REPORT ON THE CONSERVATION STATUS OF *Howellia aquatilis*, A CANDIDATE THREATENED SPECIES

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Taxon name:	*Howellia aquatilis* A. Gray
Common name:	Water Howellia
Family:	Campanulaceae
States where taxon occurs:	U.S.A., Idaho, Montana, Washington; historical in California, Oregon
Current federal status:	USFWS Notice of Review, Category 2
Recommended federal status:	Listed Treatened
Authors of report:	J. Stephen Shelly and Robert Moseley
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I. SPECIES INFORMATION

1. Classification and nomenclature.

A. Species.

1. Scientific name.

a. Binomial: Howellia aquatilis A. Gray.

b. Full bibliographic citation: Gray, A. 1879. Proc. Am. Acad. 15: 43-44.

c. Type specimen: Oregon, Multnomah County, Sauvies Island, 1879, Thomas & Joseph Howell 137, GH.

2. Pertinent synonyms: None.

3. Common name: Water Howellia.

4. Taxon codes: PDCAM0A010 (The Nature Conservancy); 4886, HOWAQU (U.S. Forest Service, Region 1); NT.L72 (Washington Natural Heritage Program; California Nongame-Heritage Program); HOAQ (Garrison et al. 1976; Soil Conservation Service 1982).

5. Size of genus: Monotypic genus.

B. Family classification.

1. Family name: Campanulaceae.

2. Pertinent family synonyms: None.

3. Common names for family: Harebell Family, Bellflower Family.

C. Major plant group: Dicotyledoneae.

D. History of knowledge of taxon:

Howellia aquatilis was first collected in May, 1879, by two early Oregon botanists, Thomas and Joseph Howell. The initial discovery was made in a slough on Sauvies Island, along the Columbia River near Portland. The initially collected material included only submergent, cleistogamous flowers. They returned to a nearby area in August of that year, and collected material bearing well-developed, emergent, chasmogamous flowers. The specimens were determined to represent a new genus and species by Asa Gray, and it was described in the same year (Gray 1879).

Subsequent collections were made in Mendocino County, California in 1928 (Smith and Berg 1988); Clackamas (1892), Marion (1926, 1928), and Multnomah (1879, 1881, 1885, 1886) counties, Oregon (Oregon Natural Heritage Data Base); Clark (1980), Mason (1937), and Spokane (1983, 1986, 1987) counties, Washington (Washington Natural Heritage Program); and Kootenai (1892) and Latah (1988) counties, Idaho. The first collection in Montana was made in 1978 by Bruce McCune (McCune 1982), when it was found in the Swan Valley in Missoula County. Further surveys (1983-1986) in the Swan Valley, primarily by John Pierce and Peter Lesica, revealed the presence of 15 additional populations, from three sites within the drainage.

In 1987, the Montana Natural Heritage Program (MTNHP) was contracted by the U.S. Fish and Wildlife Service (the Service), with funds appropriated under Section 6 of the Endangered Species Act, to conduct a status survey of Howellia aquatilis in Montana (Project Agreement SE-4-P-1). In June-July 1987, field

surveys were conducted by the first author, with assistance from Lisa Campbell, Anne Morley, and Peter Lesica; further surveys were also conducted in July 1988. Surveys were completed in the Swan and Clearwater River drainages, Lake and Missoula Counties, Montana. Surveys in Idaho were conducted in 1988 by the second author, also under Section 6 sponsorship.

Of the 16 Montana populations of Howellia aquatilis which were initially recorded by the MTNHP prior to the start of the surveys, ten of these were monitored during the 1987 surveys; six others were not revisited. Thirty-six new populations were located; collections were made at 18 of these, and the remaining 18 were recorded as sight records. In 1988, three additional populations were found, and collections were made from them. In Idaho, one recently observed population was verified, but no new populations were located. All data and photos are from 1987 and 1988, except where noted.

E. Comments on current alternative taxonomic treatments: There are no known current alternative taxonomic treatments.

2. Present legal or other formal status.

A. International: None.

B. National.

1. United States.

a. Present designated or proposed legal protection or regulation: U.S. Fish and Wildlife Service: Currently, the species is included in Category 2 of the U.S. Fish and Wildlife Service Notice of Review (U.S. Department of Interior 1985), under consideration for federal listing as a threatened species. Category 2 taxa are those "...for which information now in possession of the Service indicates that proposing to list them as endangered or threatened species is possibly appropriate, but for which substantial data on biological vulnerability and threat(s) are not currently known or on file to support the immediate preparation of rules."

b. Other current formal status recommendations: The species is currently listed as "endangered throughout range" (global rank = G2) by The Nature Conservancy.

c. Review of past status: The species was originally placed in Category 2 in 1980 (U.S. Department of Interior 1980).

C. State.

1. California.

a. Present designated or proposed legal protection or regulation: Howellia aquatilis is included on List 1A (plants presumed extinct in California) in the California Native Plant Society inventory of rare and endangered vascular plants; all of the plants in this category are eligible for state listing (Smith and Berg 1988). However, the species currently has no state listing status (California Department of Fish and Game 1988).

b. **Other current formal status recommendations:** As described above.

c. **Review of past status:** Placed on List 1A in the California Native Plant Society inventory, as defined above (Smith and York 1984).

2. Idaho.

a. **Present designated or proposed legal protection or regulation:** None.

b. **Other current formal status recommendations:** The species is listed as "endangered" (in danger of becoming extinct or extirpated in the state within the foreseeable future, if identifiable factors contributing to its decline continue to operate) by the Idaho Natural Heritage Program.

c. **Review of past status:** Although the Idaho population was unknown to him at the time, Brunsfeld (1983) recommended that Howellia aquatilis be placed on the "Federal Watch List."

3. Montana.

a. **Present designated or proposed legal protection or regulation:** None.

b. **Other current formal status recommendations:** The species is currently listed as "endangered in Montana" (state rank = S2) by the MTNHP (Shelly 1988).

c. **Review of past status:** Previously listed as "recommended endangered" by the Montana Rare Plant Project (Lesica et al. 1984).

4. Oregon.

a. **Present designated or proposed legal protection or regulation:** Howellia aquatilis is a candidate for potential state listing under the 1987 Oregon Endangered Species Act (R. Meinke, Oregon Department of Agriculture, pers. comm.).

b. **Other current formal status recommendations:** The species is currently included on List 1 (taxa endangered throughout range), and is considered possibly extirpated from the state (Oregon Natural Heritage Data Base 1987).

c. **Review of past status:** Formerly listed in Group IIb (known from only a few widely disjunct populations), and considered rare and endangered in Oregon (Siddall et al. 1979).

5. Washington.

a. **Present designated or proposed legal protection or regulation:** None.

b. **Other current formal status recommendations:** The species is currently included on the list of endangered plant taxa (in danger of becoming extinct or extirpated in the state within the near future if factors contributing to its decline continue; Washington Natural Heritage Program 1987).

c. **Review of past status:** None known.

3. Description.

A. General nontechnical description: Howellia aquatilis is a strictly aquatic species, which grows as a mostly submerged plant rooted in the bottom sediments of the ponds and sloughs to which it is adapted. Later in the season, it can sometimes be found persisting in the muck on the edges of these areas as they dry out. It is an annual, completing its entire life cycle in one growing season, and becoming inconspicuous upon desiccation of its habitat at the end of the summer. The stems are branched several inches from the base, and each branch then extends to the surface of the water. The numerous leaves are an inch or two long and very narrow.

Howellia aquatilis produces two types of flowers. Along the stem beneath the water surface, small flowers form which do not develop a conspicuous corolla (floral tube). However, as the branches reach the surface, more conspicuous flowers develop above the water. These emergent flowers are white, have five lobes on one side of the corolla, and are about ¼ inch across. Both types of flowers give rise to thin-walled fruits which are an inch or more long, and which contain one to five or so large, shiny brown seeds which can be about ¼ inch long.

In Idaho and Washington, emergent flowers are evident in May. In Montana, the emergent flowers are in bloom from late June to August. The actual duration of the plants and flowers may be longer in certain cases, depending on the rate of drying of the habitat.

B. Technical description: Flaccid annual, aquatic herb, mostly submergent, often with emergent branches; plants naked below, branched above; whole plant glabrous, green, about 10-60 cm. (4-24 in.) tall, occasionally taller; leaves numerous, alternate, or some of them subopposite or whorled in threes, linear or linear-filiform, entire or nearly so, 1-5 cm. (0.4-2 in.) long, up to 1.5 mm. (0.06 in.) wide; flowers white, mostly 3-10, axillary, often scattered, pedicellate or subsessile, both petaliferous (when emergent) or much reduced and inconspicuous (when submerged), the fully-developed corollas about 2-2.7 mm (0.08-0.11 in.) long, irregular, with the tubes deeply cleft dorsally, and five-lobed; filaments and anthers connate, two of the anthers shorter than the others; calyx lobes 1.5-7 mm. (0.06-0.28 in.) long; stout pedicels 1-4 (8) mm. (0.04-0.16 (0.3) in.) long, merging gradually with the base of the capsule; ovary unilocular, with parietal placentation; stigma 2-lobed; fruit 5-13 mm. (0.2-0.5 in.) long, 1-2 mm. (0.04-0.08 in.) thick, irregularly dehiscent by the rupture of the very thin lateral walls; seeds large, 2-4 mm. (0.08-0.16 in.) long, 5 or fewer, shiny brown (adapted from Hitchcock et al. 1959; Dorn 1984).

