Platanthera orbiculata (Pursh.) Lindl.: Conservation Assessment on the Tongass National Forest, Alaska Region

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Prepared for:

USDA Forest Service, Tongass National Forest, Alaska Region

Species Conservation Project

Draft Submitted: February 2015

Draft Reviewed by USFS:

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Patricia Krosse, June 2015 and December 2015

Mary Stensvold, December 2015

Recommended Citation:

J.R. Fulkerson, K. Dillman, and M.L. Carlson. 2017. *Platanthera orbiculata* (Pursh.) Lindl.: Conservation Assessment on the Tongass National Forest, Alaska Region. U.S. Department of Agriculture, and Alaska Natural Heritage Program, University of Alaska Anchorage. Anchorage, Alaska. 43 pp. plus appendix

Cover Photo:

Platanthera orbicula in flower on the Tongass National Forest. Photo by K. Dillman.

EXECUTIVE SUMMARY

Platanthera orbiculata (Pursh.) Lindl. (Large round-leaved orchid) is an endemic of North America. It is found to occur throughout Canada, south to Washington, South Dakota, Minnesota, Tennessee and South Carolina. It is not listed as threatened or endangered or as a species proposed for listing by the US Fish and Wildlife Service. It is listed as sensitive by the USFS in Region 2 (Rocky Mountains), Region 9 (Midwest and Eastern US) and is proposed as sensitive in Region 10 (Alaska). It currently is designated as an S3S4 in Alaska (imperiled in the state).

This orchid has a disjunct distribution in southeast Alaska in the humid temperate forests in the southern portion of the Alexander Archipelago. There are 61 documented occurrences on the Tongass in low elevation, productive old- growth hemlock forests and forested wetlands. It appears to have a strong association in forests with a red cedar component (*Thuja plicata*), although it is associated with many conifers and hardwoods across its range in North America. The persistence of the species on the Tongass National Forest is unknown. However, what limits its population on the forest is probably related to its interactions with other organisms such as mycorrhizal fungi as much as environmental factors, such as climate. Large extents of productive forested wetland habitats that may be preferred habitat for this orchid occur across the Tongass.

Management activities such as timber harvest and road building may cause direct damage to plants or severely alter its habitat. Other management activities like recreation, mining, and renewable energy development may also damage individual plants or change the habitat. All activities may affect the different stages of the orchid life cycle at various intensities. Because *P. orbiculata* often exists in small populations and may also temporally go dormant, a small spatially isolated disturbance event could possibly destroy all potentially reproducing plants in an area. Long-term persistence of the species depends upon protection of known populations and areas where suitable habitat may exist. Silvicultural treatments of young growth may enhance conditions for recolonization in certain areas, although no monitoring has occurred to document this. Predicted climate changes characterized by wetter and warmer conditions may be another risk to the orchid and its habitat. A monitoring plan was initiated for this species with some known occurrences on the Tongass. This plant is currently listed as a Region 10 sensitive species, which requires managers to consider how projects will affect local occurrences and its viability on the forest. In the absence of a viability assessment, this analysis has been problematic.

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INTRODUCTION

This assessment is one of many being produced to support current and future forest planning efforts on the Tongass National Forest. *Platanthera orbiculata* is the focus of an assessment because it is both designated as a Sensitive Species' by the Alaska Regional Forester, and it is a Rare Species in Alaska. Within the National Forest System, Sensitive Species are plants and animals whose population viability is identified as a concern by a Regional Forester because of significant current or predicted downward trends in abundance or significant current or predicted downward trends in habitat capability that would reduce a species distribution (FSM 2670.5 (19)). Sensitive Species require a detailed effects analysis to be conducted during project planning which identifies any special management that may be needed for a particular population. Knowledge of their biology and ecology is critical for a science-based, informed analysis that is consistent amongst resource managers. Rare Species serve as a barometer for species viability at the State level.

This assessment addresses the biology of *Platanthera orbiculata* throughout its range in Alaska Region, and more specifically within the Tongass National Forest, as the "planning area". The broad nature of the assessment leads to some constraints on the specificity of information for particular locales. Furthermore, completing the assessments promptly requires establishment of some limits concerning the geographic scope of particular aspects of the assessment and further analysis of existing (but unanalyzed) field data. This introduction outlines the scope of the assessment and describes the process used in producing the assessments.

Goal

Species assessments are designed to provide forest managers, research biologists, and the public a thorough discussion of the biology, ecology, and conservation status of certain species based on the most current body of scientific knowledge for the species. The assessment goals limit the scope of the work to critical summaries of scientific knowledge, discussion of broad implications of that knowledge, and outlines of information needs. The assessment does not seek to develop specific management recommendations but provides the ecological background upon which management should be based. It focuses on the consequences of changes in the environment that result from management (i.e. management implications). Furthermore, it cites management recommendations proposed elsewhere and, when management recommendations have been implemented, the assessment examines the success of the implementation.

Scope

The *Platanthera orbiculata* assessment examines the biology, ecology, and management of this species with specific reference to the geographic and ecological characteristics of the Tongass National Forest and the Alaska Region. Although some (or a majority) of the literature on the species may originate from field investigations outside the region, this document places that literature in the ecological and social context of southeastern and to a lesser extent, southcentral Alaska. Similarly, this assessment is concerned with reproductive behavior, population dynamics, and other characteristics of *Platanthera orbiculata* in the context of the current environment rather than under historical conditions 200, 2000, or 2 million years ago. The evolutionary environment of the species is considered in conducting the synthesis, but placed in a current context.

In producing the assessment, we reviewed refereed literature, non-refereed publications, research reports, and data accumulated by resource management agencies. Not all publications on *Platanthera orbiculata* are referenced in the assessment, nor were all published material considered equally reliable. The assessment emphasizes refereed literature because this is the accepted standard in science. Nonrefereed publications or reports were regarded with greater skepticism. We chose to use some nonrefereed literature in the assessments, however, when information was unavailable elsewhere. Unpublished data (e.g. Natural Heritage Program and USFS records) were important in estimating the geographic distribution. These data required special attention because of the diversity of persons and methods used to collect the data.

Motivation to produce species assessments rapidly, in order to make information available for a Forest Plan amendment, lead to tight timelines. The goal to produce assessments rapidly limited the analysis of existing, unpublished data, or attempts to conduct meta-analysis to synthesize information from published literature. Review of literature found inherent data gaps in the natural history of the species. For example there were limited to not data in basic habitat requirements, physiological limits, or response to any disturbance. We relied on the best available data such as observations of *P. orbiculata* populations in its range or data from other *Platantherea* species. There are levels in uncertainty in observation data and response to disturbance. These data are not experimentally repeated measures and therefore caution should be used in the use of currently available data.

