood ducks in flight over the wetland areas. Twenty-three bird species were detected at cottonwood sites, for an average of 13.6 individuals per site. Nineteen species were detected at upland sites, for an average of 11.9 birds per site. Only 9 species were detected at reed canarygrass sites, for an average of 4.5 birds per site. These results support our choice of model species. Although numerical results are preliminary in nature (because surveys were limited to 1 day), they also support the hypothesis that reed canarygrass may be limiting bird populations at the Sandy River Delta.

Black-capped Chickadee

Black-capped chickadee habitat was evaluated only in the cottonwood forest, and all 5 sites contained suitable habitat. Three sites had sufficient canopy cover and tree heights and had ≥ 2 snags, resulting in HSI scores >0.90. Two of the sites, however, had only 1 snag each, lowering their HSI value to 0.51.

Marsh Wren

Only site 3 currently contained water during the breeding season; thus, all other sites scored 0.00 for marsh wren habitat. The HSI value of site 3 was, nevertheless, low (HSI = 0.07) largely because of the amount and type of emergent vegetation present.

Future scenario 3 resulted in high quality habitat for marsh wrens (HSI = 1.00; Table 4). Because scenario 1 maintained current reed canarygrass cover, HSI scores were evaluated separately for each site. Site 3 had an HSI of 0.29 and Site 11 had an HSI of 0.65 for scenario 1. Scenario 2 resulted in an HSI score of 0.47 and scenario 4 scored 0.00 at both sites.

Red-winged Blackbird

No sites were currently categorized as Condition A wetlands. One site was a Condition B wetland, with an HSI score of 0.28. All other sites were Condition C upland habitats, with HSI scores from 0.00-0.10.

Seven sites were evaluated for future condition. Two sites were upgraded to Condition A wetlands and evaluated under 4 future scenarios (Table 5). Only scenario 2 resulted in high-quality habitat for red-winged blackbirds (HSI = 1.00). Scenario 1 resulted in an HSI score of 0.03, scenario 3 scored 0.30, and scenario 4 scored 0.01. Five sites were upgraded to Condition B wetlands, based on their proximity to the new Condition A wetlands. Scenario 5 scored 0.30 and scenario 6 scored 0.42 (Table 6).

Wood Duck

Current winter cover for wood duck was low ($\leq$ 5%) on the 5 ponds (Table 7). Cover of reed canarygrass averaged 69%. All ponds were currently unsuitable for wintering wood duck, with all HSI scores $\leq$ 0.10.

Future scenarios 2, 3, 4, and 5 offered improvement for wood duck habitat. The greatest gains were for scenarios 3 and 4, with a mean HSI score for both of 0.69. Scenario 1 scored 0.00.

Yellow Warbler

None of the sites scored high for suitable habitat for yellow warbler. The highest value obtained was 0.41. The absence of hydrophitic shrubs was the driving variable behind the low HSI scores. *Salix* spp. were the only hydrophitic shrubs encountered, and these were present at low values (<5% cover). The 5 cottonwood sites had shrubs of sufficient cover and height, but these shrubs were mostly Himalayan blackberry. The average HSI score at cottonwood sites was 0.35 (Table 8). The average HSI score at reed canarygrass sites was 0.17 and was 0.14 at upland sites.

Future scenario 1 produced the highest quality habitats for yellow warblers, followed by, in order, scenarios 2, 3, and 4 (Table 9). The average HSI score for scenario 1 was 0.68. All scenarios produced higher HSI scores than those for current condition.

DISCUSSION

Cottonwood forests at the Sandy River Delta were largely suitable for black-capped chickadees. The abundance of snags was the only identified limiting factor for black-capped chickadees, and possibly for other natural-cavity-nesting birds. Our vegetation-sampling method may not have been, however, the best method to measure snag abundance. Snags do not occur randomly throughout a forest, and are often found in clusters (Ohmann et al. 1994). Transect methods may better measure snag abundance and availability (Bate et al. 1999). It is unknown whether Himalayan blackberry affects the distribution and abundance of black-capped chickadees. However, the dense cover of Himalayan blackberry may prevent cottonwood seedling establishment, and may, therefore, influence future populations of black-capped chickadees and other forest birds.