C. Local field characters: Howellia aquatilis is the only member of the Campanulaceae in Montana which is strictly aquatic. Downingia laeta can occur in wet places in meadows or on the edges of ponds, but is distinguishable by its light blue or purplish flowers marked with white or yellow; it was not observed in the Swan Valley during field surveys. Heterocodon rariflorum, a species of moist areas in Lake and Ravalli counties, has regular, blue flowers. The annual habit,

distinctive habitat, and irregular white flowers of H. aquatilis thus serve to distinguish it from all other members of the family in northwestern Montana.

An unrelated species which is vegetatively similar to H. aquatilis, and which is frequently found growing with it, is Callitriche heterophylla (Callitrichaceae). However, the submergent linear leaves of this species are most often opposite (only rarely whorled), and the floating leaves are broadly obovate. In addition, the flowers of C. heterophylla are axillary, very inconspicuous, and do not have a corolla.

D. Identifying characteristics of material which is in interstate or international commerce or trade: No interstate or international commerce or trade known.

E. Photographs and line drawings: Figure 1 provides a copy of the illustration of this species, adapted from Meinke (1982). The color slides (p. 8) are duplicates of those taken at the sites indicated. Additional slides from other locations in Montana are housed at the MTNHP office in Helena.

4. Significance.

A. Natural: As a monotypic genus, H. aquatilis is taxonomically unique. The only genus which seems closely related to Howellia is Legenere. The latter is also monotypic, consisting only of the species L. limosa, and occurs in dried beds of vernal pools in the Central Valley of California (Munz 1959). Recent electrophoretic studies (Lesica et al. 1988) indicate that there is no genetic variation either within or among populations of H. aquatilis; this is also unique, especially considering its wide geographic distribution pattern. However, lack of genetic variation is often correlated with the narrow ecological amplitude possessed by species such as H. aquatilis (Waller et al. 1987). Howellia aquatilis has thus provided a valuable subject for conservation biology studies. Otherwise, the species is not known to have any peculiar adaptations or structures, or roles in stabilizing landforms. Obligate relationships with other species are unknown.

B. Human: As discussed, H. aquatilis would be of scientific significance in studies addressing its systematic relationships and isolation, and has been an important subject in conservation biology research. Otherwise, the species has no known agricultural, economic, horticultural, or other human uses or significance at this time.

5. Geographical distribution.

A. Geographical range: Howellia aquatilis is currently known from a total of 13 sites: one in Idaho (Latah County); three in Washington (Clark and Spokane counties; J. Gamon, pers. comm.); and nine in Montana (Lake and Missoula counties). It is historically known from one collection in California (Mendocino County; Smith and Berg 1988), four locations in northwestern Oregon (Clackamas, Marion and Multnomah counties; S. Vrilakas, pers. comm.), one location in Washington (Mason County; J. Gamon, pers. comm.), and one collection from northern Idaho (Kootenai County). The range is indicated in Figure 2, p. 9.

B. Precise occurrences.

1. **Populations currently or recently known extant:** Table 1, pp. 11-27, lists currently known populations by state and county. Exact locations for the Montana and Idaho populations are provided in the maps on pp. 139-149.

2. **Populations known or assumed extirpated:**

a. Sauvie Island.
   1. U.S.A., Oregon, Multnomah County.
   4. USGS quad: Sauvie Island, 7.5'.
   5. Year of initial discovery: 1879.
   6. Year of most recent observation: 1886.
   7. Location: Sauvie Island, Willamette Slough (type locality).
   8. Alternative site name: Sauvies Island.

b. Lake Oswego.
   1. U.S.A., Oregon, Clackamas County.
   4. USGS quad: Lake Oswego, 7.5'.
   5. Year of initial discovery: 1892.
   6. Year of most recent observation: 1892.
   7. Location: Lake Oswego, west of Portland about 4 miles (Howell s.n., WS).
   8. Alternative site name: none known.

c. Painter's Woods.
   1. U.S.A., Oregon, Marion County.
   4. USGS quad: Salem West, 7.5'.
   5. Year of initial discovery: 1926.
   6. Year of most recent observation: 1935.
   7. Location: Area near Painter's Woods, near Salem (Thompson (4927, 4967), ORE; J.C. Nelson (5075), GH; M.E. Peck (15935), WILLU).
   8. Alternative site name: none known.

d. Mission Bottom.
   1. U.S.A., Oregon, Marion County.
   4. USGS quad: Mission Bottom, 7.5'.
   5. Year of initial discovery: 1977.
   6. Year of most recent observation: 1977.
   7. Location: Mission Bottom, near Salem (W. Bluhm, sight record).
   8. Alternative site name: none known.

e. Howard Lake.
   1. U.S.A., California, Mendocino County.
   2. Latitude, longitude, altitude: unknown.
   3. Legal description: unknown.
   4. USGS quad: Buck Rock, 7.5'.
   5. Year of initial discovery: 1928.
   6. Year of most recent observation: 1928.
   7. Location: Pond near Howard Lake, Mendocino County Forest Reserve (A. Eastwood 13267a, CAS).

8. Alternative site name: none known.

The populations in Oregon have been searched for to no avail (J. Kagan, pers. comm.); the Marion and Clackamas county sites are in areas which have largely been developed, and intensive relocation efforts at the Multnomah County site (type locality) have remained unsuccessful. Likewise, the California collection locality has not been relocated, despite searches for it in 1979 (Griggs and Dibble 1979), and again in 1980 (R. Bittman, pers. comm.).

3. Historically known populations where current status not known:

a. Shelton.

1. U.S.A., Washington, Mason County.
2. Latitude, longitude, altitude: unknown.
3. Legal description: unknown.
4. USGS quad: unknown.
5. Year of initial discovery: 1937.
6. Year of most recent observation: 1937.
7. Location: In a small lake about 20 mi. n. of Shelton (W.J. Eyerdam 1211, UC).
8. Alternative site name: none known.

4. Locations not yet investigated believed likely to support additional natural populations: In western Montana, an extensive assemblage of glacial pothole ponds and wetlands is located in the Flathead Valley in Lake County. However, this region of the state has been extensively altered by agricultural and residential development; also, upland areas are dominated by grassland vegetation, and habitat consisting of ponds surrounded by coniferous and deciduous trees is absent. There may be some appropriate habitat on the Lolo National Forest in west-central Montana (J. Diebert, pers. comm.), especially in the Clearwater River drainage in Missoula County.

An extensive search in northern Idaho, during June 1988, was unsuccessful in locating new Howellia aquatilis populations. It is possible that other populations may exist in Idaho north of the Clearwater River drainage. As in the other states, however, past and ongoing alteration and conversion of native low elevation bottomlands makes the prospect unlikely.

In Washington, areas near the historical record north of Shelton contain numerous wetlands, so the potential exists for relocating H. aquatilis in this region. Also, the forested portions of the channeled scablands in eastern Washington (Spokane County) probably harbor additional populations. There is some potential along the forested northern periphery of the Columbia Basin, as well (J. Gamon, pers. comm.).

In Oregon, the type locality on Sauvies Island in the Columbia River has been adequately searched; however, there may still be some potential

habitat in the Willamette River valley (J. Kagan, pers. comm.).

In California, there may be habitat in temporary ponds or vernal pools on the Mendocino National Forest near where the historical collection was made. These areas should be searched in May to June or July (Griggs and Dibble 1979).

5. Reports having ambiguous or incomplete locality information:

a. Spirit Lake.

1. U.S.A., Idaho, Kootenai County.
2. Latitude, longitude, altitude: unknown.
3. Legal description: unknown.
4. USGS quad: unknown.
5. Year of initial discovery: 1892.
6. Year of most recent observation: 1892.
7. Location: "Valley of Lake Tesemini, Kootenai Co." (J.H. Sandberg 699, US).
8. Alternative site name: Lake Tesemini.

On 22 July 1892, J.H. Sandberg collected Howellia aquatilis near Lake Tesemini (now known as Spirit Lake) in Kootenai County, Idaho. Holzinger (1895) described Sandberg's exploration of this area as follows: "Camp 10 was situated a short distance to the north of Rathdrum, Kootenai Co. The time occupied in the vicinity of this camp was from July 20 to July 25. The plants collected were numbered 670 to 740. The region explored was the vicinity of Rathdrum, Lake Tesemini, and Mud Lake."

Habitat information on the Sandberg label states "floating in subalpine lakes." After reviewing topographic maps for the Spirit Lake area, it was determined that no subalpine lakes exist in the Spirit Lake watershed. Subalpine elevations are reached on the eastern slopes of Mt. Spokane, Washington, at the head of Brickel Creek, but no lakes occur there. Sandberg, it appears, had a bad reputation among his contemporaries and was careless in his note-taking. Leiberg reported in a letter to C.V. Piper (cited in Mack 1988) that Sandberg's report of 1892 (Holzinger 1895) erred by as much as 240 km in the location of some specimens.

A search was conducted in the vicinity of Spirit Lake during June 1988, and while suitable habitat exists in the area, no H. aquatilis populations were found (Appendix A, p. 153).

6. Locations known or suspected to be erroneous reports:

a. Columbia River Gorge (two sightings, considered to be misidentifications by the Oregon Natural Heritage Data Base (S. Vrilakas, pers. comm.).

