Water howellia

(*Howellia aquatilis*)

5-Year Review:

Summary and Evaluation

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U.S. Fish and Wildlife Service

Montana Ecological Services Field Office

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5-YEAR REVIEW
Species reviewed: Water howellia (*Howellia aquatilis*)

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5-YEAR REVIEW
Water howellia (*Howellia aquatilis*)

1. GENERAL INFORMATION

1.1. Purpose of 5-Year Reviews

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since the time it was listed or since the most recent 5-year review. Based on the outcome of the 5-year review, we recommend whether the species should: 1) be removed from the list of endangered and threatened species; 2) be changed in status from endangered to threatened; 3) be changed in status from threatened to endangered; or 4) remain unchanged in its current status. Our original decision to list a species as endangered or threatened is based on the five threat factors described in section 4(a)(1) of the Act. These same five factors are considered in any subsequent reclassification or delisting decisions. In the 5-year review, we consider the best available scientific and commercial data on the species, and we review new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process that includes public review and comment.

1.2. Reviewers

Lead Regional Office: Mountain-Prairie Region (Region 6)
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Terry Rabot, ARD, Ecological Services, 503-231-6179
Marilet Zablan, Endangered Species Program Manager
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Cooperating Field Office(s):
Sacramento Field Office
Oregon Fish and Wildlife Office
Idaho Fish and Wildlife Office
Washington Fish and Wildlife Office

1.3. Methodology used to complete the review

On April 18, 2007, we published a notice in the Federal Register (72 FR 19549) soliciting any new information on water howellia *(Howellia aquatilis)* that may have a bearing on its classification as endangered or threatened. We did not receive any comments in response to the Federal Register notice. This 5-year review was primarily written by the Montana Ecological Services Field Office, with substantive contributions and review by cooperating field and regional offices. It summarizes and evaluates information provided in the draft recovery plan, current scientific research, and surveys related to the species. All pertinent literature and documents on file at the Montana Ecological Services Field Office were used for this review (See References section below for a list of cited documents). We interviewed individuals familiar with water howellia as needed to clarify or obtain specific information.

1.4. Background

1.4.1. Federal Register Notice citation announcing initiation of this review

72 FR 19549, April 18, 2007

1.4.2. Listing history

Original Listing

Federal Register notice:	59 FR 35860, July 14, 1994
Entity listed:	Species
Classification:	Threatened range-wide

1.4.3. Associated rulemakings

Critical habitat was not considered prudent at the time of listing. There is no other rulemaking associated with this species.

1.4.4. Review History

This is the first 5-year review for water howellia. The Service's final listing rule was published on July 14, 1994 (59 FR 35860). A draft Water Howellia Recovery Plan was published in 1996 (61 FR 50044, September 24, 1996).

1.4.5. Species' Recovery Priority Number at start of 5-year review

At the start of the 5-year review, the Recovery Priority Number for the water howellia was 7. This number indicated that: (1) the plant was listed as a monotypic genus; (2) populations face a moderate degree of threat; (3) recovery potential is high; and (4) recovery of the water howellia is not in conflict with construction or other development projects (see Table 1). A moderate degree of threat means the species will not face extinction if recovery is temporarily held off, although there is a continual population decline or threat to its habitat. High recovery potential means the biological and ecological limiting factors are well understood, the threats to the species existence are well understood or easily alleviated, and intensive management is not needed or recovery techniques are well documented with high probability of success (48 FR 43098, September 21, 1983).

TABLE 1.–The Below Ranking System for Determining Recovery Priority Numbers was Established in 1983 (48 FR 43098, September 21, 1983 as corrected in 48 FR 51985, November 15, 1983).

Degree of Threat	Recovery Potential	Taxonomy	Priority	Conflict
High	High	Monotypic Genus	1	1C
		Species	2	2C
		Subspecies/DPS	3	3C
	Low	Monotyp ic Genus	4	4C
		Species	5	5C
		Subspecies/DPS	6	6C
Moderate	**High**	**Monotypic Genus**	**7**	7C
		Species	8	8C
		Subspecies/DPS	9	9C
	Low	Monotypic Genus	10	10C
		Species	11	11C
		Subspecies/DPS	12	12C
Low	High	Monotypic Genus	13	13C
		Species	14	14C
		Subspecies/DPS	15	15C
	Low	Monotypic Genus	16	16C
		Species	17	17C
		Subspecies/DPS	18	18C

1.4.6. Recovery Plan [or Outline]

Name of plan [or outline]: Public and Agency Review Draft–Water Howellia (*Howellia aquatilis*) Recovery Plan
Date approved: Not approved
Dates of previous revisions, if applicable: Not applicable

2. REVIEW ANALYSIS

2.1. Application of the 1996 Distinct Population Segment policy

This section of the 5-year review is not applicable to this species because the Endangered Species Act (ESA) precludes listing Distinct Population Segments (DPS) of plants or invertebrates. For more information, see our 1996 DPS policy (61 FR 4722, February 7, 1996).

2.2. Recovery Planning and Implementation[1]

2.2.1. Does the species have a final, approved recovery plan?

☐ Yes
☒ No

2.2.2. Adequacy of recovery plan?

The draft recovery plan includes objective, measurable criteria for delisting; however, this plan no longer reflects the best scientific information available for water howellia. First, monitoring since 1994 has revealed new occurrences (defined as known populations) of water howellia in all five States within the known historical range of the species. Some of the new occurrences have been discovered in Oregon and California, states where the species was once thought extirpated. Second, several significant exchanges of land occupied by water howellia have occurred in Montana. The ownership changes (from private to Federal or State ownership) have resulted in more protective regulations for many water howellia occurrences within Montana. Third, research conducted since 1994 has increased our understanding of the biology and ecology of water howellia.

[1] Recovery plans provide guidance to the Service, States, and other partners and interested parties on ways to minimize threats to listed species, and on criteria that may be used to determine when recovery goals are achieved. There are many paths to accomplishing the recovery of a species, and recovery may be achieved without fully meeting all recovery plan criteria. For example, one or more criteria may have been exceeded while other criteria may not have been accomplished. In that instance, we may determine that, over all, the threats have been minimized sufficiently, and the species is robust enough, to downlist or delist the species. In other cases, new recovery approaches and/or opportunities unknown at the time the recovery plan was finalized may be more appropriate ways to achieve recovery. Likewise, new information may change the extent that criteria need to be met for recognizing recovery of the species. Overall, recovery is a dynamic process requiring adaptive management, and assessing a species' degree of recovery is likewise an adaptive process that may, or may not, fully follow the guidance provided in a recovery plan. We focus our evaluation of species status in this 5-year review on progress that has been made toward recovery since the species was listed (or since the most recent 5-year review) by eliminating or reducing the threats discussed in the five-factor analysis. In that context, progress towards fulfilling recovery criteria serves to indicate the extent to which threat factors have been reduced or eliminated.

2.2.3. Progress toward recovery citing the draft recovery plan criterion

Below are the recovery criteria as stated in the Draft Water Howellia Recovery Plan. A final recovery plan has not been completed. Note, the first recovery criterion references a final recovery plan; this language was written (in 1996) with the assumption that a recovery plan for water howellia would be finalized.

First Recovery Criterion: Management practices, in accordance with habitat management plans, have reduced and/or controlled anthropogenic threats, thereby maintaining the species and its habitat integrity throughout the currently known range on public lands in five geographic areas for ten years after the effective date of the final recovery plan (when finalized). Monitoring will demonstrate effectiveness of management plans. Management plans will be in place for, at minimum, the following occurrences (defined as known populations) in the referenced geographic area:

a. 67 in Montana
b. 33 in Spokane County, Washington
c. 5 in Pierce County, Washington
d. 4 in Clark County, Washington
e. 5 in Mendocino County, California

Status: This criterion has been partially met. The recovery plan has not been finalized. However, management plans are in place on public lands for the minimum number of occurrences identified in this criterion. Formalized management plans have been in place for the following number of occurrences and years:

a. 188 in Montana–since 1997, (16 years)
b. 37 in Spokane County, Washington–since 2007, (6 years)
c. 19 in Pierce County, Washington–since 2003, (10 years)
d. 4 in Clark County, Washington–since 2010, (3 years)
e. 7 in Mendocino County, California–since 1995, (18 years).

Monitoring indicates management plans have been effective at maintaining the minimum number of occurrences by reducing or eliminating anthropogenic threats associated with land management activities (e.g., timber harvest, road construction) and other threats (e.g., invasive species). Prior to formalized management plans, some conservation efforts were occurring on Federal, State, and some private land. In addition, recent survey efforts have documented substantially more occurrences of water howellia range-wide (see Table 2).