Future scenarios indicated that habitat for marsh-nesting birds, such as marsh wren and red-winged blackbird, may be improved at the Sandy River Delta with appropriate water management and the replacement of reed canarygrass with cattail and/or bulrush. Although both species will nest in reed canarygrass, it may not provide adequate nest support (Gutzwiller and Anderson 1987). Furthermore, reed canarygrass does not grow over permanent deep water as does cattail and bulrush (i.e., reed canary grass usually becomes established on sites that become dry during some period of the annual cycle). Numerous studies have indicated increased protection from predators when nests of these species were placed over deep water that persisted throughout the breeding season (Verner and Engelsen 1970, Shipley 1979, Searcy and Yasukawa 1995).

Management for both of these species, however, may not be entirely compatible, particularly on small marshes. Marsh wrens are typically more abundant on marshes with dense cover of emergent vegetation (Gutzwiller and Anderson 1987). Red-winged blackbirds are more abundant in areas with an equal mix of water and emergents (Short 1985). Furthermore, marsh wrens destroy eggs and nestlings of red-winged blackbirds, presumably due to competition (Picman 1977, Picman et al. 1993, Kroodsma and Verner 1997). Red-winged blackbirds, in turn, are aggressive to adult marsh wrens (Kroodsma and Verner 1997). These species, therefore, are often spatially segregated on large marshes (Gutzwiller and Anderson 1987). One management scenario may not, therefore, be beneficial to all target species.

Likewise, wood ducks would benefit from the removal of reed canarygrass and its replacement by sturdy herbaceous species that would persist and provide cover during the winter. Other wintering waterfowl would also undoubtedly benefit (especially from establishment of native aquatic plants), although some species may require varying amounts of cover and open water. An evaluation of wood duck breeding habitat in riparian areas of the Sandy River Delta may also be useful.

Yellow warblers are closely tied to willow habitats. All future scenarios indicated that yellow warblers would benefit by the removal or reduction in Himalayan blackberry, and its subsequent replacement by native hydrophitic shrubs. An analysis of historic conditions at the Sandy River Delta verified that hydrophitic shrubs, such as willows, dogwoods, and hawthorn, were common in the under story of the cottonwood forest (unpublished data, personal communication, V. Kelly, U.S. Forest Service). Yellow warblers commonly nest in these shrub species (Knopf and Sedgwick 1992, Lowther et al. 1999). We could find no references to indicate whether Himalayan blackberry is used for nesting, but yellow warblers will nest in native *Rubus* species (Lowther et al. 1999).

Based on the future scenarios, it is apparent that wetland birds at the Sandy River Delta would benefit by the removal of reed canary grass, and its subsequent replacement by emergent vegetation, such as cattail and bulrush. Likewise yellow warblers would benefit by the reduction in Himalayan blackberry and the regrowth of native hydrophitic willows, hawthorn, and dogwood. However, we emphasize that these results are not true values and that we cannot expect exact changes in species densities with particular vegetation values. These results predict potential responses. Furthermore, vegetation responses may not be immediate, and there may be a time lag in bird responses to vegetation (e.g., Rocklage and Ratti 2000). We recommend that bird and vegetation responses to the removal of these invasive-plant species be monitored and evaluated. This information will be beneficial to other land managers who aim to eradicate reed canary grass and Himalayan blackberry on their lands.

ACKNOWLEDGEMENTS

We thank Dan Golner, Virginia Kelly, and Dave Johnson for assistance with various aspects of this project and report.

LITERATURE CITED

Antieau, C. J. 2000. Biology and management of reed canarygrass, and implications for ecological restoration. Washington State Department of Transportation, Seattle, Washington.

Apfelbaum, S. I., and C. E. Sams. 1987. Ecology and control of reed canarygrass (*Phalaris arundinacea* L.). Natural Areas Journal 7:69-74.

Bate, L. J., E. O. Garton, and M. J. Wisdom. 1999. Estimating snag and large tree densities and distribution on a landscape for wildlife management. U.S. Forest Service General Technical Report PNW-GTR-425.

Gutzwiller, K. J., and S. A. Anderson. 1987. Habitat suitability index models: marsh wren. U.S. Dept. of Interior, Fish and Wildlife Service FWS/OBS-82/10.139.

Hobbs, N. T., and T. A. Hanley. 1990. Habitat evaluation: do use/availability data reflect carrying capacity? Journal of Wildlife Management 54(4)515-522.

Hoshovshy, M. 2000. Element stewardship abstract for *Rubus discolor,* (*Rubus procerus*). The Nature Conservancy.