Treatment of Uncertainty

Science represents a rigorous, systematic approach to obtaining knowledge. Competing ideas regarding how the world works are measured against observations. However, because our descriptions of the world are always incomplete and observations limited, science focuses on approaches for dealing with uncertainty. A commonly accepted approach to science is based on a progression of critical experiments to develop strong inference (Platt 1964). However, strong inference, as described by Platt, suggests that experiments will produce clean results (Hillborn and Mangel 1997), as may be observed in certain physical sciences. The geologist, T. C. Chamberlain (1897) suggested an alternative approach to science where multiple competing hypotheses are confronted with observation and data. Sorting among alternatives may be accomplished using a variety of scientific tools (experiments, modeling, logical inference). Ecological science is, in some ways, more similar to geology than physical science because of the difficulty in conducting critical experiments and the reliance on observation, inference, logical thinking, and models to guide understanding of the world (Hillborn and Mangel 1997).

Confronting uncertainty, then, is not prescriptive. In this assessment, the strength of evidence for particular ideas is noted and alternative explanations described when appropriate. While well-executed experiments represent a strong approach to developing knowledge, alternative approaches such as modeling, critical assessment of observations, and inference are accepted as sound approaches to understanding and used in synthesis for this assessment.

Publication of Assessment on the World WideWeb

To facilitate use of species assessments in this Project, assessments may be published on the Tongass N.F. and Alaska Region world wide web site. Placing the documents on the web makes them available to agency biologists and the public more rapidly than publication as a book or report. More important, revision of the assessments will be facilitated. Revision will be accomplished based on guidelines established by the USFS in the Alaska Region.

Peer Review

Assessments developed for the Species Conservation Process have been peer reviewed prior to release on the web. This report was reviewed through a process administered by an independent scientific organization which chose two recognized experts to provide critical input on the manuscript. Peer review was designed to improve the quality of communication and increase the rigor of the assessment.

MANAGEMENT STATUS AND NATURAL HISTORY

Management Status

The global conservation rank of *Platanthera orbiculata* (Pursh) Lindl. is considered globally secure being ranked at G5 (NatureServe 2015). There is no listing for the species under the IUCN Red List (IUCN 2015). It has a wide geographic range in North America, especially throughout Canada. It occurs across the northern areas of North America from Newfoundland to Alaska, and south to Tennessee and South Carolina. It is considered rare in the Pacific region, and its occurrence increases with increasing continentality (Klinka et al. 1989). In the United States, this orchid is Possibly Extirpated (SH) in Connecticut and Rhode Island, and Presumed Extirpated (SX) in Indiana. It is Critically Imperiled (S1) in Wyoming and Illinois (NatureServe 2015). It is Vulnerable (S3S4) in Alaska, Tennessee, North Carolina, South Dakota, and Wisconsin (NatureServe 2015, South Dakota Natural Heritage Program 2015). It is Secure (S4) in Idaho, New York, Ohio and Virginia and West Virginia (NatureServe 2015). All the remaining states where it is known it is Not Ranked (Massachusetts, Maine, Michigan, Minnesota, Montana, New Hampshire, Oregon, Pennsylvania, South Carolina, Vermont, and Washington). Populations have been extirpated in Indiana since the mid 1980's (Aldrich et al 1986). It was once listed as Presumed Extirpated by the Oregon Natural Heritage Program but the ranking was removed because the rank was based on an incorrectly identified specimen (Lesher and Henderson 1998).

In Canada, *P. orbiculata* is considered secure (S4) in Alberta, British Columbia, New Brunswick, Nova Scotia, Ontario, and Yukon. It is vulnerable to secure (S3S4) in, Newfoundland and Labrador, New Brunswick, and Quebec (NatureServe 2015). It is vulnerable (S3) in Manitoba. It is considered vulnerable to imperiled (S3S2) in Saskatchewan. It is vulnerable (S2) in Prince Edward Island. It is considered Sensitive in Northwest Territories.

Existing Regulatory Mechanisms, Management Plans, and Conservation Strategies

Platanthera orbiculata is not designated as an endangered or candidate species by the US Fish and Wildlife Service. It is currently designated as Sensitive by the USFS Rocky Mountain Region and Alaska Region. Sensitive species status provides consideration of needed protection on National Forest lands. The USFS management objectives for sensitive species are designed to ensure continued viability throughout their range on National Forest System lands (FSM 2670.22). Existing policy calls for avoiding or minimizing negative effects to species whose viability has been identified as a concern, or if effects cannot be avoided, analyzing the significance of potentially adverse effects on populations or habitat within the area of concern and on the species as a whole (FSM 2670.32).

The National Forest System Land Management Planning Rule was revised in 2012 and under the new regulations discontinues the concept of "sensitive species" and adopts a revised approach to at "At risk species" by evaluating potential "Species of Conservation Concern (SCC)". Similar to the sensitive species process of listing, formal SCC lists are designated by the Regional Forester in consultation with Forest managers who prepare recommendations based on a species ability to persist over the long term in the plan area (36 CFR 219.9). The Forest Service through direction from the National Forest Management Act requires that plans provide for diversity of plant and animal communities (16 USC 1604 (g)(3)(B)). The new planning rule requires that all plans identify and assess “At risk species” (36 CFR 219.6(b)). In addition, new direction requires plans to assess the status of the ecosystems for ecosystem integrity for the purpose of determining whether ecosystems are functioning normally and are uncompromised. The plan shall identify and assess available information relevant to the plan area for threatened, endangered, proposed and candidate species and potential species of conservation concern present in the plan area by assessing the ecological conditions for these species in the assessment.

Adopting the revised National Forest System regulations provided in the 2012 Planning Rule and new directive system (FSM 1909.12.52) which defines “At risk species” is currently in transition. The departure of the “Sensitive Species” designation and subsequent adoption of “Species of Conservation Concern” will likely take the Tongass N.F. several years. In the meanwhile, it is important to note that to date, this species (and others on the Tongass) remain under the “Sensitive Species” policy (FSM 2670.22 and 2670.32). Whether designated as “Sensitive” or as “SCC”, the core concept of “At risk species” remains consistent in both definitions.

Other than controls by the Convention on International Trade in Endangered Species that pertain only to international trade (CITES 2011), regulatory protections that apply to this species only affect occurrences on National Forest System land.

Platantherea orbiculata was recently under review to be designated as a species of conservation concern by the Alaska Region but was not recommended for this status due to the number of occurrences that are well distributed throughout its range on the Tongass N.F. as well as a robust Old Growth Conservation Strategy which avoids destruction of this species’ primary habitat (USDA 2015). However, it currently remains on the Regional Forester’s Sensitive Species List.

Biology and Ecology

Classification and Description

The genus *Platanthera* in the Orchidaceae family was created by L. C. Richard (1818) in to distinguish orchids with concave, recessed stigmatic surfaces from those of *Habenaria* Willd., with convex projecting stigmatic processes (Reddoch and Reddoch 1993). *Platanthera* was not widely accepted in the botanical literature throughout the later part of the 1800’s and during the first half of the 1900’s. At that time, *Platanthera* was often considered as *Habenaria sensu latu*. It was not until the mid to late 20th century when botanists began accepting *Platanthera* and *Habenaria* as separate genera (Luer 1972, 1975; Stoutamire 1974; Webb 1980; Inoue 1983). Genetic studies confirms this and strongly placed *P. orbiculata* within *Platanthera* (Hapeman and Inoue 1997, Bateman 2003). Synonyms of *Platanthera orbiculata* are summarized in Table 1 (Sheviak 2002).