Second Recovery Criterion: Conservation of occurrences on lands not addressed in agency management plans, including those that are within meta-populations as well as outlying geographic extensions, is fostered. Confirm that long-term conservation measures are in place for the occurrence in Latah County, Idaho.

Status: This criterion has been partially met. Long-term conservation measures for water howellia have been established through land transfers, conservation

easements, and management plans on some private lands. For example, in Montana, land supporting known water howellia occurrences has been transferred from private to Federal ownership; those occurrences are now protected under Federal agency management plans. In addition, one occurrence located on private land in Latah County, Idaho is protected under a conservation agreement and a management plan is currently being developed. New occurrences on private land in Idaho have been documented; Idaho Natural Heritage Program is actively engaging soil conservation districts and private landowners, seeking collaborative partnerships (Idaho NHP 2012, p. 6) to conserve these occurrences and search for new ones. We are unaware of any information regarding efforts to protect water howellia occurrences on private lands in other parts of the species' range.

Third Recovery Criterion: A post-delisting strategy for monitoring the species population dynamics is in place.

Status: No monitoring strategy has been developed; therefore, this criterion has not been met.

2.3. Updated Information and Current Species Status

2.3.1. Background on the Species

2.3.1.1. Biology, life history, and habitat

Water howellia is an annual, aquatic herb in the bellflower family (Campanulaceae) and a monotypic genus. The entire plant is smooth, possessing no hairs or projections. The stems are fragile, submerged and floating, reaching up to 39 inches (in.) (100 centimeters [cm]) in length. Stems branch several inches from the base, and each branch extends to the water surface. The numerous leaves are narrow and range from 1–2 in. (25–50 millimeters [mm]) long.

Water howellia produce two types of flowers; cleistogamous (closed) and chasmogamous (showy, open for pollination). Small cleistogamous flowers are produced along the stem below the water surface and are, by nature, self-fertilizing. Chasmogamous flowers are produced on the water surface and commonly self-pollinate (Lesica *et al.* 1988, p. 276; Shelly and Moseley 1988, pp. 5–6). The petals of the chasmogamous flowers are 0.08–0.12 in. (2–3 mm) long, 5-lobed, and distributed on one side of the flower. Fruit capsules from chasmogamous flowers are 0.39–0.78 in. (10–20 mm) long with elongate seeds 0.08–0.15 in. (2–4 mm) long (from Hitchcock *et al.* 1959 and Dorn 1984 *in* Shelly and Moseley 1988).

Seed germination occurs in the fall, only when ponds dry and seeds are exposed to air (Lesica 1990, pp. 5–7, 13). Water howellia seedlings overwinter in soil and resume growth in spring in northern climates (Mincemoyer 2005, p. 3) or begin growing after fall germination in

southern climates (e.g., California) (Johnson 2013, pers. comm.). Spring growth in California and low elevation populations in western Washington typically commences in early April, in eastern Washington, Idaho, and Montana by early May. Range-wide, emergent (chasmogamous) flowers bloom soon after the stems reach the water surface and are typically present from May through July. Seed dispersal starts in June from submerged (cleistogamous) flowers and extends until late summer from emergent flowers (Shelly and Moseley 1988, p. 5).

Long-term viability of water howellia seeds is uncertain. Decreased germination rates have been documented for seeds residing in soil longer than 8 months (Lesica 1992, pp. 415–416). However, monitoring data and observations from Montana (USFS 2002, pp. 6–7; USFWS 1996, pp. 17–18) and Washington (Gilbert 2008, pers. comm.) indicate the presence of water howellia populations after 2 consecutive years with no plant observations, suggesting a significant number of seeds may remain viable for at least 3 years. This life history strategy likely provides a buffer against unfavorable growing conditions in consecutive years.

Water howellia typically inhabit small, vernal freshwater wetlands and ponds with an annual cycle of filling with water in spring and drying up in summer or autumn (USFWS 1996, p.14). These habitats can be glacial potholes or depressions (Shapley and Lesica 1997, p. 8; USDOD 2006, p. 3-3) or river oxbows (Lesica 1997) in Montana and western Washington, riverine meander scars (Idaho NHP 2012, p. 1) in Idaho, glacial-flood remnant wetlands (Robison 2007, p. 8) in eastern Washington, or landslide depressions (Johnson 2013, pers. comm.) in California, but are all ephemeral to some degree. Depending on annual patterns of temperature and precipitation, the drying of the ponds may be complete or partial by autumn; these sites are usually shallow and less than 1 meter in depth. Some ponds supporting water howellia are dependent on complex ground and surface water interactions. Snow melt runoff is important in maintaining suitable conditions in the spring, while localized groundwater flow mitigates water loss from evaporation and plant transpiration later in the summer (Reeves and Woessner 2004, pp. 7–9).

Consolidated clay and organic sediments typically dominate composition of soils underlying ponds and wetlands occupied by water howellia (USFWS 1996, p.14). Organic substrates appear to be important to growth and overall vigor in Montana populations (Lesica 1992, p. 416). In Montana, soils in the Swan Valley are comprised of clayey alluvium and clayey colluvium (Shelly and Moseley 1988, p. 34). Wetlands in western Washington are composed of well-drained glacial till (Clegg and Lombardi 2000, p. 6). The substrates of ponds occupied by water howellia in eastern Washington are higher in coarse organic soil than unoccupied ponds (Robison 2007, p. 22). Several occupied ponds in

California had significant amounts of organic matter (McCarten *et a*l. 1998, p. 4).

Water chemistry analyses within occupied water howellia habitat in Montana, California, and Washington indicate poor to intermediate nutrient levels (Lesica 1990, p. 21; McCarten *et al*. 1998, p. 2; Clegg and Lombardi 2000, p. 6). Hydrogen ion concentration (pH) varied from 5.8 to 7.8, with most readings between 6.5 and 7.5 in Montana and California (Lesica 1990, p. 31; Shapley and Lesica 1997, p. 11; McCarten *et al.* 1998, pp. 2–3). The relationship between water chemistry and suitability of water howellia habitat is unclear. The chemical properties of water howellia habitats in Idaho, Washington, and Oregon are unknown.

Water howellia habitat is typically surrounded or nearly surrounded by forested vegetation. Broadleaf deciduous trees or shrubs are usually a component, with species composition varying with geographic location (Mincemoyer 2005, p. 7). This aspect of water howellia habitat may be important because of numerous observations reporting water howellia occupying shaded portions of ponds and wetlands (Isle 1997, p. 32; McCarten *et al.* 1998, p. 4). It has been hypothesized that water howellia can photosynthesize at lower light levels than other wetland species (e.g., reed canarygrass [*Phalaris arundinacea*] [McCarten *et al* 1998, p. 4]), thus intact canopy cover surrounding water howellia habitat that provides shade to the water surface may provide a competitive advantage to water howellia. Forested vegetation surrounding water howellia habitat also contributes large woody debris to the water body; a feature thought to be important in water howellia persistence (Robison 2007, p. 17, 28).

2.3.1.2. Distribution, abundance, and trends

Water howellia is endemic to the Pacific Northwest with historical occurrences identified in California, Oregon, Washington, Idaho, and Montana (Shelly and Moseley 1988, pp. 6, 9). Currently, the species still occurs in all five States (Figure 1). It is unknown how widespread the species was before European settlement and modern development in the Pacific Northwest. However, it is likely the geographic area occupied was small even before settlement, due to the species' requirement of ephemeral wetlands with specific filling and drying regimes. Since listing, new occurrences have been documented in all five States, generally in areas known historically to support the species (Figure 1). Thus, locations of extant occurrences are generally representative of the areas where the species was thought to historically occur.