1. U.S.A., Oregon, Wasco County.
2. Latitude, longitude, altitude: unknown.
3. Legal description: unknown.

4. USGS quad: unknown.
5. Year of observation: unknown.
6. Location: unknown.

C. Biogeographical and phylogenetic history: Details unknown, and not yet investigated. It has been speculated that the widely scattered distribution of H. aquatilis may be due to the wanderings of migratory waterfowl (Meinke 1982). The distributional pattern of H. aquatilis in Montana is undoubtedly related in part to the glacial history of the Swan Valley. The valley floor was glaciated approximately 10,000 years ago, and many of the pothole ponds and wetlands were formed upon retreat of the glacier. Thus, it is possible that the present distribution pattern of the species in Montana was recently established. In Washington, all but one of the known extant sites occur in the channeled scablands, which were formed by the Bretz floods (J. Gamon, pers. comm.).

6. General environment and habitat description.

A. Concise statement of general environment and habitat: Howellia aquatilis is an aquatic plant occurring in small pothole ponds or the quiet water of retired river oxbows. These wetlands usually have bottom surfaces of firm, consolidated clay and organic sediments. They are virtually always partially surrounded by broadleaf deciduous trees, such as Populus trichocarpa (Black Cottonwood) and/or P. tremuloides (Quaking Aspen) in Montana, and Fraxinus latifolia (Ash) or Quercus garryana (Garry Oak) in Washington. Characteristic associated aquatic species include Carex vesicaria (Inflated Sedge), Sium suave (Hemlock Water-parsnip), and/or Equisetum fluviatile (Water Horsetail) in Montana. In Idaho, H. aquatilis occurs in a small pond in a cutoff river channel, in a broad valley bottom surrounded by low, forested hills. Rangewide, the ponds are generally filled by spring rains or snowmelt run-off, and many are usually dry by the end of the growing season. Howellia aquatilis occurs at elevations from 3 m (10 feet) in Washington to 1350 m (4420 feet) in Montana.

B. Physical characteristics.

1. Climate.

a. Koppen climate classification (extant sites): Types Csa and Csb (warm, maritime or semimaritime types with dry summers), and Dfb (cool temperate climate, with numerous summer thunderstorms) (Visher 1954).

b. Regional macroclimate: The climates in which H. aquatilis has been found range from semi-arid Meditteranean (California; R. Bittman, pers. comm.) to moist temperate (northwestern Montana).

Near the distributional area of H. aquatilis in the Swan Valley, Montana, the closest climatological stations are located in Bigfork (3010 ft. (918 m) elevation) and Seeley Lake (4100 ft. (1250 m) elevation). Data for the period 1951-1980 are provided by the U.S. Department of Commerce (1982). At Bigfork, the mean annual precipitation was 56.08 cm (22.08 in.); the mean annual temperature was 7.5• C (45.5• F), and the mean July maximum

temperature was 27.6• C (81.7• F). At Seeley Lake, the mean annual precipitation was 56.16 cm (22.11 in.); the mean annual temperature was 5.2• C (41.3• F), and the mean July maximum temperature was 27.8• C (82.0• F).

The climate of northern Idaho is influenced primarily by Pacific maritime air. However, Idaho is 500 to 650 km inland from the Pacific Ocean, and the Cascade Mountains separate Idaho from the coast. The distance and the mountain barrier result in a climate with many continental characteristics. Because prevailing westerly winds blow inland from the Pacific Ocean, winters are warmer and milder than might be expected. These mild, moist winds result in winters that are humid and cloudy. Snowfall is heavy in the mountains. Periodically, the westerly flow of air is interrupted by outbreaks of clear, cold continental air from Canada. During the summer months, the westerly winds weaken, and continental climatic conditions prevail. Rain fall, cloud cover, and relative humidity are at their minimum in summer. The Soil Conservation Service (1981) estimates that, in Latah County, the average annual precipitation is 63.5 cm (25 in.), the average annual air temperature is about 6.7• C (44• F), and the average frost-free season is about 110 days.

The climate in western Washington is undoubtedly warmer and moister than in Idaho or Montana.

c. Local microclimate: No detailed quantitative information available. The aquatic habitats occupied by H. aquatilis are probably less subject to diurnal temperature fluctuations than the atmosphere. In Montana, the species often occurs along the margins of small ponds surrounded by heavy forest cover, and thus would be shaded for much of the day. In Idaho, the small pond containing Howellia aquatilis is partially shaded throughout the summer by tall shrubs that immediately border it. Cold air pooling can be intense during the fall, winter and spring, but is moderate during most of the growing season due to the relatively low elevation.

2. Air and water quality requirements: In Montana, water samples from nine ponds supporting H. aquatilis, and three ponds not supporting the species, were analyzed to determine pH and conductivity. In addition, five samples (three from H. aquatilis ponds, two from others) were analyzed to determine alkalinity. The results of these analyses are presented in Table 2.

None of the factors analyzed appear to distinguish among ponds containing or not containing H. aquatilis. The pH values for ponds with or without the species are all in the neutral range (6.75-7.92). It is possible

that other factors which were not analyzed are more important in determining the suitability of a particular site for supporting H. aquatilis (i.e., dissolved oxygen, temperature).

Air quality requirements are unknown.

3. **Physiographic provinces:** Known from the Northern Rocky Mountain, Columbia Plateaus, and Pacific Border provinces mapped by Fenneman (1931); the Rocky Mountains, Columbia-Snake River Plateau, and Pacific Border provinces mapped by Hunt (1974); and the Columbia Basin Province mapped by Franklin and Dyrness (1973).

4. **Physiographic and topographic characteristics:** In the Montana portion of the range, the topography of the Swan Valley is of glacial origin. Generally, the floor of the valley is level to gently sloping, with drumlins in numerous areas. The pothole ponds in which H. aquatilis most often occurs were formed upon the retreat of a continental glacier about 10,000 years ago. These ponds could represent depressions left when masses of ice buried in outwash gravels melted; they could also be formed when areas of ice melted out between areas of outwash sediments which accumulated upon the glacier surface (Alt and Hyndman 1986).

   In Montana, the species is currently known to occur only in the Swan River drainage, within Hydrologic Unit No. 17010211 as mapped by the United States Geological Survey (1980).

   The Idaho population occurs in a mature river bottom, characterized by a wide floodplain and a meandering river. The deep, alluvial soils are derived from the erosion of loess and volcanic ash that were deposited on the surrounding mountains during the Pleistocene.

   In Washington, the ponds in the Spokane region are in an area of basalt flows, and several of them are immediately rimmed by basalt outcrops. The area is characterized by low topographic relief (J. Gamon, pers. comm.).

   The sites for H. aquatilis in Montana range from 945 m (3100 ft.) near the south end of Swan Lake, to 1348 m (4420 ft.) near the east side of Lindbergh Lake. The elevations in Washington range from 3 m (10 ft.) near the Columbia River, to 707 m (2320 ft.) in the Spokane area. The Idaho site occurs at 780 m (2560 ft.).

5. **Edaphic factors:** Howellia aquatilis is found almost exclusively in ponds with bottom surfaces which consist of firm, consolidated clay and organic sediments. Only in two cases were plants found in ponds with deeper, largely unconsolidated bottom sediments; in these situations, most H. aquatilis plants were then found in shallower areas near the shore, in more consolidated portions of the ponds. The texture and depth of these

bottom sediments may be very important in relation to seed germination requirements and early growth of H. aquatilis. Loose, silty soil sediments may lead to burial of seeds too deeply to physically allow efficient germination and establishment.

In Montana, the soil units which comprise the Swan Valley floor consist of Cryochrepts, Eutroboralfs, and Eutrochrepts. The parent materials for these soils consist of clayey alluvium and clayey colluvium; the resultant soils are deep (Montagne et al. 1982).

The Swan River Oxbow (005) site is unusual in that the H. aquatilis populations occupy areas in and near an old, retired oxbow of the previous river channel. The site is physiographically very different from the glacial pothole depressions which the species inhabits elsewhere in the Swan Valley. However, the bottom sediments of the sloughs are of a similar consolidated texture, and many of the common associated species are present, especially Carex vesicaria and Equisetum fluviatile.

Most sites in Spokane County, Washington, are mapped as Cocalalla silty clay loam, a poorly drained soil formed in volcanic ash mixed with silty alluvium, under sedges, rushes and grasses. At least one site is mapped as Semiahoo muck, a very poorly drained organic soil (Donaldson and Giese 1968).

The Idaho population falls within a mapping unit containing soils of the Hampson series, which are coarse-silty, mixed, frigid Fluventic Haploxerolls. They are very deep, moderately well drained soils on valley floors. The soils are formed in alluvium derived from various sources. Slope is 0-3% (Soil Conservation Service 1981). These soils actually occur in adjacent bottomland meadows and are generally not submerged.

6. **Dependence on natural disturbance:** Howellia aquatilis is restricted to aquatic habitats which typically contain water for most of the growing season, but which dry out in many areas by late summer or early fall. The pothole ponds are stable landforms which would be influenced mainly by vegetational changes. However, in the case of the Swan River Oxbow (005) site in Montana, it occurs in a flood plain area which is completely inundated during spring run-off. Howellia aquatilis appears to be tolerant of this situation, as the populations return each season (with variation in size) from the seed bank. The extent, if any, to which the species depends on the drying of its habitat each year, i.e., to promote seed germination, is unknown. However, H. aquatilis may behave as a true "vernal pool" species. It is suspected that any disturbance which alters the local surface or subsurface hydrology around the habitats may influence the populations.
7. **Other unusual physical features:** None known or observed.