Kellner, C. J., J. D. Brawn, and J. R. Karr. 1992. What is habitat suitability and how should it be measured? Pages 476-487 *in* D. R. McCullough and R. H. Barrett, editors. Wildlife 2001: populations. Elsevier Science Publishers, Essex, England.

Knopf, F. L., and J. A. Sedgwick. 1992. An experimental study of nest-site selection by yellow warblers. Condor 94:734-742.

Kroodsma, D. E., and J. Verner. 1997. Marsh wren (*Cistothorus palustris*). *In* A. Poole and F. Gill, editors. The birds of North America, No. 308. The Academy of

Natural Sciences, Philadelphia, Pennsylvania, and The American Ornithologists' Union, Washington, D.C., USA.

Laymon, S. A., and R. H. Barrett. 1986. Developing and testing habitat-capability models: pitfalls and recommendations. Pages 87-91 *in* J. Verner, M. Morrison, and C. J. Ralph, editors. Wildlife 2000: modeling habitat relationships of terrestrial vertebrates. University of Wisconsin Press, Madison, Wisconsin, USA.

Lowther, P. E., C. Celada, N. K. Klein, C. C. Rimmer, and D. A. Spector. 1999. Yellow warbler (*Dendroica petechia*). *In* A. Poole and F. Gill, editors. The birds of North America, No. 454. The Birds of North America, Philadelphia, Pennsylvania, USA.

Ohmann, J. L., W. C. McComb, and A. A. Zumrawi. 1994. Snag abundance for primary cavity-nesting birds on nonfederal forest lands in Oregon and Washington. Wildlife Society Bulletin 22:607-620.

Picman, J. 1977. Destruction of eggs by the long-billed marsh wren (*Telmatodytes palustris palustris*). Canadian Journal of Zoology 55:2284-2296.

______, M. L. Milks, and M. Leptich. 1993. Patterns of predation on passerine nests in marshes: effects of water depth and distance from edge. Auk 110:89-94.

Ralph, C. J., G. R. Geupel, P. Pyle, T. E. Martin, and D. F. DeSante. 1993. Handbook of field methods for monitoring landbirds. U.S. Forest Service General Technical Report PSW-GTR-144.

Rocklage, A. M., and J. T. Ratti. 2000. Avian use of recently evolved riparian habitat on the lower Snake River, Washington. Northwest Science 74:286-293.

Schmidt, K. A., and C. J. Whelan. 1999. Effect of exotic *Lonicera* and *Rhamnus* on songbird nest predation. Conservation Biology 13(6):1502-1506.

Schroeder, R. L. 1982. Habitat suitability index models: yellow warbler. U.S. Dept. of Interior, Fish and Wildlife Service FWS/OBS-82/10.27.

______. 1983. Habitat suitability index models: black-capped chickadee. U.S. Dept. of Interior, Fish and Wildlife Service FWS/OBS-82/10.37.

Searcy, W. A., and K. Yasukawa. 1995. Polygyny and sexual selection in red-winged blackbirds. Princeton University Press, Princeton, New Jersey, USA.

Shipley, F. S. 1979. Predation on red-winged blackbird eggs and nestlings. Wilson Bulletin 91(3)426-433.

Short, H. L. 1985. Habitat suitability index model: red-winged blackbird. U.S. Dept. of Interior, Fish and Wildlife Service FWS/OBS-82/10.95.

Sousa, P. J., and A. H. Farmer. 1983. Habitat suitability index models: wood duck. U.S. Dept. of Interior, Fish and Wildlife Service FWS/OBS-82/10.43.

Stiehl, R. B. 1994. Habitat evaluation procedures workbook. National Biological Survey, Midcontinent Ecological Science Center, Fort Collins, Colorado.

Van Horne, B. 1983. Density as a misleading indicator of habitat quality. Journal of Wildlife Management 47(4):893-901.

Verner, J., and G. H. Engelsen. 1970. Territories, multiple nest building, and polygyny in the long-billed marsh wren. Auk 87:557-567.

Whitson, T. D., L. C. Burrill, S. A. Dewey, D. W. Cudney, B. E. Nelson, R. D. Lee, and R. Parker. 1996. Weeds of the west. The Western Society of Weed Science and the Western United States Land Grant Universities Cooperative Extension Services, Laramie, Wyoming, USA.

TABLES

Table 1. Mean values of vegetation variables used in Habitat Suitability Index models, Sandy River Delta, 2000.