Table 1. Synonyms of *Platanthera orbiculata*

List of Synonym of Platanthera orbiculata (Pursh) Lindl.
Orchis orbiculata Pursh
Habenaria orbiculata (Pursh) Torrey
Habenaria orbiculata var. *menziesii* (Lindl.) Fernald
Habenaria orbiculata var. *lehorsii* (Fernald)
Platanthera orbiculata var. *lehorsii* (Fernald) Catling

Species Description

Species descriptions and illustrations can be found in regional floras including: Cody (1996), Douglas et al (2001), Hitchcock and Cronquist (1973), Hultén (1941, 1968), Sheviak (2002), and Welsh (1974). The orchid is characterized by a pair of large, succulent, shiny, deep green and nearly round leaves that lay on the ground. Often, the emerging leaves hug the ground so close that they follow the contours of objects that are not pushed aside as the leaves expand (Luhr 1975).

The following species description is adapted from Sheviak (2002; Figure 1):

> **Perennial**, 17–62 cm tall, fleshy tuberous root. **Leaves:** two, in a subequal basal pair, 5–21 x 3–22 cm; bracts 1–6, scattered on stem, elliptic to orbiculate. **Inflorescence:** spike, dense to lightly loose. **Flowers:** resupinate; calyx greenish white; corolla white; lateral sepals reflexed or spreading; lip descending to reflexed without basal thickening, 7–17 x 1–2.5 mm; spur clavate, 14–27 mm. **Pollinia:** nearly straight, 3–4.5 mm. **Fruit:** curved and erect, capsule.

A few populations in coastal Canada and Alaska have small and few flowered plants with narrow leaves (Figure 2). Sheviak (2002) notes that considerable variation in leaf size and shape occurs and Alaska material is not warranted to be designated as a different species. The smaller leaves and fewer flowered individuals display a strong resemblance to some Asiatic orchid species such as *Platanthera freynii* Kränzlin. Further genetic work is being conducted at the Rancho Santa Ana Botanical Gardens by Robert Lauri to determine phylogeny of the genera. However, at this time, all the genetic material analyzed from North America (including some specimens from the Tongass) contain their genetic origins in North America. Until good Asian material is obtained, it is unknown how closely related the Asian *Platanthera freynii* is related to the North American (B. Lauri pers comm. 2008).

Due to the considerable variation of leaf morphology in *Platanthera orbiculata*, it is often mistaken for *Platanthera macrophylla* where their distribution overlaps in the Great Lakes region. Recently the morphological characters has been resolved by spur length ratios (Reddoch and Reddoch 1993, Sheviak 2002). The distribution range of *Platantherea macrophylla* does not extend past the Great Lakes region to the Pacific Northwest and specifically, Forest Service Region 10. From a distance, a young plant without an inflorescence can often look similar to the occasionally associated plant *Clintonia uniflora* (Queen's cup or Bluebead). However, the leaf margins of *C. uniflora* possess minute hairs and the leaves are less succulent and less rounded. Superficially

Platanthera orbiculata may look similar to other orchids in the region that have a distinct slender spur at the base of the lip. However, it can be distinguished by other characters summarized in Table 2 below.

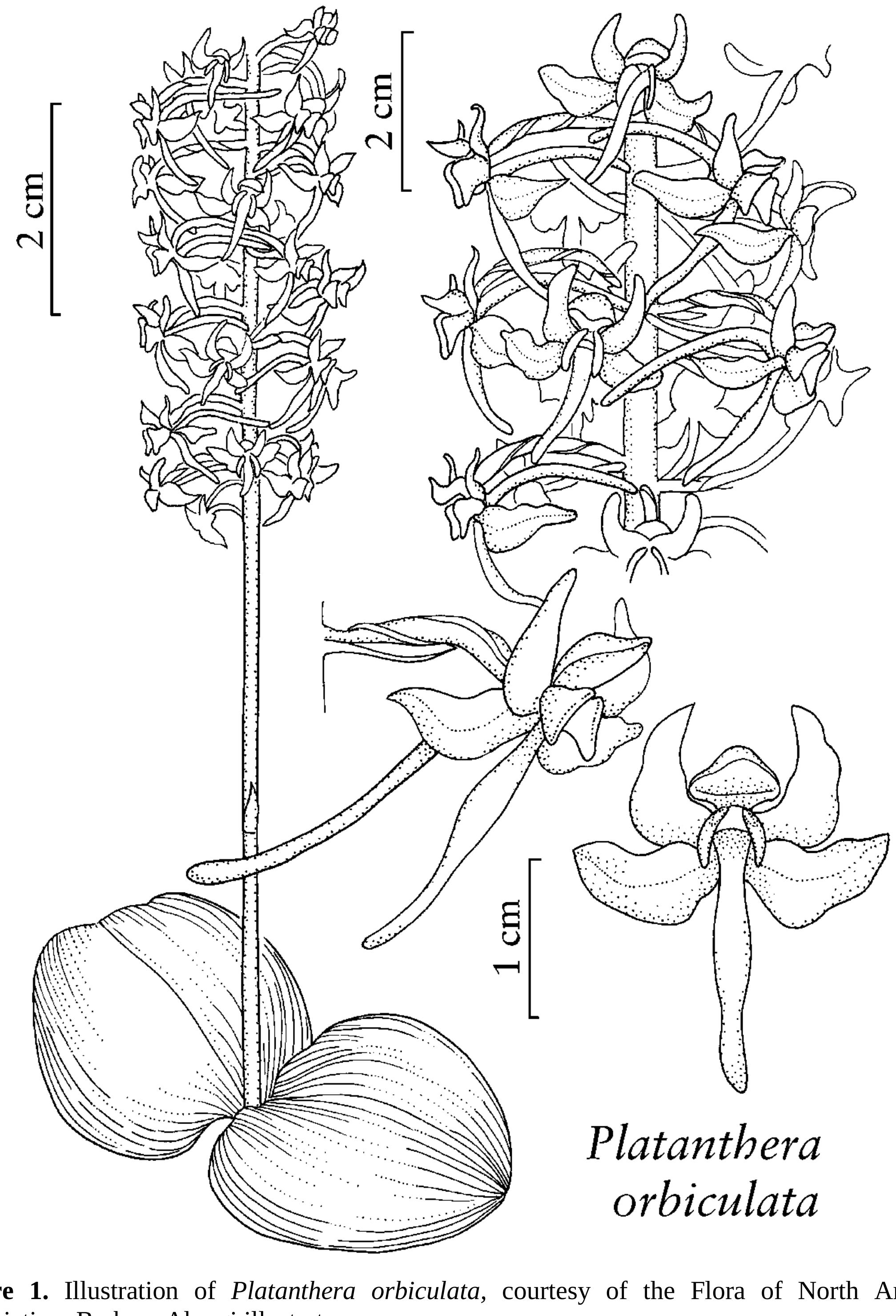

Figure 1. Illustration of *Platanthera orbiculata*, courtesy of the Flora of North America Association, Barbara Alongi illustrator.