C. Biological characteristics.

1. **Vegetation physiognomy and community structure:** Howellia aquatilis occurs in wetland communities dominated by emergent vegetation. In Montana and Idaho, the ponds and wetlands are typically surrounded by temperate coniferous forests dominated by trees with more or less conical crowns. The immediate margins of these wetlands often have a shrub zone which overhangs the shoreline. In addition, large deciduous tree species are almost always found along the margins.
2. **Regional vegetation types:** In Montana, within the Cedar-Hemlock-Douglas-fir Forest Section; in eastern Washington and Idaho, near the border between the Palouse Grassland Province and the Douglas-fir Forest Section; and in western Washington, within the Willamette-Puget Forest Province, all as mapped by Bailey (1976). In Montana, within the Subalpine Fir, Douglas-fir, and Grand Fir Climax Forest zone mapped by Ross and Hunter (1976). The Idaho population occurs in a riparian zone at the interface of two Kuchler types: Grand Fir-Douglas Fir Forests and Wheatgrass- Bluegrass (Kuchler 1964). Surrounding forest types fall into three Society of American Foresters (SAF) cover types: Interior Douglas-fir (210), Western Larch (212), Grand Fir (213), and Western White Pine (215) (Eyre 1980). Habitat types fall into the grand fir, western redcedar, and Douglas-fir series (Cooper et al. 1987).
3. **Frequently associated species:** In Montana, Howellia aquatilis is most often found in small pothole ponds of glacial origin, at lower elevations in the Swan River drainage. The zonal vegetation in these areas consists of diverse coniferous forests which contain varying amounts of the following tree species:

   Abies grandis (Grand Fir)
   Abies lasiocarpa (Subalpine Fir)
   Larix occidentalis (Western Larch)
   Picea engelmannii (Engelmann Spruce)
   Pinus contorta (Lodgepole Pine)
   Pinus monticola (Western White Pine)
   Pinus ponderosa (Ponderosa Pine)
   Pseudotsuga menziesii (Douglas Fir)

   Immediately surrounding the ponds in which H. aquatilis has been found, the following deciduous broadleaf tree species are virtually always present: Populus tremuloides (Quaking Aspen) and/or Populus trichocarpa (Black Cottonwood). In the northern Swan Valley, Betula papyrifera (Paper Birch) is also associated with some sites.

   Shrub species bordering H. aquatilis sites include:

   Alnus incana (Thinleaf Alder)
   Cornus stolonifera (Red Osier Dogwood)

Juniperus communis (Common Juniper)
Rhamnus alnifolia (Alder Buckthorn)
Salix spp. (Willows)

The following aquatic herbaceous species were found to be commonly associated with H. aquatilis; those marked with an asterisk can be considered indicator species:

*Carex vesicaria (Inflated Sedge)
Callitriche heterophylla (Different-leaved Water-starwort)
*Equisetum fluviatile (Water Horsetail)
Potamogeton gramineus (Variable Leaf Pondweed)
Ranunculus aquatilis (Hairleaf Water Buttercup)
*Sium suave (Hemlock Water-parsnip)
Sparganium minimum (Small Bur-reed)

Other herbaceous species less frequently associated with H. aquatilis in Montana include:

Alisma plantago-aquatica (American Waterplantain)
Alopecurus aequalis (Shortawn Foxtail)
Carex atherodes (Slough Sedge)
Carex rostrata (Beaked Sedge)
Eleocharis palustris (Common Spikesedge)
Glyceria borealis (Northern Mannagrass)
Myriophyllum spicatum (Spiked Water-milfoil)
Nuphar variegatum (Yellow Water-lily)
Phalaris arundinacea (Reed Canarygrass)
Ranunculus gmelinii (Gmelin's Buttercup)
Sagittaria cuneata (Duckpotato Arrowhead)
Typha latifolia (Common Cattail)
Utricularia vulgaris (Common Bladderwort)
Veronica catenata (Chain Speedwell)

In Washington, the ponds are surrounded most often by the following tree and shrub species:

Cornus stolonifera (Red Osier Dogwood)
Fraxinus latifolia (Ash)
Pinus ponderosa (Ponderosa Pine)
Populus tremuloides (Quaking Aspen)
Populus trichocarpa (Black Cottonwood)
Symphoricarpos albus (Common Snowberry)

Associated aquatic species in Washington include:

Callitriche stagnalis (Pond Water-starwort)
Ludwigia palustris (Ludwigia) - drying areas
Nuphar polysepalum (Spatter-dock)
Polygonum coccineum (Water Smartweed)
Ranunculus flabellaris (Yellow Buttercup)
Ranunculus flammula (Creeping Buttercup) - drying areas

In Idaho, the forests bordering the broad river bottom are dominated by a mixture of coniferous species, including Pinus contorta, Larix occidentalis, Thuja plicata (Western Red-cedar), Abies grandis, Pinus ponderosa, and Abies lasiocarpa. Species immediately bordering the pond include Crataegus douglasii (Hawthorn), Cornus stolonifera, Alnus incana, Symphoricarpos albus, Phlaris arundinacea, and Rosa sp. Associated aquatic species include Alisma plantago-aquatica, Sium suave, Carex rostrata, Lemna minor (Duckweed), Eleocharis sp., and Callitriche heterophylla.

4. **Dominance and frequency of the taxon:** Howellia aquatilis is often distributed in a patchy pattern within its habitat, and varies from scarce to relatively frequent (20-30% cover). It was generally observed to occupy less densely vegetated areas. In Montana, two situations were observed in particular: 1.) in many ponds, the greatest densities of H. aquatilis were found around the pond margins, under the cover of surrounding overhanging shrubs (Salix spp., Alnus incana, Cornus stolonifera). In this zone other emergent aquatic species do not occur in abundance, and H. aquatilis is able to spread throughout the open areas, often growing in thick mats; 2.) in ponds dominated throughout by Carex vesicaria and/or Equisetum fluviatile, H. aquatilis was frequently observed to occupy openings among such vegetation. Similarly, in the central open water of some ponds H. aquatilis becomes very dense (near 100% cover). While the species was found to occur amongst the stems of other emergent plants, it was often not as abundant in such situations. These observations suggest that H. aquatilis may prefer more open microhabitats within the ponds it occupies, and that it cannot compete vigorously with other aquatic plant species. However, at least one site in Washington is dominated by Phalaris arundinacea (Reed Canary Grass), but H. aquatilis is abundant (J. Gamon, pers. comm.). In Idaho, the 30 individuals observed in 1988 had a patchy distribution, occurring mostly in the center of the pond. No observable factors appeared responsible for this pattern.

5. **Successional phenomena:** In Montana, the pothole ponds inhabited by H. aquatilis appear to be at an early stage within the successional series for such habitats. In classifications of wetland habitat types, such ponds could generally be classified as inland shallow fresh marshes (Shaw and Fredine 1956) or seasonal ponds (Stewart and Kantrud 1971). Such wetlands are often characterized by aquatic grasses (i.e, Glyceria spp., Alopecurus aequalis) and sedges (i.e., Carex vesicaria, C. rostrata, C.

atherodes), pondweeds (Potamogeton spp.), and burreeds (Sparganium spp.) (Weller 1981). With increasing sedimentation and accumulation of organic matter, and subsequent lowering of the water table, such habitats can eventually develop into sedge meadows (Reuter 1986). Numerous examples of such meadows can be found in the Swan Valley in Montana. They are dominated most often by Carex lasiocarpa, and the water table is at or below the soil surface. Such sites were never observed to contain H. aquatilis.

The characteristic which may be most important in maintaining the pothole ponds inhabited by H. aquatilis is that they generally always dry completely by the end of the growing season (late August-September in Montana). Such drying inhibits the rate of muck accumulation (Reuter 1986), and may serve to maintain these ponds in an earlier emergent successional stage.

In ponds which are more successionally advanced, and which may remain wetter for most of the growing season, Typha latifolia and Nuphar variegatum are more frequent. In Montana, Howellia aquatilis occurs in association with T. latifolia in 12 such ponds or wetlands (Condon Creek (031), Dog Creek (018), Lindbergh Lake (004, 012, 032, 033, 037, 040, 042, 046, 047, 048), and Swan River Oxbow (005)); it is associated with N. variegatum in three locations (Lost Creek-Cilly Creek Ponds (011, 012), Lindbergh Lake (047)). In many cases, these ponds support less vigorous populations of H. aquatilis, possibly owing to the advancing succession and deeper unconsolidated bottom sediments of such habitats.

Successional trends at the Idaho site could not be discerned due to the limited number of visits made to the area. Vernal ponds have been present at the site for at least 20 years (Ruth Ownbey, pers. comm.).

Despite the fact that H. aquatilis occurs over a large geographic area, it is ecologically adapted to a narrowly defined aquatic habitat. Thus, any direct impacts on its habitat may be more likely to cause extirpation. The species does not appear to be capable of colonizing disturbed habitats.