Site	%Canopy	Tree Height, m	# Snags	% Shrubs	% Black-berry	% Hydrophitic Shrubs	% Emergent Vegetation	% Reed Canarygrass	% Upland Herbaceous	% Bulrush/ Cattail	Shrub Height, m	Blackberry Height, m
1	20.98	15.30	0	0.00	0.00	0.00	0.00	77.11	9.89	0.00	NA	NA
2	29.53	12.67	0	1.28	1.17	0.00	0.00	24.00	61.33	0.00	1.11	0.41
3	0.00	NA	0	1.06	1.06	0.00	21.83	22.89	59.39	0.00	0.26	0.26
4	0.00	NA	0	0.39	0.28	0.00	0.00	1.67	92.44	0.00	0.68	0.75
5	0.00	5.10	0	18.56	16.33	0.22	0.00	24.00	51.06	0.00	0.77	0.73
6	3.53	7.50	0	27.94	6.83	0.00	0.00	8.00	41.78	0.17	0.86	0.82
7	0.00	NA	0	0.00	0.00	0.00	0.00	0.00	98.78	0.11	NA	NA
8	0.18	NA	0	8.33	8.33	0.00	0.00	4.33	81.61	0.00	0.98	0.98
9	0.00	NA	0	7.83	7.83	0.00	0.00	81.11	7.39	0.00	1.05	1.05
10	0.00	4.35	0	0.00	0.00	0.00	0.00	83.94	13.39	0.00	NA	NA
11	0.04	NA	0	0.00	0.00	0.00	0.00	64.78	16.94	0.17	NA	NA
12	4.90	4.90	0	6.72	6.17	0.00	0.00	90.50	1.44	0.00	1.17	1.17
13	17.75	14.60	0	38.94	38.94	0.00	0.00	60.22	0.78	0.00	1.35	2.49
14	72.30	17.48	4	70.17	57.72	0.11	0.00	0.39	8.11	0.00	1.22	2.32

Table 1. Continued. Mean values of vegetation variables used in Habitat Suitability Index models, Sandy River Delta, 2000.

Site	%Canopy	Tree Height, m	# Snags	% Shrubs	% Blackberry	% Hydrophitic Shrubs	% Emergent Vegetation	% Reed Canarygrass	% Upland Herbaceous	% Bulrush/ Cattail	Shrub Height, m	Blackberry Height, m
15	59.85	14.05	2	10.94	10.11	0.33	0.00	0.00	78.17	0.00	0.72	1.43
16	86.45	18.15	5	77.50	73.61	0.00	0.00	0.00	3.00	0.00	1.30	2.29
17	0.00	NA	0	2.72	2.72	0.00	0.00	0.00	92.44	0.00	0.58	0.58
18	81.10	16.53	1	80.61	65.17	0.11	0.00	0.00	4.17	0.00	1.18	1.30
19	93.85	17.31	1	49.22	28.78	0.72	0.00	6.00	12.44	0.00	0.98	1.78
20	1.06	NA	0	21.17	21.17	0.00	0.00	71.22	6.78	0.00	1.51	1.20
21	3.71	6.00	0	36.17	34.39	0.00	0.00	50.56	9.39	0.00	0.77	0.77

Table 2. Mean ± standard error for vegetation variables at cottonwood, reed canarygrass, and upland habitats, Sandy River Delta, 2000.

Variables	Cottonwood	Reed Canarygrass	Upland
% Tree Canopy	78.71 ± 5.88	6.05 ± 2.99	4.16 ± 3.65
Tree Height, m	16.70 ± 0.71	5.64 ± 2.20	3.16 ± 1.71
% Shrubs	57.69 ± 12.91	13.85 ± 5.74	7.54 ± 2.99
% Blackberry	47.08 ± 11.93	13.56 ± 5.63	4.59 ± 2.00
% Reed Canary grass	1.28 ± 1.18	72.43 ± 4.71	10.61 ± 3.92
% Upland-Herbaceous	21.18 ± 14.34	8.25 ± 1.94	72.35 ± 7.64
Shrub Height, m	1.08 ± 0.10	0.73 ± 0.23	1.08 ± 0.10
Blackberry Height, m	1.82 ± 0.21	0.84 ± 0.30	1.82 ± 0.21

Table 3. Mean number of bird species detected per site within 50 m, at cottonwood, reed canarygrass, and upland sites, Sandy River Delta, 2000.