Figure 2. This plant displays narrow leaf morphology of *P. orbiculata* from Etolin Island, Tongass National Forest. Photo by P. Rak USFS.

Table 2. Plant traits of *Platanthera orbiculata* and similar species.

Species	Basal Leaves	Spur	Plant Height
Platanthera orbiculata	2	Slender; 14–27 mm	17–62 cm
Platanthera obtusata	1	Slender, conical; 3–8 mm	5.5–35 cm
Platanthera chorisiana	2	Sac-like and cylindric; < 1.2 mm	4–20 cm

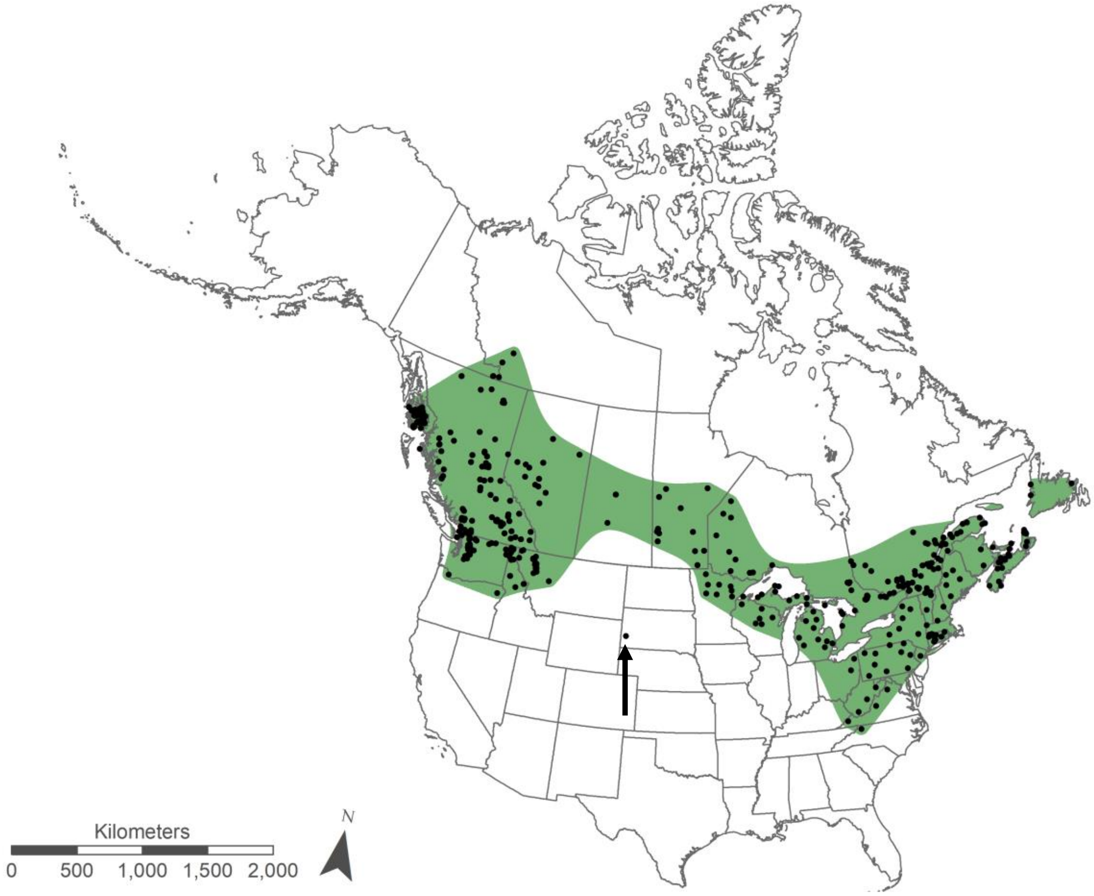

Figure 3. Distribution of *Platanthera orbiculata* based on herbarium records. Arrows indicate disjunct populations.

Distribution

Platanthera orbiculata is widespread across North America from southern southeastern Alaska, British Columbia, and northern Pacific Northwest east across Canadian Great Plains to Massachusetts, Maine, Nova Scotia and Newfoundland and Labrador (Figure 3). A disjunct population occurs in South Dakota. In Alaska, most occurrences are on the Tongass National Forest (Figure 4). The earliest collection of this plant in Alaska is documented from 1889, the collector and exact location are unknown (US: 423928). Hultén (1941) described occurrences in Karta Bay (Prince of Wales Island), Port Chester (location unknown), Ketchikan (according to Anderson, no collection can be found), and Helm Bay (Cleveland Peninsula). There are 302 unique records of *P. orbiculata* on the Tongass National Forest collected by USFS employees since 1996 (NRIS database 2015). However, spatially, these data do not necessarily represent biologically significant populations or occurrences because the data are at a very fine scale, sometimes to the individual. The Alaska Natural Heritage Program follows NatureServe guidelines for determining and identifying rare plant populations (Element Occurrences), where populations are defined as occurring ≤ 1 km apart and/or incorporates natural barriers such as water bodies or mountain ranges that limit genetic crossover (NatureServe 2002). Applying these national standards of rare plant population defines 61 occurrences of

P. orbiculata in Alaska (Figure 5). *Platanthera orbiculata* is known on private lands on Gravina and Revillagigedo Islands. These populations will not be considered further in this assessment.

Of the total area occupied by the 61 known populations, 44% are located within Non-development Land Use Designations (LUDs) and 56% are located within Development LUDs (USDA 2015). Non-development LUDs represent landscapes that are not currently open to resource development, such as timber harvest, road construction or renewable energy and mineral development.