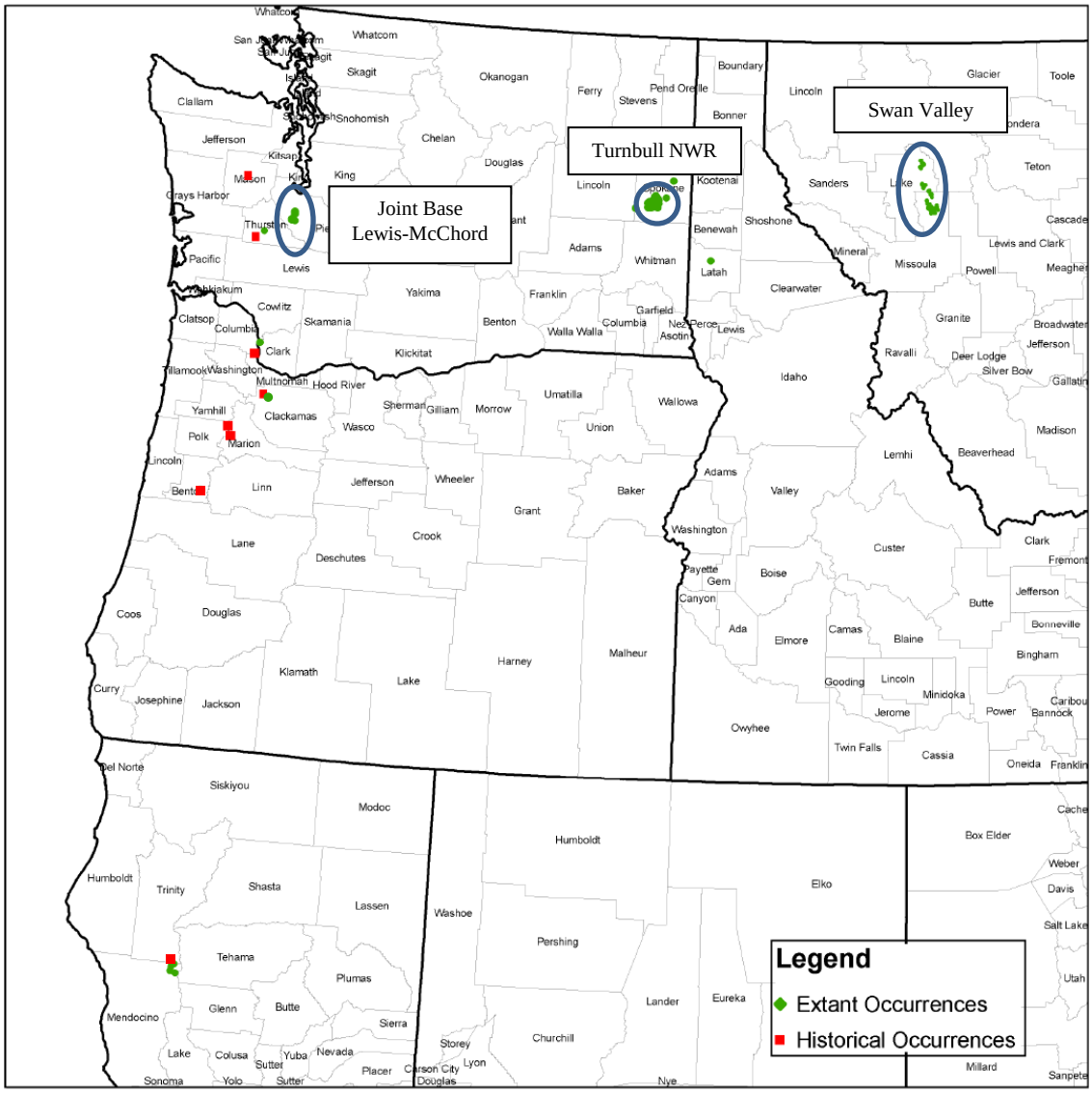

FIGURE 1.—Range-wide Historical and Extant Occurrences of Water Howellia. Three meta-populations that include the majority (~90 percent) of total known occurrences are circled. Figure adapted from Mincemoyer 2005.

At the time of Federal listing (1994), 107 water howellia occurrences (defined as known populations) were known to occupy an estimated 200 acres (81 hectares) across its range (USFWS 1994, p. 35861; Table 2). In 2012, a minimum of 302 occurrences were documented (Table 2); current, occupied acreage was unavailable. The majority of extant occurrences (91 percent) are within three meta-populations occupying three distinct, geographic areas: Montana's Swan Valley (Lake and Missoula Counties); Department of Defense property at Joint Base Lewis-McChord (JBLM), Pierce County in western Washington; and Turnbull National Wildlife Refuge, Spokane County in

northeastern Washington (Figure 1; Table 2). A meta-population is defined as a collection of interdependent populations affected by recurrent extinctions and linked by recolonizations (Murphy *et al*. 1990, p. 47). Currently, 244 of the 302 (80 percent) reported water howellia occurrences are on lands administered by the Federal government (Table 2).

Trends for water howellia are difficult to determine. Substantial numbers of new occurrences have been discovered since listing (Table 2); however, this may not necessarily indicate a positive population trend. Rather, this could indicate increased efficiency at finding new occurrences. A lack of consistent, standardized monitoring precludes the ability to document trends. Additionally, an occurrence is broadly defined as "a known population"; abundance of individual plants within occurrences is not accounted for. Further, annual counts of individual water howellia plants within occurrences fluctuate widely; due, in part, to environmental conditions of the preceding autumn, which affect seed germination rates.

2.3.1.3. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.)

Genetic variation among water howellia populations is low. Populations in California and Montana are genetically similar; however, populations in Idaho and Washington are more distantly related (Schierenbeck and Phipps 2010, p. 5). These data suggest that gene flow is occurring between populations separated by large geographic distances, albeit at a relatively low rate. A correlation between migratory waterfowl routes with either genetic similarity or distance indicate that waterfowl may be transporting seeds or plant material between water howellia population areas (Schierenbeck and Phipps 2010, pp. 6–7). A more robust sampling and genetic analysis of water howellia populations across its range would be necessary to support or refute this hypothesis.

TABLE 2.—Occurrences and Percentage of Water Howellia by Land Ownership Within States in 1994 (year of Federal listing), 2012 (current) and the Change in Occurrences Between Years.

		1994		2012		Change from 1994 to 2012[a]
State	**Ownership**	**Occurrences**	**%**	**Occurrences**	**%**	**Occurrences**
Oregon	Metro[b]	0	0	1	0	+1
California	USFS[c]	0	0	7	2	+7
Idaho	Private	1	1	6	2	+5
Montana	USFS	34	32	176	58	+142
	State	0	0	3	1	+3
	TNC	0	0	5	2	+5
	Private	21	20	23	8	+2
	USFS/Private[d]	4	4	5	2	+1
	State/TNC[d]	n/a	n/a	1	0	+1
	USFS/TNC[d]	n/a	n/a	3	1	+3
Washington	USFWS	34	32	37	12	+3
	USDOD	0	0	23	8	+23
	BLM	1	1	1	0	0
	State	1	1	3	1	+2
	Private	11	10	8	3	-3
Totals		107		302		+195
Federal Land		69	64	244[e]	80[e]	+175

[a] Change in occurrences between years should be interpreted with caution. Positive differences between years do not necessarily reflect a positive population trend.
[b] Metro = Portland-area Regional government
[c] Three of the seven occurrences in California are within the Yolla Bolly-Middle Eel Wilderness, which is administered by the USFS. The remaining four occurrences are on the Mendocino National Forest.
[d] Some water howellia occurrences cross jurisdictional boundaries and are reported under joint ownership.

2.3.1.4. Taxonomic classification or changes in nomenclature

Water howellia was first described from specimens collected in 1879 near Portland, Oregon (Gray 1879, p. 2). The taxonomy of water howellia as a full species in a monotypic genus is widely accepted as valid by the scientific community (The Plant List 2010, entire; ITIS 2011, p. 1).

2.3.2. Five-Factor Analysis - threats, conservation measures, and regulatory mechanisms

2.3.2.1. Present or threatened destruction, modification or curtailment of its habitat or range

Five threats to water howellia habitat or range were cited in the final listing rule: narrow ecological requirements of the species, invasive species, land management (primarily timber harvest and road building), trampling by domestic livestock, and direct habitat loss from urbanization or dam construction (USFWS 1994, p. 35861–35864). All threats, except the narrow ecological requirements of the species, are discussed in this section. Discussion of the narrow ecological requirements of water howellia is addressed in **Section 2.3.2.5. Other natural or manmade factors affecting its continued existence.**

Invasive species: Invasive plant species can pose a threat to water howellia in habitats where the two species overlap (USFWS 1994, pp. 35861–35862). Invasive species such as reed canarygrass (*Phalaris arundinacea),* sweet flag (*Acorus calamus),* yellow flag *(Iris pseudacorus),* and climbing nightshade (*Solanum dulcamara)* can outcompete water howellia, presumably for nutrients and space, effectively excluding water howellia from historically occupied water bodies (Lesica 1997, p. 367). Reed canarygrass, in particular, is widespread across the range of water howellia. Reed canarygrass and water howellia coexist in four of the five States with extant water howellia populations. No overlap between the two species occurs in California (Johnson 2013, pers. comm.), while extensive overlap (~83 percent) occurs in Washington (USFWS 1994, p. 35862).