Species	Cottonwood	Reed Canarygrass	Upland
American goldfinch	0.60	0.17	0.43
American robin	0.80	0.00	0.14
Barn swallow	0.00	0.00	1.57
Bewick's wren	0.40	0.00	0.00
Black-capped chickadee	0.40	0.00	0.14
Black-headed grosbeak	0.20	0.00	0.00
Brown-headed cowbird	0.40	0.00	0.14
Bullock's oriole	1.20	0.00	0.00
Cedar waxwing	0.40	0.00	0.00
Common yellowthroat	0.60	1.17	1.43
European starling	0.00	0.00	0.29
House finch	0.60	0.00	0.14
Lazuli bunting	0.00	0.17	0.00
Marsh wren	0.00	0.00	0.29
Mourning dove	0.00	0.00	0.14
Northern flicker	0.60	0.00	0.00
Northern harrier	0.00	0.17	0.00
Oregon junco	0.20	0.00	0.00
Purple finch	0.20	0.00	0.00
Red-eyed vireo	0.40	0.00	0.00
Red-winged blackbird	0.00	0.00	1.00

Table 3. Continued. Mean number of bird species detected per site within 50 m, at cottonwood, reed canarygrass, and upland sites, Sandy River Delta, 2000.

Species	Cottonwood	Reed Canarygrass	Upland
Savannah sparrow	0.20	0.17	1.00
Scrub jay	0.20	0.00	0.00
Song Sparrow	1.80	1.83	2.29
Sora	0.00	0.00	0.14
Spotted towhee	1.20	0.00	0.00
Swainson's thrush	0.40	0.50	0.00
Tree swallow	0.20	0.17	0.71
Western kingbird	0.00	0.00	0.14
Western wood-pewee	1.20	0.00	0.00
White-crowned sparrow	0.40	0.00	0.43
Willow flycatcher	0.00	0.17	1.29
Yellow warbler	0.40	0.00	0.14
Grand mean	13.60	4.50	11.86

Table 4. Habitat Suitability Index (HSI) scores at 2 wetland sites for marsh wren for current habitat conditions and 4 future scenarios, Sandy River Delta, 2000.

Site	Current HSI	Scenario 1 HSI	Scenario 2 HSI	Scenario 3 HSI	Scenario 4 HSI
3	0.07	0.29	0.47	1.00	0.00
11	0.00	0.65	0.47	1.00	0.00

Table 5. Habitat Suitability Index (HSI) scores at 2 wetland sites for red-winged blackbird for current habitat conditions and 4 future scenarios (Condition A wetlands), Sandy River Delta, 2000.

Site	Current HSI	Scenario 1 HSI	Scenario 2 HSI	Scenario 3 HSI	Scenario 4 HSI
3	0.28	0.03	1.00	0.30	0.01
11	0.10	0.03	1.00	0.30	0.01

Table 6. Habitat Suitability Index (HSI) scores at 5 sites for red-winged blackbird for current habitat conditions and 2 future scenarios (Condition B wetlands), Sandy River Delta, 2000.

Site	Current HSI	Scenario 5 HSI	Scenario 6 HSI
1	0.10	0.30	0.42
2	0.09	0.30	0.42
4	0.07	0.30	0.42
20	0.10	0.30	0.42
21	0.10	0.30	0.42

Table 7. Current winter-habitat conditions for wood duck at 5 ponds and mean Habitat Suitability Index (HSI) scores for current habitat conditions and 5 future scenarios, Sandy River Delta, 2000.

Pond	% Wood Duck Cover	% Reed Canary grass	Current HSI	Scenario 1 HSI	Scenario 2 HSI	Scenario 3 HSI	Scenario 4 HSI	Scenario 5 HSI
1	5.00	90.00	0.10	0.00	0.40	0.90	0.90	0.45
2	0.00	85.00	0.00	0.00	0.60	0.85	0.85	0.43
3	2.00	65.00	0.04	0.00	1.00	0.65	0.65	0.33
4	1.00	89.00	0.02	0.00	0.44	0.89	0.89	0.45
5	5.00	15.00	0.10	0.00	0.30	0.15	0.15	0.08
Mean	2.60	68.80	0.05	0.00	0.55	0.69	0.69	0.34

Table 8. Mean Habitat Suitability Index (HSI) scores, standard errors, minimum and maximum values at cottonwood, reed canarygrass, and upland sites for yellow warbler, Sandy River Delta, 2000.