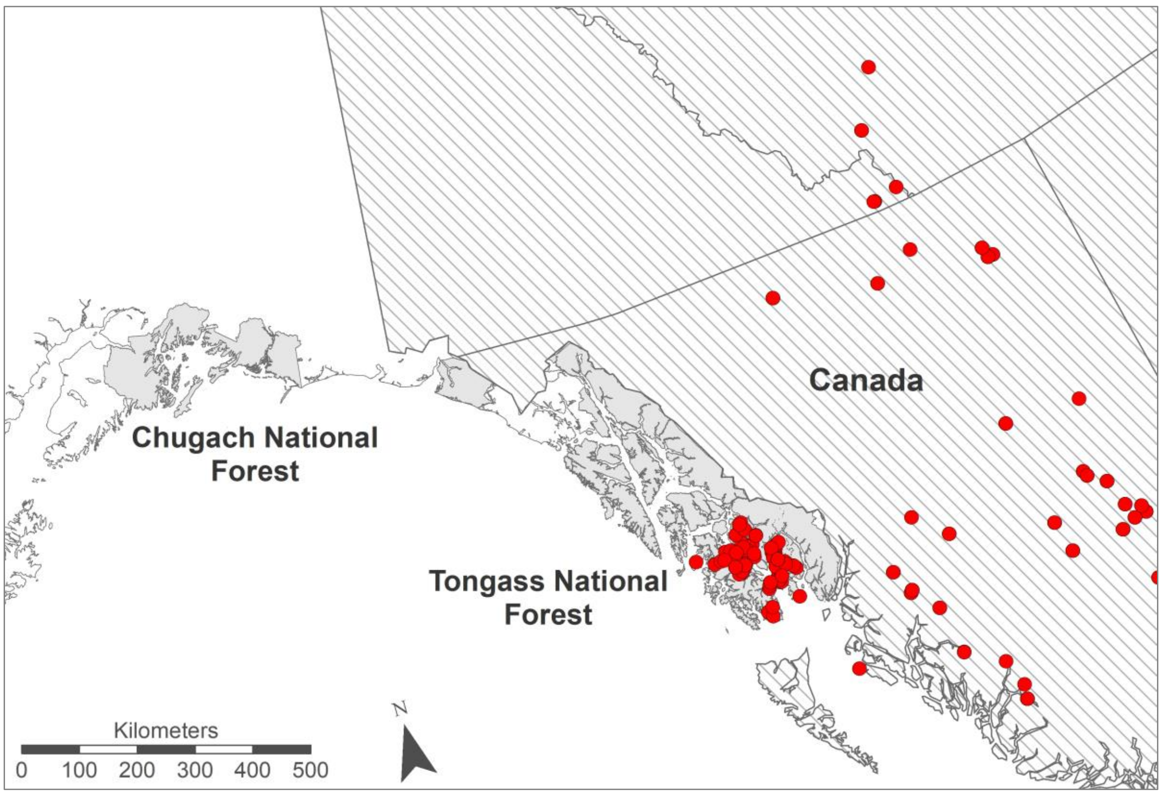

Figure 4. Distribution of *Platanthera orbiculata* in USDA Forest Service Alaska Region and neighboring Canadaian Territories.

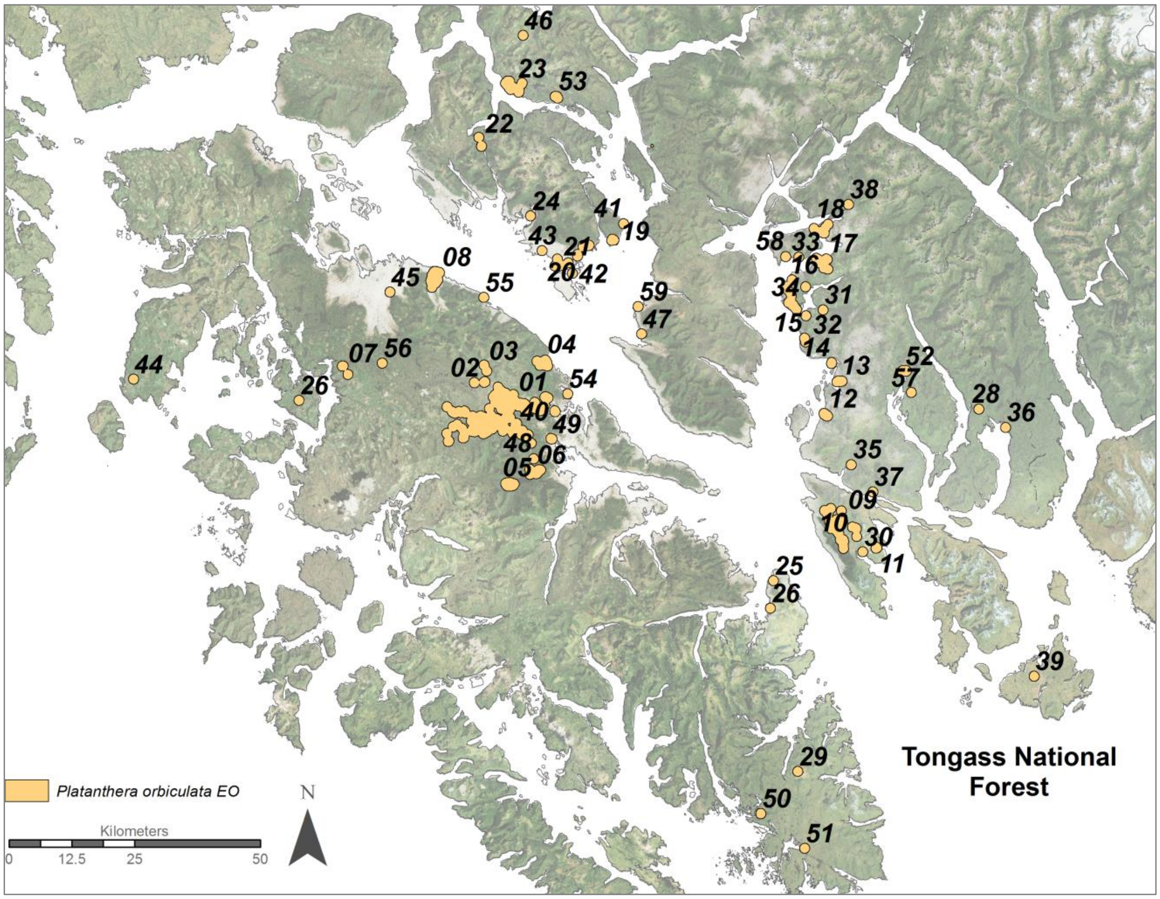

Figure 5. *Platanthera orbiculata* Element Occurrences (EOs) in Alaska, EO number in bold. EOs are defined by occurring ≤ 1 km apart as defined by the NatureServe national standard.

On the Tongass National Forest, Prince of Wales Island near Thorne Bay has the largest number of populations and area occupied, with 22 occurrences. Both Revillagigedo Island and nearby Gravina Island have 19 occurrences each (Table 3; Figure 5). The northern limit of known occurrences in Alaska is on Wrangell Island (Figure 5).

Sighting records of *P. orbiculata* on the Tongass are recorded in a GIS database as part of the botany program. Some sightings were recorded before GPS technology and therefore locations were approximated on aerial photos before being digitized. The majority of sightings were documented as part of rare plant surveys during environmental analysis of proposed management activities, with lesser amounts discovered indirectly by resource specialists while conducting other field duties, and from FIA plots. For example, sightings on South Etolin Island Wilderness were found and documented by Tongass wilderness rangers but have not been relocated by a Tongass botanist. In other regions, *P. orbiculata* has observed periods of dormancy, during which time no evidence of its presence is visible (Hornbeck et al. 2002). The number of occurrences on the Tongass may only reflect the extent and intensities that the federal lands have been surveyed, noting that the majority of the survey areas were associated with planned timber harvest units and roaded areas. Therefore, the number of occurrences reported may not indicate accurate distribution or abundance and indeed represent a sampling strategy that has not taken into account the full range and preferred habitat for the species distribution within the planning area (e.g., Tongass N.F.).