6. **Dependence on dynamic aspects of biotic associations and ecosystem features:** Howellia aquatilis occurs in shallow ponds and wetlands which generally contain water from spring to mid- or late summer, depending on climatic conditions. In the majority of cases, at least in Montana, these habitats then dry completely near the end of summer (September); in some cases in which H. aquatilis occurs near the margins of deeper ponds, these margins may dry out while the center remains filled. Thus, the species appears to be adapted to "vernal pool" conditions; substantial seed germination may require yearly drying after seed dispersal. This habitat relationship would surely be closely

influenced by yearly variation in precipitation amounts, especially snow depth and resultant run-off. In Washington, some of the ponds which contain H. aquatilis were dry through all of 1987; it remains to be seen how the populations will respond once these sites have water in them again (J. Gamon, pers. comm.).

7. Other endangered, threatened, rare, or vulnerable species occurring in habitat of this taxon:

Idaho - Tauschia tenuissima (Leiberg's Lomatium), a Category 2 federal candidate, occurs in bottomland meadows adjacent to the pond containing H. aquatilis.

Montana - The only state sensitive aquatic species which is known to occur in the vicinity of H. aquatilis is Potamogeton obtusifolius (Blunt-leaved Pondweed, G5/S1S2). This species occurs at the Swan River Oxbow (005) site.

Washington - Cypripedium calceolus var. parviflorum (Small Yellow Lady's-slipper), which is considered endangered in the state (Washington Natural Heritage Program 1987), occurs on the periphery of some ponds which contain H. aquatilis (J. Gamon, pers. comm.).

7. Population biology of taxon.

A. General summary: Populations of H. aquatilis generally consist of a few to several thousand individuals. The species is an annual; population size is known to fluctuate yearly, and is probably mainly associated with variation in annual climatic patterns (precipitation and temperature fluctuations). Recent evidence indicates that the species has no intra- or inter-population genetic variation. Morphological studies and field observations indicate that H. aquatilis is an obligate self-pollinator. Seeds may be dispersed between wetland habitats by wildlife use and migration. Evidence for the existence of seed banks has been obtained from one location in Montana.

B. Demography.

1. Known populations: A total of 72 recently extant populations, from 13 sites, are known: 55 (9 sites) in Montana; 16 (3 sites) in Washington; and 1 in Idaho. A site is considered to be a cluster of adjacent populations, each of which is generally no more than 1.6 km from the next nearest population. Populations vary from only a few individuals, up to many thousands of plants. Owing to the annual life history, and the presence of seed banks, the total number of known individuals cannot be meaningfully estimated.

2. General demographic details: See Table 3, pp. 41-49.

C. Phenology.

1. Patterns: Recent observations in Montana revealed that H. aquatilis can germinate in the fall (P. Lesica, pers. comm.). In Idaho and Montana, the plants are then actively growing beneath the water surface by early May.

The submergent, cleistogamous flowers begin to form shortly thereafter; the first fruits from these have been found in June. The emergent, chasmogamous flowers begin to bloom when the stems reach the water surface, and are usually conspicuous from late June until August. Seed dispersal largely takes place from mid- to late summer. In Washington, the sites are lower in elevation, and emergent flowering begins during May (J. Gamon, pers. comm.). In Idaho in 1988, during which near average climatic conditions occurred during the spring, cleistogamous flowers were in bud on unbranched, submerged stems on 6 May. Plants were in flower above the water surface on 14 June, and cleistogamous fruits were near maturity.

2. Relation to climate and microclimate: Because H. aquatilis is an aquatic species largely restricted to vernal ponds and wetlands, its phenology is intimately tied to the climatic factors influencing these habitats. These factors would include precipitation (especially winter snowpack and subsequent run-off, and spring rains) and summer weather patterns. The current drought conditions in the Pacific Northwest have resulted in an earlier drying of some of the habitats in Montana. A subsequent reduction in the total amount of seed production would be expected, since the actual duration of the plants and flowers would be shorter. In Washington, the current drought conditions have resulted in some ponds remaining dry (or at least without ponded water) throughout the year (J. Gamon, pers. comm.). However, drought conditions experienced in northern Idaho during the winters of 1986-87 and 1987-88 did not appear to affect the water level of the pond; it was at high water mark.

D. Reproductive biology.

1. Types of reproduction: The breeding system of H. aquatilis has been studied by Lesica et al. (1988). Anatomical studies showed that in the cleistogamous flowers, the corolla develops a small closed bud and then drops off, leaving an enlarging ovary. Although the chasmogamous flowers develop fully, anther dehiscence and embryo development before the flowers had opened was repeatedly observed. In these flowers, as the corolla opens the stigma pushes up through the filament tube in close proximity to the dehiscing anthers; this sequence would almost assure self-pollination if it had not previously taken place. No evidence of agamospermy was observed; in both cleistogamous and chasmogamous flowers, embryo and/or endosperm development was observed only after penetration of the ovule by a pollen tube. Additionally, pollen stainability of samples from the Condon Creek site in Montana was 93% (s.d.=3%), indicating normal fertility. All of these observations suggest that, although not impossible, the occurrence of outcrossing in this species is probably extremely restricted, and that the breeding system approaches obligate autogamy. Reproduction by cloning or other asexual means has not been observed.

2. Pollination.

a. **Mechanisms:** As described above, H. aquatilis largely appears to be an obligate self-pollinator.

b. **Specific pollination agents:** None known or suspected, although small insects (i.e., dipterons) have been very rarely observed on the chasmogamous flowers (J. Pierce, pers. comm.; J.S. Shelly, pers. observation).

c. **Other suspected pollination agents:** None known, although it is possible that pollen transfer via water might occur.

d. **Vulnerability of pollination mechanisms:** None suspected.

3. Seed dispersal.

a. **General mechanisms:** The seeds of H. aquatilis are relatively large (2-4 mm. long). They do not possess any wings, appendages, or other structures which appear to provide them with any buoyancy. Though capable of floating on the surface owing to water surface tension, the seeds sink readily when pushed or released below the surface. It is likely that all of the seeds produced by the submergent cleistogamous flowers sink to the bottom upon release. Although seeds released from emergent capsules could float for a short distance from the point of dispersal, it is likely that these seeds sink fairly soon after release as well.

The majority of the populations of H. aquatilis occur in ponds which are not connected by above-ground drainages or by spring run-off. The exception to this is the Swan River Oxbow (005) site, where the species occurs in four adjacent wetlands on the floodplain of the Swan River. During years of high spring run-off, this area is inundated, and it is likely that these wetlands are thus interconnected. Water from the Swan River was observed flowing through the surrounding forests in June, 1986. In this situation, it is possible that some dispersal of seed by water movement is occurring.

In numerous cases broken stems, bearing fruits produced by both cleistogamous and chasmogamous flowers, were observed floating in the water. These fragments could be dispersed to other areas within the same wetland habitat, although the species is restricted to very quiet water.

b. **Specific agents:** Another possible means of seed dispersal for H. aquatilis is by wildlife dissemination. Waterfowl were frequently observed in the pothole ponds; it is likely that, when feeding on aquatic vegetation, these birds could ingest H. aquatilis and distribute the seeds later in other ponds.

In addition, seed movement by mammals (i.e., deer, bears, moose)

also appears to be possible. Deer and moose browse in such ponds, and could thus ingest and transport seeds. In Montana, signs of bear foraging were noted at the Lost Creek-Cilly Creek site (008) late in the summer, after all water had dried from the pond; dispersal between ponds could perhaps also occur in this way.

Seed movement between ponds, in sediments lodged in the feet of these bird and mammal species, may also be possible.

c. Vulnerability of dispersal agents and mechanisms: To the extent that habitat alteration might cause permanent drying of its habitat, or impacts on the putative wildife dispersers, the dispersal of H. aquatilis could be influenced by disturbance.

d. Patterns of propagule dispersal: Seed dispersal by waterfowl could partially explain the scattered distribution of H. aquatilis in the Pacific Northwest; in Montana, dispersal by waterfowl and mammals between adjacent ponds could produce the clustered arrangement of adjacent populations at the Lost Creek-Cilly Creek Ponds (008-017), Dog Creek (018, 019), Condon Creek (020-031), Elk Creek (054, 055) and Lindbergh Lake (001-004, 032-051) sites. Meinke (1982) also suggested that H. aquatilis may be "...randomly dispersed through the wanderings of migratory waterfowl," and that this could produce the wide, patchy distribution pattern. In Idaho, H. aquatilis has been present on the Ownbey property for at least 20 years, but has never occurred in more than one pond (Ruth Ownbey, pers. comm.). This suggests that dispersal mechanisms are limited at this site.