Despite the widespread distribution of reed canarygrass and substantial overlap with water howellia in some areas, the effectiveness of invasion is varied (Lesica 1997, p. 367–368). For example, reed canarygrass coverage of the North Marsh study area in Montana increased from 20 percent to 95 percent coverage over a 9 year period with a corresponding decrease in water howellia plants (Lesica 1997, p. 367–368). Conversely, an adjacent marsh showed no measurable expansion of reed canarygrass coverage and no apparent decrease in water howellia cover over that same period (Lesica 1997, p. 367–368). Reed canarygrass invasion in water howellia ponds in Idaho has advanced some years and retracted others (Idaho NHP 2010, p. 8–9); monitoring protocols, sampling dates, and suppression efforts varied during this time, making interpretation of data difficult. In Idaho, reed canarygrass did reinvade an area in one pond where suppression had been conducted previously (Idaho NHP 2010, p. 8–9; Table 3). Abundance of reed canarygrass in ponds occupied by water howellia on the JBLM and Turnbull NWR has fluctuated through

time,with no definitive trend (Gilbert 2013, pers. comm., Rule 2013a, pers. comm.).

Factors believed to affect the establishment of reed canarygrass include moisture gradient, period of inundation, soil type, and amount of riparian shading (Lefor 1987, p. 1; Robison 2007, pp. 17, 21–22; Rule 2013b, pers. comm.). Reed canarygrass is rarely found in depths of permanently inundated water greater than 0.3 meters (Lefor 1987, p. 1). Reed canarygrass has not become established in wetlands on Turnbull NWR with steeper wetland-to-upland slopes, coarse organic soil, and more extensive riparian shading and woody debris (Robison 2007, pp. 17, 21–22). These studies and observations suggest environmental and site-specific conditions likely influence the establishment and spread of the invasive reed canarygrass.

Mechanical and chemical treatment efforts to preclude the spread or reduce populations of reed canarygrass have largely been successful (TNC 2006, p. 65; Gilbert 2008, 2013, pers. comm., Idaho NHP 2010b , p. 9, 14; Johnson 2011, pers. comm.). In California, mechanical treatment (e.g., cutting with gas-powered trimmers) has stopped the spread of reed canarygrass in ponds and wetlands adjacent to water howellia occurrences and chemical treatment (e.g., Glyphosate [Round-up®]) is further reducing the size of reed canarygrass patches (Johnson 2011, pers. comm.). Similarly, consistent suppression of reed canarygrass and yellow flag at JBLM in Washington have reduced patch sizes of reed canarygrass in the past (TNC 2006, p. 65; Engler 2008, pers. comm.; Gilbert 2008, pers. comm.; Table 3). Currently, no suppression efforts are underway at JBLM, due to a lack of expansion of reed canarygrass in the past 15–20 years (Gilbert 2013, pers. comm.). Invasive species suppression efforts in Idaho were initially successful; distribution and abundance of reed canarygrass appeared to vary more with fluctuating environmental conditions once suppression efforts were stopped (Idaho NHP 2010, p. 9). No suppression efforts to control or eradicate reed canarygrass on the Turnbull National Wildlife Refuge in Washington are currently underway; the invasive is present but not currently expanding (Rule 2009, 2013a, pers. comm.; Table 3). In Montana, the invasive exhibited a slight upward trend from 1998 – 2007 (USFS 2010, p. 1–2), but has not advanced recently (Table 3) (Mincemoyer 2013, pers. comm.); no suppression efforts have been attempted.

TABLE 3.—Existing Conservation Mechanisms and Measures, and Threat Status for Known Water Howellia Occurrences by State and Ownership, 2012.

State	Ownership	2012 Occurrences	%	Conservation mechanism*	Conservation measure	Threats reduced / eliminated**	Threats remaining	Citation(s)
Oregon	Metro	1	0	State T&E law	Consultation -no take	None known	None known	Currin 2013a, pers. comm.
California	USFS	7	2	LRMP	300' buffer	IN, LM, LV, HL	None known	Johnson 2013, pers. comm.
Idaho	Private	6[a]	2	Easement	Restoration	LM, LV, HL	IN	USFWS 2009; Idaho NHP 2012
Montana	USFS	176	58	CS	300' buffer	LM, LV, HL	None known	USFS 1997
	State	3	1	SMZ	Riparian prohibitions	LM, LV, HL	None known	Montana DNRC 2012; Mincemoyer 2005
	TNC	5	2	TNC ownership	TNC policy	LM, LV, HL	None known	Mincemoyer 2005; TNC 2009
	Private	23	8	Unknown	–	–	–	–
	USFS/Private[b]	5	2	Unknown	–	–	–	–
	State/TNC	1	0	SMZ and TNC ownership	Riparian prohibitions	LM, LV, HL	None known	Montana DNRC 2012; Mincemoyer 2005; TNC 2009
	USFS/TNC	3	1	CS	300' buffer	LM, LV, HL	None known	USFS 1997; TNC 2009
Washington	USFWS	37	12	CCP	Wetland restoration	IN, LM, LV, HL	None known	USFWS 2007b; USFWS 2010
	USDOD	23	8	INRMP	Wetland restrictions	IN, LM, HL	None known	USDOD 2003; USDOD 2006; Gilbert 2013, pers. comm.
	BLM	1	0	RMP	BMPs	LM, LV, HL	None known	BLM 2013
	State	3	1	FPA	Minimum 25' buffer	LM, LV, HL	None known	Anderson 2013, pers. comm.
	Private	8	3	Unknown	–	–	–	–
Totals		302						
Federal		244	80					
Conserved[c]		261	86					

* LRMP=Land Resource Management Plan, CS=Conservation Strategy, SMZ=Streamside Management Zone, CCP=Comprehensive Conservation Plan, INRMP=Integrated Natural Resource Management Plan, RMP=Resource Management Plan, FPA=Forest Practices Act, BMP=Best Management Practices.
** IN=Invasive Species, LM=Land Management (including timber harvest, thinning, prescribed burning, road building), LV=Livestock, HL=Habitat Loss.
[a] Only one occurrence in Idaho is protected by a conservation easement.
[b] USFS/Private lands were not included in the total for Conserved lands because of the uncertainty of conservation implementation.
[c] Conserved lands are those with existing conservation mechanisms benefitting water howellia.

Summary: Invasive species, particularly reed canarygrass, occur in many of the same habitats where water howellia are found. Invasion success of reed canarygrass appears to vary with site-specific factors. Reed canarygrass is present in all three meta-populations of water howellia; however, progressive invasion is not occurring in any of the meta-populations (Swan Valley, MT, Turnbull NWR, Washington, JBLM, Washington), even in the absence of suppression efforts. Reed canarygrass may be expanding in Idaho, although data limitations preclude meaningful interpretation at this time. Given the absence of active invasion of reed canarygrass within the three meta-populations of water howellia and the success of existing suppression efforts where they have been applied, we do not consider invasive species to be a threat to water howellia.

Land management (Vegetative manipulation [e.g., timber harvest, thinning, prescribed burning], road building): Land management activities, such as timber harvest or prescribed fire, can result in a loss of forest vegetation at the pond fringe, which may disrupt the hydrological cycle and negatively impact the phenology of water howellia (Reeves and Woessner 2004, pp. 10, 15). Removal of canopy cover near ponds and wetlands can decrease woody debris recruitment and shading, both important factors in favoring water howellia growth over reed canarygrass. Currently, timber harvest is prohibited within 300 feet of water howellia occurrences on USFS lands in Montana and California (USFS 1997, p. 17; Johnson 2013, pers. comm.); prescribed fire may be allowed within this buffer, but only if needed to maintain the characteristics of the overstory vegetation (e.g., reduce understory competition) (USFS 1997, p. 17; Johnson 2013, pers. comm.). On State land in Montana, clear-cutting of timber and burning are prohibited within defined buffers surrounding waterbodies (Montana Code Annotated, p. 1). In Washington, wetlands containing water howellia on the Turnbull NWR are buffered from mechanical thinning and prescribed fire used in treating conifer encroachment (Rule 2009, pers. comm.). Timber harvest and prescribed fire were not cited as potential threats to other water howellia populations in Washington (USDOD 2003, entire; USDOD 2006, entire; entire; Anderson 2013, pers. comm.; Gilbert 2013, pers. comm.), or populations in Oregon or Idaho (Currin 2013a, pers. comm.; USFWS 2009, entire; Idaho NHP 2012, entire).