Habitat	n	HSI	SE	Minimum HSI	Maximum HSI
Cottonwood	5	0.35	0.040	0.19	0.41
Reed Canary grass	8	0.17	0.052	0.00	0.35
Upland	8	0.14	0.032	0.00	0.27

Table 9. Habitat Suitability Index (HSI) scores at 5 cottonwood sites for yellow warbler for current habitat conditions and 4 future scenarios, Sandy River Delta, 2000.

Site	Current HSI	Scenario 1 HSI	Scenario 2 HSI	Scenario 3 HSI	Scenario 4 HSI
14	0.40	0.78	0.65	0.65	0.42
15	0.19	0.37	0.30	0.23	0.17
16	0.41	0.80	0.68	0.66	0.41
18	0.39	0.77	0.67	0.65	0.43
19	0.35	0.67	0.54	0.54	0.35
Mean	0.35	0.68	0.57	0.54	0.36

FIGURES

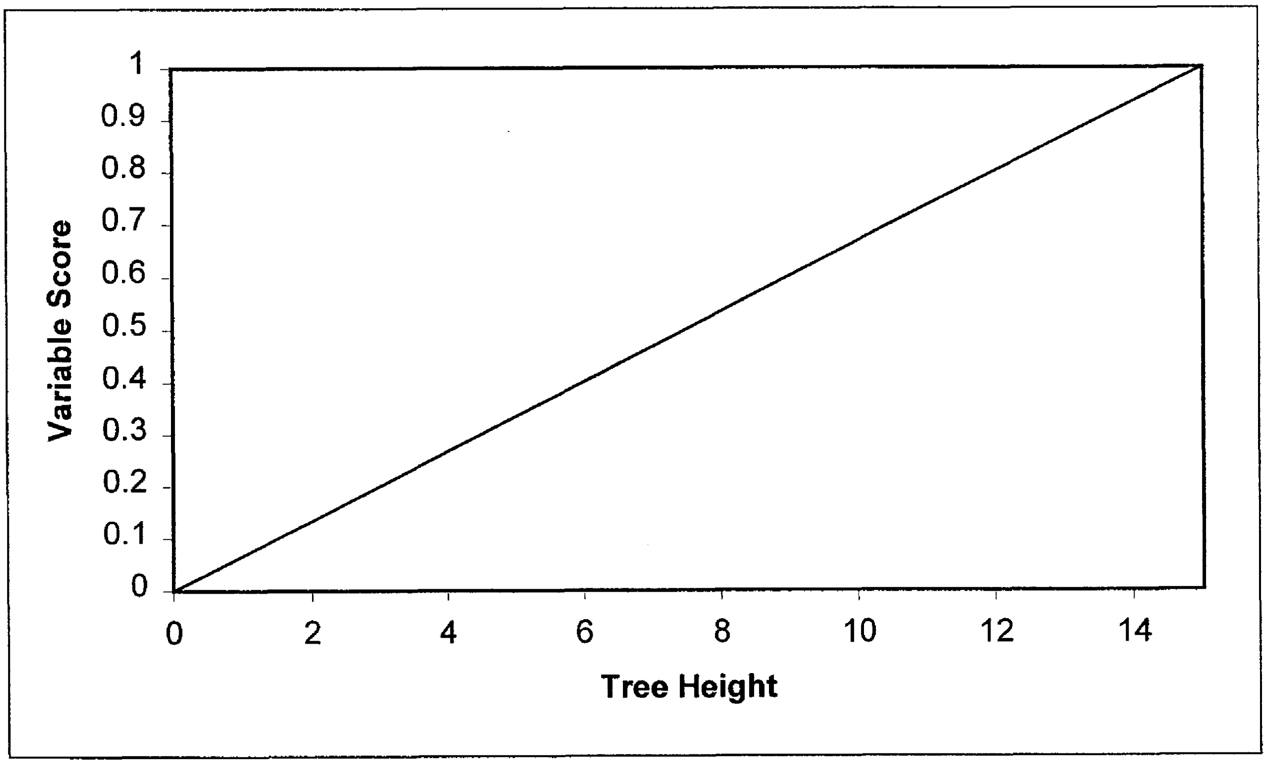

Figure 1. Example of a linear relationship between variable value and variable score in a Habitat Suitability Index model.

Figure 2. Location of 21 sampling points, Sandy River Delta, Oregon. Each sampling point is indicated by the blue # symbols.