4. Seed biology.

a. Amount and variation of annual seed production: Evidence for the presence of a seed bank is reported by Lesica et al. (1987). At the Swan River Oxbow (005) site, examination of the surface 3 cm of soil from three 2.25 dm^2 quadrats in 1986 yielded an estimate of approximately 200 seeds/m^2. The presence of such a seed bank should help buffer the occurrences from periodic environmental fluctuations which could cause varying population sizes.

b. Seed viability and longevity: No detailed quantitative information; because H. aquatilis is an annual species which occurs in vernal wetlands, its population sizes fluctuate from year to year depending on seasonal conditions. For example, at the Swan River Oxbow (005) site in Montana, approximately 10,000 plants were observed in 1985, but fewer than 100 plants were seen in 1986 (Lesica et al. 1987). During field surveys in 1987, the population was very large again, with many hundreds of plants observed. These observations suggest that some seeds can remain viable for at least two years.

c. Dormancy requirements: Unknown.

d. Germination requirements: For seeds to germinate, water must be present in the vernal ponds and wetlands. In addition, H. aquatilis is found almost exclusively in ponds with bottom surfaces which consist of firm, consolidated clay and organic sediments. Only in two cases in Montana were plants found in ponds with deeper, largely unconsolidated bottom sediments; in these situations, most H. aquatilis plants were then found in shallower areas near the shore, in more consolidated portions of the ponds. The texture and depth of these bottom sediments may be very important in relation to seed germination requirements and early growth of H. aquatilis. Loose, silty soil sediments may lead to burial of seeds too deeply to ensure efficient germination and establishment.

e. Percent germination: No quantitative information.

5. Seedling ecology: See germination requirements described above.

6. Survival and nature of mortality: No quantitative information; the plants occur predominantly in more open areas within the habitat, and some seedling mortality in densely vegetated areas would be expected.

7. Overall assessment of taxon's reproductive success: Reproduction appears to be vigorous in most populations in Montana, when habitat conditions are satisfactory. In some ponds the plants have been observed to produce very dense mats, and the seed output in these cases is probably high. Prevailing ecological conditions (especially climate) are probably most important in determining annual rates of seed production and germination. Observations of the Idaho population have revealed that Howellia aquatilis has been in the same pond at the site for at least 20 years.

8. Population ecology of taxon.

A. General summary: In general, Howellia aquatilis was observed to occupy less densely vegetated areas within the wetlands where it occurs. This suggests that it cannot compete vigorously with other aquatic plant species. In areas of more open water, the species can grow very densely, forming mats in some cases. No specific obligate relationships are known.

B. Positive and neutral interactions: The submersed stems and leaves of H. aquatilis were frequently observed to have egg masses attached to them, as well as caddis fly cases. None of these were observed to have a negative effect on the plants.

C. Negative interactions.

1. Herbivores, predators, pests, parasites and diseases: None directly observed; it is likely that some plants are ingested by browsing animals, and/or disturbed by movements of the latter in the associated wetlands.

2. Competition.

a. Intraspecific: In several Montana populations (i.e., Lindbergh Lake (044)), H. aquatilis was observed to grow very densely in open water. No adverse effects were observed in such sites.

b. Interspecific: Two patterns were observed in Montana: 1.) in many ponds, the greatest densities of H. aquatilis were found around the pond margins, under the cover of surrounding overhanging shrubs (Salix spp., Alnus incana, Cornus stolonifera). In this zone, other emergent aquatic species do not occur in abundance, and H. aquatilis is able to spread throughout such open areas, often growing in thick mats; 2.) in ponds dominated throughout by Carex vesicaria and/or Equisetum fluviatile, H. aquatilis was frequently observed to occupy openings among such vegetation. Similarly, in ponds with open water in the center, H. aquatilis was observed to be most dense in such areas. While the species was found to occur amongst the stems of other emergent plants, it was often not as abundant in such situations. These observations suggest that H. aquatilis may prefer more open microhabitats within the ponds it occupies, and that it cannot compete vigorously with other aquatic plant species. In Idaho, Howellia aquatilis does occur within the moderately dense matrix of associated submergent species.

3. Toxic and allelopathic interactions: None known or observed.

D. Hybridization: None known; the potential for hybridization, either natural or induced, is low owing to the taxonomic isolation of the genus.

E. Other factors of population ecology: None known or observed.

9. Current land ownership and management responsibility.

A. General nature of ownership: Idaho: private; Montana: United States Government, Burlington Northern, and private; Washington: United States Government and private.

B. Specific landowners:

1. Idaho.

a. Ruth Ownbey

2. Montana.

a. U.S. Forest Service
Flathead National Forest
1935 3rd Ave. East
Kalispell, MT 59901

b. Plum Creek Timber Company (Burlington Northern lands)
2050 Hwy. 2 West
P.O. Box 1957
Kalispell, MT 59901

c. The Nature Conservancy
Big Sky Field Office
P.O. Box 258
Helena, MT 59624

d. Pat Halterman

e. Horace H. Koessler

f. Robert E. Hardy

g. Mrs. G.A. Martel

3. Washington.

a. U.S. Fish and Wildlife Service
Turnbull National Wildlife Refuge
Cheney, WA 99004

b. U.S. Fish and Wildlife Service
Ridgefield National Wildlife Refuge
Ridgefield, WA 98642

c. The Nature Conservancy
Washington Field Office
1601 Second Ave., Suite 910
Seattle, WA 98101

d. Private landowners.

C. Management responsibility: As outlined under specific landowners.

D. Easements, conservation restrictions, etc.: In Montana, The Nature Conservancy has recently purchased land containing a majority of the Swan River Oxbow (005) site in Lake County, and will manage it as a preserve. Two populations on private land in the Lindbergh Lake area (041, 042) in Missoula County have been designated as registry (voluntary protection) sites in cooperation with The Nature Conservancy. In Idaho, the occurrence in Latah County is on property which has been willed to the Audubon Society for eventual designation as a wildlife sanctuary. In Washington, the occurrence on the Ridgefield National Wildlife Refuge in Clark County is proposed for inclusion in the Blackwater Islands Research Natural Area. The Dishman Hills site in Spokane County has been acquired by The Nature Conservancy, and will be transferred to the Department of Natural Resources. It will be within the Dishman Hills Conservation Area. One additional site in Washington has been proposed for inclusion within the Washington Register of Natural Areas, a voluntary landowner protection program (J. Gamon, pers. comm.).

10. Management practices and experience.

A. Habitat management.

1. Review of past management and land-use experiences: None known.

2. Performance under changed conditions: No detailed data available. Despite the fact that H. aquatilis occurs over a large geographic area, it is ecologically restricted to a narrowly defined aquatic habitat. Thus, any direct impacts on its habitat are more likely to cause the extirpation of disturbed populations. The species does not appear to be capable of colonizing disturbed habitats.

The influence of habitat alteration around the ponds could have an effect

on their successional trends. In cases where logging has occurred near the habitat margins, an increase in siltation rate into the ponds would be expected. Such a change would probably influence both the nature of the bottom substrates and the vegetational composition of the sites. As discussed above, H. aquatilis occurs most frequently and most densely in ponds with firm, consolidated organic clay bottom sediments. It also is frequently found in more open areas within the ponds. Thus, increases in bottom sedimentation, and subsequent competition from other vegetation, could both have an adverse effect on the viability of H. aquatilis populations.

Impacts from grazing could also potentially influence the vegetation composition of the ponds, through increased nutrient levels and subsequent successional changes. Also, trampling of the bottom sediments may adversely affect the seed bank, and the consolidated substrate which appears to be necessary for vigorous germination. There is some indication that the historical site in California may have been negatively affected by livestock trampling (Griggs and Dibble 1979). However, in Spokane County, Washington, several of the ponds containing H. aquatilis have been significantly altered by past and current grazing. Some of these sites have possibly been grazed for 50 years or more, and the species has persisted, suggesting that in some situations it may be fairly tolerant to such land use, at least in the short term (J. Gamon, pers. comm.).

3. **Current management policies and actions:** In Montana, a three-year inventory and analysis program proposal has been submitted to the Flathead National Forest by the Montana Natural Heritage Program. If approved, this plan will involve additional field surveys, monitoring studies, and preparation of a management plan for populations on U.S. Forest Service lands in the state. The Nature Conservancy has established monitoring studies on the Swan River Oxbow Preserve (005) site, to assess population trends and encroachment of Phalaris arundinacea (Reed Canary Grass) into the habitat.

   The habitat in Idaho is managed as a natural area by the present owner.

   In Washington, the Dishman Hills site will essentially be managed as a Natural Area Preserve. The Ridgefield National Wildlife Refuge site is managed as a Research Natural Area. The sites within the Turnbull National Wildlife Refuge are managed primarily as waterfowl habitat. Grazing does occur at some of the sites, however. Grazing occurs on most, if not all, privately owned sites (J. Gamon, pers. comm.).

4. **Future land uses:** In Montana, timber harvesting in the Swan Valley is likely to continue in the future, particularly on private forest lands (especially those managed by the Plum Creek Timber Company).

   Upon execution of Ruth Ownbey's will, the National Audubon Society will

become the owner of the Idaho site, and will manage the area a a natural area.

In Washington, the habitat in Spokane County is increasingly being impacted by a rising population in the area. Impacts from resultant rural development may adversely affect habitat through pond drainage, riparian alteration, overgrazing, and pollution (J. Gamon, pers. comm.).

B. Cultivation.

1. Controlled propagation techniques: No information; owing to the habitat specificity of the species, ex situ propagation from seed may be difficult.