The effects of road building on water howellia habitat have largely been mitigated on Federal and State lands. Roads have been stabilized to reduce sedimentation where they exist within 300 feet of water howellia ponds in Montana (USFS 2001, p. II-46). Similarly in California, small spur roads are being closed and hydrologically stabilized in areas occupied by water howellia on the Mendocino National Forest to minimize anthropogenic contribution to landscape instability (Johnson 2008, pers.

comm.). Roads were not cited as a potential threat to water howellia populations in Washington, Idaho, or Oregon (USDOD 2003, entire; USDOD 2006, entire; USFWS 2007b, entire; USFWS 2010; entire; Idaho NHP 2012, entire; Anderson 2013, pers. comm.; Curin, 2013, pers. comm.).

Summary: Historically, land management activities such as timber harvest, prescribed fire, and road building constituted a greater threat to water howellia habitat than they currently do. Effects from these activities on Federal and State lands have been mitigated through the various conservation strategies employed by Federal and State agencies. Currently, land management activities on these lands do not constitute a threat to water howellia; the severity of threat posed by these activities on private land is unknown.

Trampling by domestic livestock: Trampling of water howellia by domestic livestock was cited as a threat in the final listing rule (USFWS 1994, p. 35862). Direct effects of plant crushing, seed bank disturbance, and alterations to substrate are likely to occur when livestock enter and exit ponds and wetlands. Increased nutrient loading may be an indirect effect of livestock occupancy in and near water howellia habitat. However, many water howellia occurrences are within habitats actively used by livestock. The level of livestock use water howellia can withstand is not known, and likely varies with site-specific conditions, as well as timing, severity, and duration of use.

The effects of trampling on water howellia occurrences on Federal and State land have largely been mitigated with fencing, cattle guards, elimination of grazing in some areas occupied by water howellia, or timely removal or relocation of livestock from sensitive pond and wetland habitats (USFS 2002, p. 6; Mincemoyer 2005, p. 11; Johnson 2008, 2013, pers. comm.; Table 3). In Montana, no trampling or other effects of domestic livestock on water howellia habitat have been observed within the last 5 years, which included site visits to several hundred ponds and wetlands (Mincemoyer 2013, pers. comm.). In California, timely removal of livestock away from five occupied ponds within an active grazing allotment on National Forest land appears to be effective; monitoring indicates no effects to water howellia populations from livestock trampling (Johnson 2013, pers. comm.). Two other water howellia occurrences in California are within inactive grazing allotments, thus livestock are not currently present (Johnson 2013, pers. comm.). Trampling is not reported as a threat in Washington, Idaho, or Oregon (USDOD 2003, entire; USDOD 2006, entire; USFWS 2007b, entire; USFWS 2010, entire; Idaho NHP 2012, entire; Curin 2013, pers. comm.; Table 3). It is unknown the extent of trampling and other livestock-related alterations to water howellia habitat on private land.

Summary: Trampling of water howellia by domestic livestock is not a threat to the species on Federal or State land because of mitigation measures implemented, including; riparian fencing, cattle guards, and timely removal or relocation of livestock from sensitive pond and wetland habitats. The severity and frequency of trampling of water howellia populations on private land is unknown but as there are significantly fewer water howellia populations known from private lands, these impacts are, at most, likely similar to those on Federal and State land.

Habitat loss from urbanization, dam construction: Direct habitat loss from urbanization and dam construction has occurred in Oregon. It is likely that very little water howellia habitat exists in the historically described locations within the Columbia River floodplain or the broad valley of the Willamette River where agriculture and other human development is extensive (Norman 2010, pers. comm.).

Development on corporate and private land was considered a threat to water howellia at the time of listing. Most of the water howellia occurrences on these lands were on Plum Creek Timber land in Montana. Recently, over 60,000 acres of Plum Creek land were sold to The Nature Conservancy (TNC) and Trust for Public Land for transfer to the U.S. Forest Service or the State of Montana (TNC 2009, p. 1; 2010, pp. 1–2). The 47 water howellia occurrences and potential habitat, formerly on Plum Creek land, are now protected from development and covered under either the Flathead National Forest Conservation Plan (USFS 1997, entire) or State agency direction for managing timber lands (Table 3). It is unknown if habitat loss has occurred historically in California; however, known occurrences are within National Forest Land or wilderness boundaries (Johnson 2013, pers. comm.), thus no current threat of habitat loss from development is expected. It is unknown how development has affected water howellia occurrences on private land.

Summary: Habitat loss from urbanization and dam construction occurred historically, particularly in Oregon. However, in the areas surrounding the extant, larger meta-populations, habitat loss is not considered a threat to the species because of conservation strategies implemented in Montana (USFS) and Washington (USDOD and USFWS). Known habitat in California is within National Forest Land or designated wilderness, thus there is no current threat of habitat loss from urbanization or dam construction.

2.3.2.2. Overutilization for commercial, recreational, scientific, or educational purposes

Overutilization of water howellia was not known to be a threat at the time of listing. There is no new information to indicate overutilization should be considered a threat currently.

2.3.2.3. Disease or predation

Predation (herbivory) on water howellia by domestic livestock was considered a threat to the species at the time of listing (USFWS 1994, p. 35862). However, occurrences of domestic livestock foraging on water howellia have not been documented (Shelly and Moseley 1998, p. 59, Johnson 2013, pers. comm., Mincemoyer 2013, pers. comm.). Additionally, grazing practices on Federal land have been altered to largely preclude herbivory, even if it occurred historically. Alterations to grazing practices have included cattle guards, riparian fencing, allotment monitoring, and timely removal or relocation of livestock away from water howellia populations. Thus, predation on water howellia by domestic livestock is not considered a threat to the species.

Waterfowl may ingest seeds or other plant parts and transport them among water howellia populations because there appears to be gene flow along migratory routes (Schierenbeck and Phipps 2010, pp. 7–9). Other species of wildlife may also utilize water howellia as a food source and aid in dispersal (e.g., moose, black bear). However, no negative population impacts have been reported where waterfowl are using water howellia habitats, and there are no observations of herbivory by other wildlife. Therefore, we do not consider predation by waterfowl or other wildlife a threat to the species.

Incidence of disease was not reported at the time of listing. We are unaware of any reports of disease affecting water howellia since listing; therefore, we do not consider disease to currently be a threat to water howellia.

2.3.2.4. Inadequacy of existing regulatory mechanisms

Federal Endangered Species Act (1973)
The purposes of the Endangered Species Act are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in subsection (a) of this section.

Section 6 of the ESA allows for cooperation between USFWS and the States in the management and funding of projects designed to enhance the conservation of federally listed species. For water howellia, this funding has been important in allowing more comprehensive surveys and monitoring; the results of which include the discovery of numerous, undocumented occurrences of water howellia range-wide.

Section 7(a)(1) states that Federal agencies, in consultation with us, shall carry out programs for the conservation of endangered species. Section 7(a)(2) requires Federal agencies to consult with us to ensure any project they fund, authorize, or carry out is not likely to jeopardize the continued existence of listed species or modify their critical habitat. Since listing, seventeen formal Section 7 consultations have been initiated for water howellia.

Section 9(a)(2) of the ESA prohibits the following activities: 1) the removal and reduction to possession (i.e., collection) of endangered plants from lands under Federal jurisdiction, and 2) the malicious damage or destruction on lands under Federal jurisdiction, and 3) the removal, cutting, digging, damaging, or destruction of endangered plants on any other area in knowing violation of a state law or regulation, or in the course of any violation of a state criminal trespass law. Section 9 also makes illegal the international and interstate transport, import, export, and sale or offer for sale of endangered plants and animals.

Section 10(a)(1)(A) permits acts otherwise prohibited by Section 9 for scientific purposes or to enhance the propagation or survival of the affected species. Five 10(a)(1)(A) permits have been issued to aid in the conservation of water howellia range-wide; four permits are currently active and one has expired.

The provisions of the ESA are adequate to protect water howellia. Sections 7, 9, and 10 provide protection of at least 80% of known occurrences (those on Federal lands), which includes the two meta-populations in Washington and the vast majority of occurrences within the Montana meta-population. Funding authorized by Section 6 has allowed extensive surveying, resulting in more documented occurrences of water howellia range-wide.

Other Federal Regulatory Mechanisms

Clean Water Act (1973)

The Clean Water Act (CWA) (33 United States Code [U.S.C.] 1251 *et seq*.) was designed, in part, to protect surface waters of the U.S. from unregulated pollution from point sources. The CWA provides some benefit to water howellia through the regulation of discharge into surface

waters through a permitting process; however, the threats to water howellia habitat are not typically associated with point sources of pollution.

Under section 404 of the CWA, the U.S. Army Corps of Engineers (USACE) regulates the discharge of fill material into waters of the United States, including wetlands. In general, the term "wetland" refers to areas meeting the USACE's criteria of hydric soils, hydrology (either sufficient annual flooding or water on the soil surface), and hydrophytic vegetation (plants specifically adapted for growing in wetlands). Section 404 of the CWA likely provides some protection to water howellia, given the review of environmental effects required for the permitting process.