Sightings of *P. orbiculata* in the NRIS database occur as early as 1996, though there is an erroneous record from 1900. Given that observations were being recorded since the mid 1990's and every site has not been revisited, there is no apparent trend, shrinkage or expansion, in the distribution of *P. orbiculata* on the Tongass.

Table 3. Known *Platanthera orbiculata* locations on the Tongass National Forest. Numbers of sightings are from the NRIS database and exclude private land sightings.

Locality	No. of Occurrences	District
Etolin	8	Wrangell
North POW	17	Thorne Bay
South POW	5	Craig
Gravina	19	Ketchikan
Revilla	19	Ketchikan
2007 FIA plots	3	Ketchikan and Wrangell

Platanthera orbiculata is reported from approximately 180 locations in Washington. It is restricted to the northern Cascades and is not documented south of the Cedar River watershed (R Lesher pers. comm.). It is found in a couple isolated areas in the eastern Olympics and historically was documented in the San Juan Islands near Friday Harbor but not relocated (R. Lesher pers. comm.). On the Colville National Forest and vicinity in NE Washington it occurs in two locations for a total of 2048 plants (K. Ahlenslager pers. comm.) Most of the sightings in Washington are on the Mt Baker-Snoqualmie National Forest (Lesher et al 2002). This orchid is reported to occur in 25 locations on the Black Hills National Forest in South Dakota, with a total of 747 individual plants (Hornbeck et al 2003).

The populations of *P. orbiculata* on the Tongass are 165 miles west of the nearest populations in Canada in the Kitimat-Sitkine Regional District of British Columbia (Figure 4). The northernmost part of *P. orbiculata's* range is Canada, in the area where borders of the Yukon Territory' British Columbia and Northwest Territories meet (roughly 60 °N and between 123-127 °W; Figure 4). Herbarium records from the Yukon Government and the private herbarium of Bruce Bennett of the Yukon Department of the Environment contain collections from seven boreal forest locations (Yukon Government Herbarium 2015). Documented locations are near LaBiche River, Lower Beaver River, Fantasque Lake, and Larsen Creek. This plant is considered common in the lower

Figure 6. *Platanthera orbiculata* from Etolin Island. Photo by K. Dillman, USFS.

LaBiche River valley and less frequent west of this region (B. Bennett pers comm.). Collections were made in 1994, 1997, 1998, and 2004. There are several documented locations of *P. orbiculata* in the southwest portion of the Northwest Territories near Ft. Laird, where it is considered rare in this primarily boreal forest region (McJannet et al 1995, Porsild and Cody 1980).

The range of *P. orbiculata* in western Canada extends throughout British Columbia, and excludes the Queen Charlotte Islands (Klinkenberg 2007; Calder and Taylor 1968). This plant is infrequently found south of 55 °N, and rarely on the coast (Douglas et al 2001). The Biogeoclimatic Ecosystem Classification project with the Ministry of Forests and Range recorded 717 plots containing this orchid from over 20,000 plots inventoried (Klinkenberg 2007). Only a few locations are from Vancouver Island (Klinkenberg 2007). The herbarium at the University of British Columbia, contains 72 collections from across British Columbia, including several near the headwaters of the Stikine River. There is no documented expansion or contraction in the distribution of the species in its natural range.

Population Trend and Abundance

Species abundances presented (colony size and overall number of known individuals) are from database records from the Tongass and other published references from North America. *Platanthera orbiculata* is considered uncommon or rare throughout most of its range in North America and is not abundant where it occurs. Indeed, on the Tongass, 50% of the observations at the subpopulation level contain one to eight individual plants in a small area.

There is a data gap for population trend, but population abundance on the Tongass National Forest can be estimated from NRIS data. Rare plant data for *P. orbiculata* in the

NRIS database dates from to 1982 to 2013, however data were not consistently collected in all years. For example, some observations are clearly marked as repeat visits but others are not indicative of a repeat visit, making it difficult to infer population trends. Additionally, observations pre-2006 omit the number of plants observed, area occupied, and ecological data. Drawing accurate population counts of *P. orbiculata* in Alaska from data pre-2006 should be viewed with caution. Furthermore, not all individuals are flowering at the time of observation leaving some individual plants missed in a count.

In 2004 it was estimated the total population of *P. orbiculata* on the Tongass NF was approximately 1800 individual plants, including the largest known colony with between 800 and 1000 individual plants on Revilla Island (Trimble 2004; Figure 6). However, this number was reduced to close to one hundred when the site was revisited a few years later (Stensvold 2006). Based on recent count data from 2007–2013, there are approximately 5,563 individual plants on the Tongass NF (NRIS database). Populations range from 1 individual to 2,775 individuals (the largest on Prince of Wales Island). Fifty percent of the populations on the Tongass NF contain 10 individuals or less and 22% of the populations have more than 100 individuals.

Several occurrences have had several population counts in concurrent years. One subpopulation of Element Occurrence # 22 had 10 individuals in 2006. A revisit in August 2007 documented that this subpopulation still contained 10 individuals. However, in other cases, as indicated above with the Revilla Island element occurrence discovered by Trimble and later visited by Stensvold, dramatic changes in the numbers of individuals can occur from one year to the next.

Monitoring efforts of the species began in 2011 with a pilot study on the Tongass NF with eleven permanent plots established in a population on Prince of Wales Island. After the first year, results indicate a 42% decrease in the population density (individuals/ha) and an additional decrease of 26 % the subsequent year (USDA 2013). Over the 2-year pilot study there was an overall decrease of 57% in population density (USDA 2014a). The cause for the overall decline is unknown, but one population was directly affected by timber harvest activities. This pilot study had a small sample size and too short of a duration to fully capture the life history trait of *P. orbiculata*. While this population underwent a substantial decrease in population size over a two year period, other populations that have been revisited but were not part of the Prince of Wales monitoring sample universe have not shown a decreasing trend. Monitoring results for this study should be viewed with caution considering the short duration of the monitoring period coupled with the narrow focus of sample sites across the plant’s range in the planning area. The dormancy cycle and the disappearance of vegetative individuals over time of this orchid are not understood across its range, including in southeast Alaska. It is noteworthy that fluctuations in the population density of orchids due to dormancy have been observed in other orchids such as *Cypripedium montanum* and *Platantherea hookeri* (Vance 2007, Reddoch and Reddoch 2007).

Records from Washington indicate that few populations consist of more than a couple of individuals (Lesher et al 1998). The Colville National Forest documents one sighting with about 2000 plants in 1992, but has not been revisited (K. Ahlenslager pers comm. 2008). Occurrences in South Dakota's Black Hills range between one and 126 individual plants, with an average occurrence size of approximately 25 plants (Hornbeck et al 2003). Reddoch and Reddoch (1997) report that *P. orbiculata* occurs in colony sizes of one to 190 individuals in the Ottawa District in Eastern Canada. Colony or population estimates are not available for other Canadian provinces.