2. Ease of transplanting cultivated material: Unknown.

3. Pertinent horticultural knowledge: None known.

4. Status and location of presently cultivated material: No cultivated material known.

11. Evidence of threats to survival.

A. Present or threatened destruction, modification, or curtailment of habitat or range.

1. Past threats: The historical sites in Oregon and California have not been relocated, despite recent surveys. In Oregon, most of the historical locations are within urban or suburban areas which have been extensively developed in recent times, and they are thought to have been eliminated. Additionally, construction of dams along the Columbia and Willamette rivers has led to a decline of suitable pond habitats. At the type locality on Sauvies Island, carp are abundant in ponds which are connected to the Columbia River during high water periods; these fish then destroy the aquatic vegetation (J. Kagan, pers. comm.). In California, the historical collection from the vicinity of Howard Lake, in the Coast Range, was not relocated in 1979 or 1980. The status report by Griggs and Dibble (1979) suggested that cattle grazing and trampling may have eliminated the population, though they recommended further surveys earlier in the season, before cattle are allowed in the area. These past alterations have apparently extirpated H. aquatilis from approximately one-third of its known global range.

In Idaho, much of the bottomland habitat in the Palouse River drainage has been altered to some degree by roads, lumber mills (3), residential housing (3 communities), cultivation (grains), and pasture land (with seeded exotic forage). Small vernal pools are easily filled by any of these disturbances. The Ownbey property near Harvard appeared to be the only remaining parcel in a relatively undisturbed condition within the drainage. This general trend in habitat alteration of bottomlands has occurred in much of northern Idaho as well, including the Spirit Lake area.

In Washington, several ponds on the Turnbull National Wildlife Refuge have been significantly altered to improve waterfowl habitat (i.e., dredged with heavy equipment while they were dry). Although H. aquatilis was not known to be present before these manipulations, it is suspected to have been, since in some cases adjacent ponds do contain the species. It is apparently absent from the ponds which have been significantly altered (J. Gamon, pers. comm.).

2. Existing threats: MONTANA: The current threats to populations of H. aquatilis are mainly from timber harvest activities occurring adjacent to the pothole ponds which the species occupies. Additionally, some populations are adjacent to gravel logging and public access roads, and are thus susceptible to any road improvement activities which may take place. Lastly, in the vicinity of Lindbergh Lake, some ponds are currently disturbed or potentially threatened by domestic livestock grazing. The sites threatened by these activities are reviewed below:

a. TIMBER HARVEST ACTIVITIES: Of the 55 populations of H. aquatilis found in the Swan Valley, 22 occur in ponds around which logging has occurred historically or in the very recent past. In many cases, all coniferous trees were removed down to the pond margins, and the trees left standing were broadleaf deciduous species (i.e., Populus tremuloides, P. trichocarpa). In a few instances, no trees were left bordering some sides of the ponds, and in one case (Lindbergh Lake (001)) logging slash had been placed in the water.

Listed below, by site name and occurrence number, are the 22 pond habitats whose margins or immediate surroundings have been physically impacted by timber harvesting. Those which have been very recently impacted (i.e., in 1986-87) are indicated by an asterisk (*).

Condon Creek: *025, *027, *029, *030, 031

Dog Creek: 018

Elk Creek: 054

Lindbergh Lake: *001, 002, *037, *038, *039, 046, 047, 048

Lost Creek-Cilly Creek Ponds: 009-015 (seven ponds)

The following populations are located in areas where nearby forests have been logged. Though the habitat immediately surrounding these ponds may still be intact, they are considered vulnerable to further future logging activity.

Condon Creek: 006, 020, 021, 022, 023, 024, 026, 028

Lindbergh Lake: 045

Swan River West: 007

One population occurs in an area which has not yet been logged, but in which new logging roads have recently been constructed:

Lindbergh Lake: 051

b. ROAD CONSTRUCTION AND MAINTENANCE: The following ponds supporting H. aquatilis occur alongside gravel logging and public access roads:

Kraft Creek: 052

Lindbergh Lake: 004, 033, 036, 044, 049

Lost Creek-Cilly Creek Ponds: 016, 017

c. GRAZING: Two ponds (Lindbergh Lake (041, 042)), located on private land, were found to be heavily impacted by grazing of domestic livestock (esp. horses). Grazing and traversing of these sites has physically disturbed the associated shorelines and vegetation; these sites could also be influenced by changes in nutrient status from livestock bodily wastes. Both of these populations were small in 1987: four plants (041), and 50-60 plants (042). Much of the area near Lindbergh Lake is used for open cattle range, especially south of the Swan River. Three populations in this vicinity, on Flathead National Forest land, are in areas currently being used for open range cattle grazing (Lindbergh Lake (046, 047, 048)). Impacts near these ponds were noted, and it is probable that they are used for watering by the livestock.

IDAHO: Land clearing activities are continuing in the Palouse River drainage, and throughout the lower elevations of northern Idaho. The Harvard population currently appears secure, although it is very small.

WASHINGTON: Timber harvest activities are not expected to have any direct impacts on the known sites. Associated activities, such as road construction, yarding, decking, etc., could have localized impacts.

Grazing does occur at a majority of the sites in Washington. In general, it does not appear to pose an immediate threat, although it may eventually, through changes in nutrient levels and successional alteration towards more weedy species (J. Gamon, pers. comm.).

3. Potential threats: As discussed, timber harvesting in the Swan Valley in Montana is likely to continue in the foreseeable future. Further impacts to areas containing ponds inhabited by H. aquatilis may occur as a result. In Idaho, the single known population is located on private land; although

the site is willed to the National Audubon Society, the habitat is adjacent to a paved highway, and may be subject to impacts from road maintenance. Other potential threats to this population are not foreseen. However, disturbances in bottomland habitats are expected to continue throughout northern Idaho, reducing the likelihood that additional populations of Howellia aquatilis will be found.

A potential ecological threat observed in Montana involves the encroachment of Phalaris arundinacea (Reed Canary Grass) into wetlands inhabited by H. aquatilis. Because of the tenacity and rapid growth of the former, it poses a major threat to many wetland ecosystems; it is capable of forming dense monocultures which result in declines in other wetland species (Apfelbaum and Sams 1987). Several stands have become established at the recently preserved Swan River Oxbow (005) site in Montana, and impacts on H. aquatilis are being monitored closely. Phalaris arundinacea also appears to increase in wetland areas in Oregon, especially where some siltation has occurred (J. Kagan, pers. comm.). In Washington, however, H. aquatilis is persisting in some ponds where P. arundinacea has apparently been dominant for many years (J. Gamon, pers. comm.).

B. Overutilization for commercial, sporting, scientific, or educational purposes: No significant existing or potential threats known.

C. Disease or predation: Howellia aquatilis may be susceptible to some impacts from grazing by native animals which use the pothole pond habitats. Also, as discussed above, two ponds in Montana have been impacted in the past by livestock grazing, and the historical California population may have been extirpated by livestock use. In Idaho, although livestock do not feed directly on Howellia aquatilis, habitat alteration by clearing, draining, filling, and seeding exotics for livestock forage have altered much of the bottomland habitat in the Palouse River drainage, and in northern Idaho in general. Adjacent property is heavily grazed year-round and the vernal pools have little remaining native vegetation associated with them. No threats from grazing to this site are foreseen, although grazing at high stocking levels would be detrimental. Otherwise, no additional significant threats are known.

D. Inadequacy of existing regulatory mechanisms: Currently, there are no statutes in Montana, Idaho, or Washington which provide state legal protection for H. aquatilis.

E. Other natural or manmade factors: The narrow ecological amplitude and the apparent lack of genetic variation may predispose H. aquatilis to decline or extinction if major environmental perturbations occur (esp. drought and habitat alteration). Also, as successional changes occur in the wetland habitats, it is likely that populations disappear with declines in the associated water tables.

II. ASSESSMENT AND RECOMMENDATIONS

12. General assessment of vigor, trends, and status: Howellia aquatilis is an annual aquatic species with narrowly defined habitat requirements, and as a result it would be

intolerant of major environmental alterations. It is known from 13 sites in the Pacific Northwest (nine in Montana, three in Washington, and one in Idaho). Population sizes range from a few to many thousands of individuals, but large yearly fluctuations in population size have been observed. These fluctuations are most likely due to annual differences in climatic factors, and to variation in seed germination percentage. Some populations in Montana are large, and currently appear to be stable. However, long-term successional trends in the associated habitats probably result in the occasional disappearance of established populations. Additionally, habitat alteration is continuing in all extant portions of the range, primarily from timber harvesting, development, and alteration of bottomland habitats. Evidence from recent field surveys in Oregon and California indicates that H. aquatilis has been extirpated from these states. Owing to this curtailment of range, and the ecological and genetic factors summarized above, the species should continue to be closely monitored.

13. Recommendations for listing or status change.

A. Recommendation to U.S. Fish and Wildlife Service: On the basis of information obtained during recent field surveys and biological studies, it is recommended that Howellia aquatilis be listing as a threatened species. The species has been extirpated from a large portion of its previously known global range, and several factors make it susceptible to further serious declines in distribution and abundance. These factors include a narrow ecological amplitude, lack of inter- and intrapopulation genetic variation, and continuing habitat alteration in major portions of its extant range.

B. Recommendations to other U.S. federal agencies.

1. U.S. Forest Service: Howellia aquatilis is currently included on the sensitive (Montana) and watch (Idaho) plant lists in Region 1, and the sensitive list in Region 5. Agency objectives and policy provide for the management and protection of such species. It is recommended that H. aquatilis be retained on all of these lists.

2. Bureau of Land Management: Howellia aquatilis is currently included on the BLM sensitive species list for Idaho. Although it is presently not known from BLM land there, it should remain as a sensitive species because it potentially may be found in wetlands on the Coeur d'Alene District.

C. Other status recommendations.

1. Counties and local areas: No need for regulation at county or other local levels of government is apparent at this time.