The protections of the CWA to water howellia are expected to remain, without the provisions of the ESA.

Food Security Act (1985)
The Food Security Act (7 U.S.C. 1631) (also known as the Farm Bill) was designed, in part, to protect wetlands by removing incentives for farmers to convert wetlands into crop fields. This Act likely provides some indirect protection of potential water howellia habitats on private land, but not those on Federal or State land. The future of the Food Security Act (in its current form) is uncertain, thus any current protections it provides to water howellia cannot be relied upon in the future to protect the species.

National Environmental Policy Act (1970)
Environmental review of potential effects of Federal actions is mandated under the National Environmental Policy Act (NEPA) (42 U.S.C. 432 *et seq.*). When NEPA analysis reveals significant environmental effects, the Federal agencies must disclose those effects to the public and consider mitigation that could offset the effects. These mitigations usually provide some protections for listed species. However, the NEPA does not require that adverse impacts be mitigated, only disclosed. It is unclear what level of protection would be conveyed to water howellia through NEPA, in the absence of ESA protections.

National Forest Management Act (1976)
Federal activities on National Forest lands are subject to the National Forest Management Act of 1976 (NFMA) (16 U.S.C. 1601–1614). The NFMA requires the development and implementation of resource management plans that guide the maintenance of ecological conditions that support natural distributions and abundance of species and not contribute to their extirpation.

Water howellia is given consideration as a federally listed species by Federal agencies, and if delisted, would likely be included on the sensitive

species list for the Forest Service, as it was at the time of listing (USFWS 1994, p. 35862). Special status species policies (USFS Manual Section 2670, p. 4) detail the need to conserve these species and the ecosystems on which they depend using all methods and procedures which are necessary to improve the condition of these species and their habitats to a point where their special status recognition is no longer warranted. In 1997, the Flathead National Forest adopted a plan specific to guiding conservation of the known water howellia occurrences on Federal land in Montana (USFS 1997, entire; Table 3). This conservation plan is expected to remain in place, even in the absence of the ESA. The small number of occurrences of water howellia on the Mendocino National Forest in California makes the existence of the plant vulnerable to localized actions; however, buffer strips are used to protect riparian species and function surrounding occupied ponds in California (Johnson 2013, pers. comm.). The policy of using buffer strips to protect riparian function would likely be implemented in the absence of ESA provisions.

Federal Land Policy and Management Act (1976)

Similar to NFMA, the Federal Land Policy and Management Act (43 U.S.C. 1701 *et seq.*), applies to the Bureau of Land Management (BLM) with regard to the conservation and use of public lands under their management.

Water howellia is given consideration as a federally listed species by Federal agencies, and if delisted, would likely be included on the sensitive species list for the BLM as it was at the time of listing (USFWS 1994, p. 35862). Special status species policies (BLM Manual Section 6840, p. 37) detail the need to conserve these species and the ecosystems on which they depend using all methods and procedures which are necessary to improve the condition of special status species and their habitats to a point where their special status recognition is no longer warranted. The one occurrence of water howellia in Washington on BLM land makes the existence of the plant vulnerable to localized actions. However, application of Best Management Practices (BMPs) appears to have maintained this occurrence since 1993 (Table 3). The implementation of BMPs is expected to continue in the absence of ESA protections.

Sikes Act (1960)

Water howellia occurrences and habitats on Federal military installations (JBLM in Pierce County, Washington) are managed under an Integrated Natural Resources Management Plan (INRMP) (USDOD 2003, p. 70; USDOD 2006, p. 4-6; Table 3) authorized by the Sikes Act (16 U.S.C. 670a *et seq.*). Protections for water howellia habitat in the INRMP include restrictions on motorized equipment and military training activities in wetlands occupied by water howellia. These protections would be

expected to continue in the absence of ESA protections, as directed by the Sikes Act.

National Wildlife Refuge System Improvement Act (1997)
As directed by the National Wildlife Refuge System Improvement Act (16 U.S.C. 668dd), managers of National Wildlife Refuges (NWR) have the authority and responsibility to protect native ecosystems, fulfill the purposes for which an individual refuge was founded, and implement strategies to achieve the goals and objectives stated in management plans. For example, Turnbull NWR (Spokane County, Washington) includes extensive habitat for water howellia, including 36 known occupied sites. The Refuge's Comprehensive Conservation Plan (CCP) directs protection of these habitats not only for water howellia, but for other riparian species and processes (USFWS 2007b, p. 2-22; Table 3). These protections would remain in place regardless of the Federal listing status. Considering the protection objectives of the Turnbull NWR's channeled scablands (unique wetlands) (USFWS 2007b, p. 2-22) that support water howellia, it is likely that habitat will persist at the site as long as overall management objectives are met.

Ridgefield NWR in western Washington finalized a CCP in 2010, which included several conservation strategies for water howellia. These strategies included allowing natural flood-up and various methods (e.g., mechanical, biological, chemical) for invasive species control (USFWS 2010, pp. 2-37, 2-54). Similar to Turnbull NWR, protections outlined in the Ridgefield CCP for water howellia are expected to remain in place regardless of the Federal listing status.

State Implemented Regulatory Mechanisms

Montana Streamside Management Zone Act (1991)
Montana Streamside Management Zone Act (SMZ), in part, designates vegetated buffer strips around surface waters within the boundaries of timber harvest units (Table 3). The SMZ law covers Federal, State, and private commercial timber practices (Montana Code Annotated 2009, p. 1). The SMZ law specifically prohibits slash fill of wetlands, off-road vehicle use, and clear cutting within 50 feet of water bodies (Administrative Rules of Montana 2007, p. 7). There are no buffer strips designated for isolated wetlands under the SMZ and only voluntary restrictions on equipment travel through isolated wetlands. Thus, the direct loss of habitat or plants for a small number of occurrences from timber harvest is a possibility. However, audits of timber sale practices conducted by interdisciplinary review teams have consistently documented few violations of the SMZ law and generally high compliance (>90%) with voluntary regulations in the recent past (Montana DNRC

2012, pp. 2, 4, 6). The protections of the SMZ are expected to continue in the absence of ESA provisions.

Montana State Comprehensive Fish and Wildlife Strategy (2005)
This conservation strategy identifies focus areas, community types, species, and inventory needs along with their conservation concerns and strategies in Montana (Montana FWP 2005, p. 170). The emphasis of the strategy is conserving a broad range of species and habitats, not just game species and their habitats. The Swan Valley (site of the Montana water howellia meta-population) is designated a "Terrestrial Conservation Focus Area in Greatest Need". Multiple conservation strategies include riparian area conservation, conservation easement planning, sustainable land management practices, and weed control partnerships. However, the implementation of these conservation actions is dependent on State Wildlife Grants; funds that have an uncertain future. For this reason, it is unlikely these conservation strategies could be relied upon to protect water howellia and its habitat, in the absence of the protections of the ESA.

Washington Natural Heritage Plan (2007)
Washington State's Natural Heritage Plan identifies priorities for preserving natural diversity, including wetlands (Washington DNR 2007, entire). The progressive Plan aids Washington DNR in conserving key habitats that are currently imperiled or expected to be in the future. The prioritization of conservation efforts provided by this plan are expected to remain in place in the absence of ESA listing; however, the effects of Plan implementation on water howellia are unclear.

Washington Forest Practices Act (2008)
Washington State's Forest Practices Act and Regulations and associated rules (Washington Annotated Code 2008, p. 30-3) provides protection of wetlands from fill and cutting that could result from commercial timber harvest operations. Minimum buffers of 25 feet are designated around ponds and wetlands inside timber sale boundaries, effectively prohibiting most harvest and all heavy equipment use in these areas (Table 3). As State law, these protections are expected to remain in place in the absence of ESA listing.

Oregon Senate Bill 533/Oregon Revised Statute 564 (1987)
Oregon SB 533/ORS 564 requires non-Federal public agencies to protect state-listed plant species found on their lands (Oregon Revised Statute 2009, entire). Any land action on Oregon non-Federal public lands which results, or might result, in the taking of a threatened or endangered species requires consultation with the Oregon Department of Agriculture (ODA) staff (Table 3). Removal of ESA protections for water howellia would remove State protection of the species under this statute since water howellia was never formally listed by ODA. However, protections are

expected to remain in place due to other rare, sensitive plant species in the area and the commitment of the Metro (Portland-area regional government) to protect the only known occurrence of water howellia in Oregon (Currin 2013b, pers. comm.).