Habitat

Throughout its range, *Platanthera orbiculata* is generally found in mixed shady forested habitats with mesic to wet soil (Luer 1975, Reddoch and Reddoch 1997). The forest floor generally contains thick layers (4 to 10 inches) of organic duff comprised of several bryophyte species (genera unknown). In the Yukon and Northwest Territories it is associated with shady boreal forests consisting of *Populus balsamifera*, *P. tremuloides*, *Picea glauca*, *P. contorta* and *P. mariana* overstory in varying amounts (BABY Herbarium 2015). Herbarium records indicate that the substrate often has a high cover of bryophytes, usually *Hylocomium splendens* (BABY Herbarium 2015). In Washington it is found associated with mature to old growth forests of *Tsuga heterophylla*, *Picea engelmannii*, and *Abies amabilis* and the forest floor dominated by layers of bryophytes (Lesher and Henderson 1998; Ahlenslager pers. comm. 2008). A disjunct population from the Black Hills area in South Dakota occurs in forested habitats similar to where it is found in Canada. Typical habitat includes dense to partially open canopy of mid to late successional *Betula papyrifera/Corylus cornuta*/*Picea glauca* forests with filtered light, damp humic soils with a deep litter and high moss cover (Hornbeck et al 2003).

In coastal British Columbia, it typically grows on soils of mor-humus, which is a 5 cm layer (or more) of compacted organic materials (matted by fungal mycelia) and overlying mineral soils that are non carbonate (Klinka et al 1989). *Platanthera orbiculata* is found in mossy, semi-open coniferous forests of the montane zone consisting of mesic soils of medium nutrient class, on 15% slopes averaging approximately 900 m elevation (Klinkenberg 2007). Some commonly associated plants in BC are *Clintonia uniflora* (forb) and *Pleurozium schreberi* (bryophyte) (Klinka et al 1989).

Habitat information for *P. orbiculata* in Alaska is based on GIS information of species presence and notes recorded during botanical surveys. Information presented from the Tongass GIS layers include: *Soils* (including wetland habitat), *Geology*, *Ecological Subsection*, *Existing Vegetation* (including forest productivity, forest type, stand size class, volume class), *Elevation Range*, and *Slope Class.* These habitat parameters associated with *P. orbiculata* occurrences are summarized in Table 4. On the Tongass National Forest, *P. orbiculata* is moderately associated (60% and 51%, respectively) with wetland habitat and forested wetlands (Table 4). Indeed, the Wetland Indicator Status of the species is listed as Facultative, equally occurring in wetland or upland habitat, in Alaska (US Army Corps of Engineers 2014). On the Tongass N.F. and elsewhere in its range, *P. orbiculata* is highly associated with old growth forest (93.5% of occurrences) and lower elevations below 152 m (81.3% of occurrences). The reported habitat conditions for *P. orbiculata* should not be viewed as habitat requirements since the requirements, as well as the habitat may change over time. Certain GIS parameters lack data for some sightings due to location on private land or GPS errors.

Table 4. Habitat parameter and percent frequency of sightings within a given parameter on the Tongass National Forest. Data are from GIS layers and 2008 sighting information. Percent frequency is the number of *P. orbiculata* occurrences for that particular parameter divided by the number of occurrences that contain data for a particular parameter.

Habitat parameter	Sample Size of Occurrences that Contain Habitat Parameter Data	Percent of *P. orbiculata* Presence in Habitat Parameter
Wetland habitats	90	60.0%
Non-wetland habitats	90	27.7%
Forested wetlands	80	51.2%
Forested non-wetlands	80	30.0%
Geology MzPzms Metasedimentary rocks	88	54.5%
Geology Kpg Plagioclase-porphyritic granodiorite and quartz diorite rocks	88	17.0%
Western Hemlock overstory	62	87.1%
Hemlock-Spruce overstory	62	10.0%
High volume class of 9-30 MBF/acre	62	88.7%
Stand size class -old growth saw timber over 150 years	62	93.5%
Elevation range between 0 and 152 m	91	81.3%
Forest productivity greater than 20 cu ft/acre	81	71.6%
Slopes between 15 and 35 %	71	40.8%
Slopes between 35 and 75%	71	33.8%

Based on GIS and field notes, the general habitat and micro-habitat characteristics for *P. orbiculata* in Alaska include: low elevation forested wetlands; medium to high volume old growth hemlock forests; slopes between 15 and 75%; high bryophyte cover; red cedar component; low forb cover; forest edges or near gaps in otherwise shady forests; near open water or boggy areas; metasedimentary geology (non-carbonate); mesic soils; deep organic duff layer; on decaying logs, stumps or base of old trees. The variability of *P. orbiculata* habitat indicates that this orchid can survive in multiple habitats and it may survive at one location long enough for a plant community to change through succession.

Reproductive Biology and Autecology

Platanthera is the largest genus of temperate orchids in North America with approximately 200 species (Sheviak 2002). This genus displays great orchid floral diversity and has made an ideal model for co-evolution studies between pollinator proboscis length and nectar spur length and breeding system evolution (Inoue 1983; Catling and Catling 1991; Johnson and Nilsson 1999; Maad and Reinhammer 2004; Little et al 2005). Most *Platanthera* have adapted to pollinators for outcrossing; self-fertilization is a rare occurrence in the group (Argue 2012). Experimental studies have yet to investigate the breeding and mating system of *P. orbiculata*. Studies on other *Platanthera* species in North America demonstrate noctuid moths (Noctuidae), which are generally nocturnal insects, are the primary pollinators (Argue 2012). There are no studies identifying the pollinators or pollinator behavior of *P. orbiculata*, however a single observation recorded two noctuid moth species, *Autographa ampla* and *Diachrysia balluca*, to visit *P. orbiculata* (Argue 2012). *Diachrysia balluca* has a north eastern distribution of North America around the Great Lakes and New England region and does not extend to Alaska (Lotts and Naberhaus 2014). The distribution of *Autographa ampla* greatly overlaps and mimics the distribution of *P. orbiculata* by extending to the Pacific Northwest into British Columbia and has been noted to occur in Alaska (Ferris et al 2012, Lotts and Naberhaus 2014, Crabo et al 2015). Other species of noctuid moths are known to occur in southeast Alaska (Opler et al. 2006, Opler pers. comm. 2008).

Generally, a moth will locate the spur opening of the flower and insert its proboscis. For effective cross pollination, the spur on the orchid flower must be short enough for the proboscis of the insect to reach the nectar at the end. As the insect pushes into the spur, its head makes contact with the viscidia which clings to the eyes or the base of the proboscis and gets extracted as the insect withdraws form the spur (Reddoch and Reddoch 1993, Argue 2012). Factors that can affect pollination rates in orchids include the number of flowers available on the plant, reward production, and pollinator behavior (Johnson and Nilsson 1999). There are mixed reports on the presence of a nocturnal odor in *P. orbiculata*, which would attract pollinators (Brackley 1985; Reddoch and Reddoch 1993). Reproductive success can be limited by the amount of pollinator visitation or resource availability, but no experimental data on the topic exist for *P. orbiculata*. Fruit and seed production is greater in *P. orbiculata* than *P. microphylla* due to more flowers per raceme (Cleavitt et al. 2016).