2. States: The species should be retained on the respective lists of each state in which it is historically or currently known to occur.

3. Other nations: Not currently pertinent.

4. International Trade Convention, etc.: None at this time.

14. Recommended critical habitat: Genetic studies indicate that H. aquatilis consists of one uniform genotype throughout its range (Lesica et al. 1988). This lack of genetic variation, coupled with the narrow ecological adaptation of the species, suggests that

H. aquatilis is vulnerable to natural and/or artificial environmental changes. Thus, it will be important to protect populations throughout as much of the range as possible. Should the species be listed, critical habitat should be designated in all three states where it is currently extant; if it is rediscovered in Oregon or California, these areas should also be included as critical habitat.

A. Concise statement: Glacial pothole and riverine pond complexes in the Swan Valley, Lake and Missoula counties, Montana; bottomland habitat in the vicinity of the population along the Palouse River in Latah County, Idaho; pond complexes in Spokane County, Washington; and habitat containing the population on the Ridgefield National Wildlife Refuge in Clark County, Washington.

B. Legal description: The following occurrences comprise the minimum recommended critical habitat:

Idaho:	Harvard (001)
Montana:	Condon Creek (006, 020-031)
	Lindbergh Lake (001-004, 032-051)
	Lost Creek-Cilly Creek Ponds (008-017)
	Swan River Oxbow (005)
Washington:	Spokane area (001, 003-016)
	Ridgefield (002)

Exact legal descriptions are provided in Table 1, pp. 11-27.

C. Latitude and longitude: Provided in Table 1, pp. 11-27.

D. Publicity sensitivity of critical habitat areas: Low to moderate at this time.

15. Conservation/recovery recommendations.

A. General conservation recommendations.

1. Recommendations regarding present or anticipated activities: Recommendations for long-term maintenance of viable populations on U.S. Forest Service lands in Montana are as follows:

a. Protection of habitats which currently support populations. Thirty-two populations of H. aquatilis have been found on U.S. Forest Service lands. Of these, timber harvesting has occurred around 15 of them:

Condon Creek (025, 027)

Dog Creek (018)

Elk Creek (054)

Lindbergh Lake (001, 046, 047, 048)

Lost Creek-Cilly Creek Ponds (009-015)

The remaining 17 populations occur in relatively intact forest communities:

Condon Creek (006, 020-024, 026)

Dog Creek (019)

Lindbergh Lake (043-045)

Lost Creek-Cilly Creek Ponds (008, 016, 017)

Swan River West (007)

All of these populations should be considered in future land use management plans, i.e., road construction, future timber harvesting, grazing allotments, etc. In addition, since the long-term influences of disturbance adjacent to the ponds are unknown, it is especially important that the undisturbed populations be maintained in their current condition.

b. Notification of U.S. Forest Service personnel of locations of populations on U.S.F.S. lands. To prevent inadvertent impacts to known populations, all appropriate Flathead National Forest personnel should be provided with detailed location information. It is especially important that Ranger District timber sale managers, engineers, and other planners know the precise locations, so that disturbance may be prevented.

c. Evaluation of projects which may affect the hydrology of habitats supporting populations. Because the ponds supporting H. aquatilis populations depend largely on run-off for water supply, impacts which may influence this source should be carefully studied. Also, projects which could result in permanent inundation or drying of the ponds should be mitigated. The hydrology of the Swan Valley is highly complex, and H. aquatilis is dependent upon intact drainage patterns.

In Washington, the Natural Heritage Program should notify all landowners of the presence of the species on their land. It is also recommended that the Turnbull National Wildlife Refuge develop a species management plan.

The population in Idaho is currently being protected by the landowner.

2. Areas recommended for protection: In Montana, areas with populations in numerous adjacent ponds in varying stages of succession would be best suited for protection or special management. Because H. aquatilis is found in aquatic habitats which appear to be in an earlier successional stage, an assemblage of such ponds would possibly allow for longer-term persistence of the species; as the habitats change, the species could be established (naturally or artificially) in nearby sites which are still ecologically suitable (Lesica et al. 1988). Such habitat

clusters are found in the Condon Creek, Lindbergh Lake, Lost Creek-Cilly Creek, and Swan River Oxbow areas in the Swan Valley (see maps, pp. 139-148). The first three areas have been impacted by timber harvesting, and future management plans and recommendations should take these impacts into account.

In Washington, the Natural Heritage Program should identify and recommend areas for protection. In Idaho, the National Audubon Society should be notified of the occurrence on the Ownbey property so that management strategies can be developed accordingly.

3. **Management and recovery recommendations:** Owing to the narrow ecological restriction of H. aquatilis, the most effective method of management will be to avoid impacts to habitats which are as yet undisturbed. Additionally, transplant experiments in suitable unoccupied habitat would provide information regarding the suitability of this potential recovery technique.
4. **Publicity sensitivity:** Low to moderate.
5. **Other recommendations:** None.

B. Monitoring activities and research needs: In Montana, a multi-year proposal to continue inventory and analysis of H. aquatilis on the Flathead National Forest has been submitted to the U.S. Forest Service. This proposal includes the following research suggestions:

1. Complete field surveys of potential habitat for H. aquatilis on Flathead National Forest lands, and evaluate the possible presence of potential habitat in other areas in northwestern Montana. Resurvey suitable habitats previously identified, but where the species was not found, to verify the reported absence of H. aquatilis from such sites.
2. Evaluate known suitable habitats identified on U.S. Forest Service lands, for inclusion in a transplant experiment to establish new populations. Conduct transplants of soil plugs from known, large populations to identified potential habitats, and monitor establishment success.
3. Continue quantitative monitoring studies established at five locations in Montana in 1988, to assess adequacy/suitability of the methodology used (line-intercept transects). Resurvey all other known populations, to obtain ongoing estimates of population size, condition, persistence, and response to management practices.
4. Evaluate the effects of wetland successional trends on the presence and quantity of suitable habitats. Investigate possible methods of maintaining such habitat, possibly through artificial methods.

In Washington, inventory efforts should continue, particularly in the forested portions of the channeled scablands in the eastern part of the state. Known sites should be periodically monitored for trends in population size. Trend information should be correlated with other site parameters, such as grazing

levels and changes in vegetation composition (J. Gamon, pers. comm.).

Phalaris arundinacea has aggressively invaded many bottomland habitats in northern Idaho, and is present at the Harvard (001) site. While it does not presently appear to be encroaching on the pond containing Howellia aquatilis, it should be monitored.

16. Interested parties:

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III. INFORMATION SOURCES

17. Sources of information.

A. Publications.

1. References cited in report: List appended (p. 72).

2. Other pertinent publications.

a. Technical: None known.

b. Popular:

Shelly, S. 1987. Rare and endangered plant profile - Howellia aquatilis. Montana Native Plant Society Newsletter 1: 2.

B. Museum collections: Specimens from Montana were examined at the University of Montana Herbarium (MONTU), and the Rocky Mountain Herbarium (RM) at the University of Wyoming. For Idaho, data from J.H. Sandberg's 1892 specimens were obtained from the U.S. National Herbarium (US) and the University of Washington Herbarium (WTU). The University of Idaho (UI) and Washington State University (WS) herbaria were also searched, but contained no Idaho collections of H. aquatilis.

Voucher specimens collected in Montana during field work for this status report are cited in the COMMENTS field of the computer printouts (Appendix A, pp. 76-131), and are deposited at MONTU. Previously collected specimens from Montana are cited in the COMMENTS or BESTSOURCE fields of these printouts. A specimen from the Idaho population is deposited at UI.

C. Fieldwork.

1. Surveys by the authors:

MONTANA:

J.S. Shelly: 23-26 & 30 June, 1-17 & 28-30 July 1987; 14-15, 21-22, & 26-29 July 1988. Surveys in Lake and Missoula counties; field notes, population surveys, photographs, and herbarium specimens.

IDAHO:

After consultation with Ruth Ownbey, the authors searched the area near Harvard and located one pond with H. aquatilis on 6 May 1988. The pond was revisited on 14 June 1988 by R. Moseley and A. Cholewa, University of Minnesota. Population and community data were collected on this date. From 24-28 June 1988, R. Moseley searched suitable habitat in northern Idaho, from the Palouse River drainage north to the Pend Oreille River. Sandberg's 1892 collection site could not be relocated, nor were any new populations found.

Maps indicating areas which were unsuccessfully searched in Idaho and Montana are included in Appendix A (pp. 150-167).

2. Surveys by contractor:

MONTANA:

L. Campbell: 2 & 9-10 July 1987. Surveys in Lake and Missoula counties; field notes, population surveys, and herbarium specimens.

D. Knowledgeable individuals.

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E. Other information sources: Color slides of additional populations in Montana are on file at the Montana Natural Heritage Program (first author's address).

18. Summary of materials on file: All detailed field survey forms and field maps are on file at the respective NHP offices. The references cited in this report are on file at the Idaho and/or Montana Natural Heritage Programs.

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20. Maintenance of status report: The respective Natural Heritage Programs will maintain current information, and update the status report as needed. Should the species be listed by the U.S. Fish and Wildlife Service, the respective USFWS offices should maintain the primary information files, encourage others to provide new information, and distribute new findings to the interested parties.

V. NEW INFORMATION

21. Record of revisions: Not currently applicable.

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