Conclusion: At listing, few regulatory mechanisms were in place that directly protected water howellia habitat from the effects of land management. However since listing, more regulations have been enacted that appear to have been effective at protecting water howellia populations from the effects of land management activities (e.g., timber harvest, prescribed fire, military activities). Multiple Federal and State regulations designate buffer strips around water bodies to protect these sensitive areas from disturbance caused by forestry practices and equipment. Further, most of these mechanisms are expected to remain in place regardless of Federal listing status. The majority (86%) of water howellia occurrences are protected by existing regulatory mechanisms. Few regulatory mechanisms are in place mandating control of invasive species, particularly reed canarygrass. However, most Agency management plans have protocols to address noxious weed invasions if monitoring indicates a need. Thus, we consider the existing regulations to be adequate to conserve water howellia, in the absence of the protections of the ESA.

2.3.2.5. Other natural or manmade factors affecting its continued existence

Climate Change: According to the Intergovernmental Panel on Climate Change (IPCC) (2007, p. 72) "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level."

Since the release of the IPCC report, new evidence that our planet is experiencing significant and potentially irreversible changes has underscored reasons for concern (Smith et al. 2009 as cited by Glick et al. 2011). In the United States, we are seeing a multitude of changes consistent with a rapidly warming climate. Climate change impacts in the United States summarized by the U.S. Global Change Research Program in Global Change Impacts in the United States (Karl et al. 2009) include:

- U.S. average temperature has risen more than 2 degrees Fahrenheit over the past 50 years and is projected to rise more in the future; how much more depends primarily on the amount of heat-trapping gases emitted globally and how sensitive the climate is to those emissions.
- Precipitation has increased an average of about 5 percent over the past 50 years. Projections of future precipitation generally indicate that northern areas will become wetter, and southern areas, particularly in

the West, will become drier.

- The amount of rain falling in the heaviest downpours has increased approximately 20 percent on average in the past century, and this trend is very likely to continue, with the largest increases in the wettest places.
- Many types of extreme weather events, such as heat waves and regional droughts, have become more frequent and intense during the past 40 to 50 years.

These changes are already having a considerable impact on species and natural systems, including changes in the timing of biological events (i.e., phonological changes), such as the onset and end of breeding seasons, migration, and flowering; shifts in geographic ranges; and changes in community dynamics and populations (Glick et al. 2011).

The ecological impacts associated with climate change do not exist in isolation, but combine with and exacerbate existing stresses on our natural systems. Vulnerability to climate change has three principle components: sensitivity, exposure, and adaptive capacity (Glick et al. 2011; Dawson et al. 2011). Sensitivity is the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli (U.S. CCSP 2008b as cited by Glick et al. 2011). Exposure is the nature and degree to which a system is exposed to significant climate variations (IPCC 2001b as cited by Glick et al. 2011). Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (IPCC 2001b as cited by Glick et al. 2011).

Increased precipitation predicted by climate models in the northern portion of the range of water howellia (e.g., Washington, Idaho, Montana) may affect the species in several ways. First, increases in precipitation may increase the surface area of existing ponds and wetlands, or create new ones. These new habitats would be available for colonization by water howellia and could increase the redundancy and resiliency of the species. However, new habitats would also be available to invader species such as reed canarygrass and may also promote expansion of invasives on the landscape. An important factor in increased habitat would likely be the site-specific conditions within each habitat; new habitat with deeper water and longer periods of inundation would likely preclude establishment of reed canarygrass and be beneficial to water howellia. Conversely, the creation of shallower habitat may favor reed canarygrass. Another possible effect of increased precipitation may be the alteration of the hydrologic cycle of water howellia habitats. Specifically, these habitats may fill earlier (with heavier spring rainfall) and dry later than historically, thereby reducing the window for air exposure needed for seed germination of water howellia in late summer and autumn.

Changes in precipitation from snow to rain may also affect water howellia, particularly in the southernmost occurrences (e.g., California) (California DWR 2011, p. 2-7). More precipitation falling as rain rather than snow would likely alter the hydrologic cycle within these habitats. These alterations could include faster drying of wetlands than was observed historically, due to a lack of spring run-off from snow fields and increased annual air temperature. More extreme precipitation events are also predicted for California (California DWR 2011, p. 2-10). The effect of more extreme precipitation events on water howellia habitat in California is unclear, especially given the potential for interactions among precipitation and other environmental variables predicted to change (e.g., reduced snowpack, increased annual air temperature).

Water howellia's ability to self-fertilize and produce seeds at both the early season submergent and later season emergent forms may be an advantage to surviving lengthened, shortened, or generally more inconsistent growing seasons than occurred historically. Seed production from both flower forms in one growing season may increase the opportunity for surviving subsequent inclement years. It is uncertain how increases in water temperature and increased evaporation due to increased ambient temperatures would affect growth and reproduction of water howellia; however, climate conditions that delimit the dual seed production and seed banking could reduce the ability of water howellia to persist over time.

Associated wetland vegetation that positively contributes to suitable microclimates for water howellia could be altered by a predicted increase in wildfire, insect pathogens such as pine bark beetles, increase in noxious weeds, and an increase in atmospheric carbon dioxide levels that could accelerate natural ecological succession. The loss of vegetation around ponds from wildfire or other events could accelerate sedimentation resulting in the loss of water howellia occurrences. The Montana and eastern Washington populations of water howellia could be more resilient to these processes than other populations because of their distribution over a larger landscape with many separate occurrences. Increasing temperatures combined with increased demand for ground and surface water for human development may compound negative impacts to water howellia in eastern Washington and northern Idaho. Climate-induced effects on water howellia may appear first in California, as these occurrences are at the southern edge of the known range. However, these effects may be buffered by the higher elevation (~3800 feet) of the California sites compared to lower elevation sites (western Washington ~15 feet). A loss of water howellia in California would result in a large gap in the known range of the species.

Summary: Predicted environmental changes resulting from climate change are expected to have both positive and negative effects on water howellia, depending on site-specific conditions within each habitat type. The primary predicted negative effect is the alteration of hydrologic regimes and resulting inconsistent growing seasons. This effect will likely be buffered by the ability of water howellia to produce seeds during both early and late seasons. Predicted environmental effects that may be positive for water howellia include increased habitat, seed dispersal, and species distribution in some areas, including within the three meta-populations due to predicted increases in precipitation across the northern range of the species. The intact nature and current spatial arrangement (geographically diverse and at varying elevations) of the three large meta-populations will likely provide more resilience to climate change than for smaller, isolated occurrences. Effects of potential composition shifts in vegetation surrounding water howellia occurrences as a result of climate change are unknown.

Small population size/low genetic diversity: The final listing rule for water howellia cited small population size and lack of genetic variation among and between populations as a contributor to its vulnerability (USFWS 1994, p. 35862–35863). Small populations with low genetic diversity could limit a species' or population's ability to respond to novel changes in its environment – necessitating redundancy of occurrences or populations across larger areas to increase the probability of survival. At the time of listing, the only genetic investigation of the species showed very low genetic diversity within and among populations in Washington and Montana (Lesica *et al.* 1988, p. 278). More current genetic results indicate greater genetic diversity within and among populations than previously thought; however, diversity was still relatively low (Brunsfeld and Baldwin 1998, p. 2; Schierenbeck and Phipps 2010, p. 5).

Summary: Genetic diversity of water howellia across the current range is low. This may limit the species ability to respond to environmental changes. However, the redundancy of smaller populations across the species' range may mitigate for a lack of plasticity within individual occurrences. The current spatial arrangement of small populations is favorable to the species' long-term persistence because these occurrences are at different elevations and within varying climatic regimes. Thus, we do not consider small population size or low genetic diversity to be a threat to water howellia.

2.4. Synthesis

At the time of listing, water howellia habitats were threatened by destruction or modification by timber harvesting practices, livestock grazing, human-related development, altered hydrology, and invasive species. Foraging by native and domestic

animals was considered a possible threat. Regulatory mechanisms were considered inadequate for protecting habitats on both Federal and non-Federal lands. Water howellia was considered vulnerable to stochastic environmental events because of small populations and lack of genetic diversity.

Since the listing of water howellia, recovery actions in the form of increased survey effort has documented 195 additional occurrences, including the rediscovery of the species in Oregon and California where it was believed to be extirpated. It is unclear whether the increase in documented occurrences is due to increased distribution of water howellia, an increase in search efficiency, or some combination of these factors. Historical records and distribution data for water howellia are limited, thus precluding a meaningful interpretation of the relationship between historic and current water howellia distribution. Regardless, increased redundancy of the species across its known range is expected to be advantageous to the species' long-term persistence.

All three meta-populations of water howellia have reed canarygrass present; however, the invasion trend is static in all meta-populations (Montana,Turnbull NWR, and JBLM). In Idaho, reed canarygrass invasions have advanced and retracted since monitoring began, likely due to changing environmental and site-specific conditions. Efforts to reduce reed canarygrass in areas proximate to water howellia populations appear successful in California.

Habitat threats related to land management activities have largely been removed or minimized for approximately 86 percent of water howellia occurrences range-wide (Table 2); this includes all lands occupied by water howellia that have active management or conservation plans that benefit water howellia (Table 3). These plans have been implemented by Federal and State agencies and some private entities and have been effective at minimizing effects from forestry practices, road construction and maintenance, and grazing/trampling. Protections for the remainder of the known water howellia occurrences on private lands without a Federal nexus are limited. Habitats on these lands may still be affected by human-related development, altered hydrology, livestock grazing/trampling, and invasive species. Approximately 14 percent of water howellia occurrences are on private lands with no known conservation measures in place.

Many regulatory mechanisms are currently in place which provide protection to water howellia habitat and are expected to provide protection in the absence of ESA listing. Federal management plans (RMPs and CCPs) are in place providing protection to most water howellia occurrences within the three meta-populations. Other regulatory mechanisms mandate protections for occurrences on State and some private lands (conservation easements). Regulatory mechanisms for controlling invasive species are few; however, most management plans have procedures outlined to control invasives if monitoring data indicate the need.

Predicted environmental changes from climate change will likely be favorable to water howellia in some areas by increasing habitat suitability of occupied and possibly unoccupied habitats. Conversely, changes to hydrologic regimes will likely be

detrimental to occurrences in some areas by altering the specific filling and drying cycles of ponds and wetlands that water howellia need for successful reproduction. The dual seed production strategy of water howellia is expected to provide some buffer against predicted inconsistent growing seasons resulting from climate change. Effects of potential composition shifts in vegetation surrounding water howellia occurrences as a result of climate change are unknown.

Small, isolated populations are vulnerable to stochastic events. However, the current distribution of water howellia is favorable to the species' long-term persistence because of the intact nature of three large meta-populations and the spatial arrangement of other occurrences at different elevations and within varying climatic regimes. This mosaic distribution should improve the species ability to persist in the face of gradual or catastrophic changes in the environment.

In conclusion, water howellia has been documented to be more widely distributed on the landscape than at the time of listing, including in areas where it was formerly considered extirpated. Federal listing and other regulatory mechanisms have provided protections from human-caused habitat destruction through management or conservation plans for the majority of occurrences (86 percent on Federal, State, and some private lands). Protection of 86 percent of known occurrences would conserve the current range-wide distribution of water howellia, including the three meta-populations. The status of invasives is reported as static, including the areas occupied by the three meta-populations. Given the reduction or elimination of threats present at the time of listing, increased redundancy range-wide, and increased habitat protections, we conclude water howellia is not in danger of extinction throughout all or a significant portion of its range (i.e., endangered). Further, we conclude that water howellia is not likely to become an endangered species in the foreseeable future throughout all or a significant portion of its range for the aforementioned reasons. Thus, water howellia does not meet the definition of an endangered or threatened species per the ESA; we recommend water howellia for delisting.

3. RESULTS

3.1. Recommended Classification:

☐ Downlist to Threatened
☐ Uplist to Endangered
☒ **Delist** (Indicate reasons for delisting per 50 CFR 424.11):
  ☐ Extinction
  ☒ Recovery
  ☐ Original data for classification in error
☐ No change is needed

3.2. New Recovery Priority Number

Currently, the threats to water howellia identified at the time of ESA-listing have

been removed or largely minimized, thus the degree of threat to water howellia is low. The recovery potential of water howellia is high; biological and ecological limiting factors and threats are relatively well known and intensive management is not needed for recovery of the species. Water howellia is the only species in the genus *Howellia*. Water howellia does not appear to be in conflict with construction and development as indicated by the relatively few consultations under Section 7 of the ESA since listing. Cumulatively, these factors suggest a new recovery priority number of 13 is appropriate (Table 4).

TABLE 4.–The Below Ranking System for Determining Recovery Priority Numbers was Established in 1983 (48 FR 43098, September 21, 1983 as corrected in 48 FR 51985, November 15, 1983).

Degree of Threat	Recovery Potential	Taxonomy	Priority	Conflict
High	High	Monotypic Genus	1	1C
		Species	2	2C
		Subspecies/DPS	3	3C
	Low	Monotypic Genus	4	4C
		Species	5	5C
		Subspecies/DPS	6	6C
Moderate	High	Monotypic Genus	7	7C
		Species	8	8C
		Subspecies/DPS	9	9C
	Low	Monotypic Genus	10	10C
		Species	11	11C
		Subspecies/DPS	12	12C
Low	**High**	**Monotypic Genus**	**13**	13C
		Species	14	14C
		Subspecies/DPS	15	15C
	Low	Monotypic Genus	16	16C
		Species	17	17C
		Subspecies/DPS	18	18C

3.3. Listing or Reclassification Priority Number

TABLE 5.–The Below Ranking System for Prioritizing Downlisting (from Endangered to Threatened) and Delisting was Established in 1983 (48 FR 43098, September 21, 1983).

Management Impact	Petition Status	Priority
High……	Petitioned action……...	1
…	Unpetitioned action……..	2
Moderate……	Petitioned action……...	3
...	Unpetitioned action……..	4
Low……	Petitioned action……...	5
...	**Unpetitioned action**……..	**6**

☐ Reclassification (from Threatened to Endangered) Priority Number
☐ Reclassification (from Endangered to Threatened) Priority Number
☒ Delisting (Removal from list) Priority Number

The management impact of the water howellia listing action is low. Most land management activities that have the potential to affect water howellia occurrences are regulated by existing mechanisms intended to generally protect sensitive areas (e.g., ponds and wetlands) and maintain certain environmental standards (e.g., water quality). If water howellia were not federally listed, management activities would still be regulated by these existing mechanisms, thus impact to management would remain similar. Because of this, it is very unlikely that the listing status of water howellia is diverting conservation resources from species more deserving or in need. The Service was not petitioned to remove water howellia from the list of threatened species, thus a delisting priority number of 6 is appropriate (with low management impact taken into account; Table 5).

4. RECOMMENDATIONS FOR FUTURE ACTIONS

4.1. Administrative actions: Develop a proposed and final delisting rule for water howellia, as resources allow.

4.2. Administrative actions: Draft a post-delisting monitoring strategy based on the information gained from the updated 5-year review.

4.3. Administrative actions: Develop a Memorandum of Understanding (MOU) with the U.S. Forest Service and U.S. Department of Defense (at JBLM) to ensure the continuation of existing conservation practices currently benefitting water howellia. This action should be completed before delisting.

4.4. Research: Better define the conditions that favor water howellia over reed canarygrass This will inform future management of both species and increase effectiveness of reed canarygrass suppression (Refer to USFWS 1996, #316, 324, 325)

4.5. Survey and Monitoring: Apply standardized survey and monitoring and reporting protocols, either range-wide or within geographic assemblages, on a consistent basis. This (these) protocol(s) would facilitate trends in invasive species incursion, identify community types, evaluation of successional dynamics, changes in hydrological conditions, and determine optimum local conditions to support persistence. (Refer to USFWS 1996, #33, 311, 313, 314, 632)

4.6. Cooperative partnerships: Because water howellia is known on primarily private lands in Idaho, pursue financial and other necessary support for partnerships to ensure habitat protections to maintain the presence of water howellia in this part of the range. (Refer to USFWS 1996, #12)

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW OF WATER HOWELLIA

Current Classification: Threatened range-wide

Recommendation resulting from the 5-Year Review:

- ☐ Downlist to Threatened
- ☐ Uplist to Endangered
- ☒ Delist
- ☐ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: 6

Review Conducted By:

FIELD OFFICE APPROVAL:

Lead Field Office Supervisor, Fish and Wildlife Service

Approve _____ Date 8/6/2013
Field Supervisor, Montana Ecological Services Field Office

REGIONAL OFFICE APPROVAL:

Lead Assistant Regional Director, Fish and Wildlife Service

Approve _____ Date 8/30/13
Acting Assistant Regional Director, Mountain-Prairie Region (Region 6)

Cooperating Assistant Regional Director, Fish and Wildlife Service

Concur _____ Date 8/22/13
Acting Assistant Regional Director, Pacific Southwest Region (Region 8)

Cooperating Assistant Regional Director, Fish and Wildlife Service

Concur _____ Date 8-20-13
Assistant Regional Director, Pacific Region (Region 1)

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