From herbaria records and NRIS data, the flowering period for *P. orbiculata* in southeastern Alaska is mid-June until mid-August. Flowers can last for several weeks before senescing. Fruiting has been observed as early as July 4, but generally fruiting and seed dispersal occurs in mid- to late-August. An abundance of tiny seeds are produced and are generally thought to be dispersed by wind. It is also plausible for orchid seeds to be dispersed by animals on their fur or feet for long distances (R. Lauri pers. comm. 2008).

The minute seeds of temperate North American terrestrial orchids do not germinate without a fungal infection, or do so with great difficulty because they do not store nutrient reserves unlike other flowering plants (Arditti et al 1990, Currah et al 1991). In the early stages of seedling germination and corm development, all orchids require a fungal relationship to receive organic and inorganic nutrients (Dearnaley 2007). The fungal relationship is complex and the fungal hyphae grow within the root cells and help transfer nutrients such as phosphorous, nitrogen, and water to the root cells but the fungus benefits by receiving carbon from the orchid (Dearnaley 2007). Fungal mycelium has also been shown to link orchids with neighboring trees, where the orchids are able to indirectly receive carbon from these trees (Dearnaley 2007). Fungal specificity appears to be a very important feature of seed germination in north and south temperate climate orchid species compared to tropical climate orchids (Arditti et al 1990). Little is known about North American fungal specificity for temperate orchid seed germination. Experiments on the inoculation of several *Platanthera* species demonstrate that *P. orbiculata* has one of the poorest germination success rates and would only be inoculated by one fungus species (Smreciu and Currah 1989). A high mortality rate is commonly observed in *Platanthera* seedlings (Zettler et al. 2005). Specifically in *P. orbiculata*, on the rare chance germination is successful, on average less than 3% of seeds develop into leaf-bearing seedlings (Smreciu and Currah 1989).

A full life cycle diagram for *P. orbiculata* can be reviewed in Cleavitt et al. (2016). The life history stages of *P. orbiculata* are composed of five stages: underground germinant/protocorm, above ground juvenile, immature, vegetative, terminal flowering adult (Reddoch and Reddoch 2007, Cleavitt et al 2016). After seed germination and fungal inoculation, the orchid develops into a non-photosynthetic corm underground. The aboveground life stages are defined by leaf size, leaf number, and flowers present. The juvenile stage is characterized with a single small, linear leaf and the immature stage has a single round leaf (Reddoch and Reddoch 2007, Cleavitt et al 2016). Both the vegetative and flowering adult have two round leaves but the flowering adult has a flowering raceme. The length of time to reach immature and vegetative stage, is unknown (Reddoch and Reddoch 2007). Mature plants in the vegetative stage produce two large leaves and can flower, remain vegetative, or go into dormancy the following year (Reddoch and Reddoch 2007). However, from following several populations life history, *P. orbiculata* most likely to flower in successive years (Cleavitt et al 2016). During the flowering stage the next year's shoot bud is initiated at the crown and a new tuber begins to elongate with the development of new roots (Currah et al 1990, Cleavitt et al 2016).

Dormancy can be a single to several years and is observed to be more common earlier in the vegetative stage of *P. orbiculata* (Reddoch and Reddoch 2007). However, Cleavitt et al. (2016) found dormancy to be very rare in the population studied, possibly due to the amount of available resources, inhibiting a stress response. Instead of suffering the consequences of mortality from environmental stressors, long-lived orchids can undergo dormancy to counteract high stressful events (Shefferson et al 2005). When dormancy begins, the previous season's tuber and roots wither and 1–2 tubers fully elongate with roots a new shoot bud is fully formed (Currah et al 1990).

Demography

A demography study of *P. orbiculata* in New Hampshire found mortality is highest, nearly double, in the juvenile and immature life stage than in its adult stages (Cleavitt et al. 2016). Over the four year study, the number of both juveniles and immature adults was only 20% of all individuals observed. The mean adult age was found to be 6 years but the majority of individuals die by age 10. It was estimated that less than 5% of individuals are able to live to 20 years, potentially creating a genetic bottleneck (Cleavitt et al. 2016).

Compared to a similar *Platanthera* species, *P. orbiculata* has a higher rate of adults that initiate flowering and also generating more flowers per raceme (Cleavitt et al. 2016). Based on a small sample size, *P. orbiculata* on average produced 2,200 seeds per fruit. Despite the large number of seeds produced, fecundity did not appear to be a significant contributing factor to population size or growth (Cleavitt et al. 2016). Generally, populations may remain stable if adult mortality is low but without significant recruitment, populations would remain low or diminish. The amount and distribution of compatible mycorrhizal, sufficient carbon supply, and favorable seed germination are all necessary limiting factors for orchids (Rasmussen et al. 2015).

The genetic characteristics of *P. orbiculata* have not been studied. There are no reported cases of hybridization between *P. orbiculata* and other *Platanthera* species.

Community Ecology

Orchids are one of the most diverse monocot families in terms of habitat, ecology and morphology; and the orchid family is one of the largest families of flowering plants (Sheviak 2002). Terrestrial orchids are not commonly cultivated, which may be a function of the difficulty in reproducing and maintaining the fungal association in horticultural conditions. Terrestrial orchids (compared to most tropical epiphytes) require a fungal association for seed and establishment of all life stages (Currah et al 1990; McCormick et al 2006). As mentioned above, terrestrial orchids are associated with specific groups of fungi throughout their life cycle, which may be a contributing factor in the decline of many species facing changing climatic conditions (McCormick et al 2006).

Two species of mycorrhizal fungi, *Leptodontium orchidicola* and *Sebacina* sp. are reported to associate with the mycorrhizae of mature *P. orbiculata* plants from boreal Canada (Currah et al 1990). The relationship the mycobionts have with other life stages of *P. orbiculata* in Alberta is unknown. The mycobiont *Sebacina* is now known to be identified as *Tulasnella* (Lee Taylor pers. comm.). No information is available for the mycobiont from *P. orbiculata* in Alaska from the protocorm or adult life cycle stages.

Throughout its range, *P. orbiculata* is generally found in mixed shady forested habitats with mesic to wet soil From 49 field records reviewed for this part of the assessment, the most commonly associated plants with *P. orbiculata* include *Tsuga heterophylla* (TSHE; 88% of the records) and *Thuja plicata* (THPL; 80% of the records) (Figure 7). Other associated plants include *Vaccinium* sp. (VACCI; 78% of the records), and *Cornus canadensis* (COCA 13; 39% of the records) (Figure 7). High bryophyte cover is a common substrate component including *Hylocomium splendens* (HYSP70), *Rhytidiadelphus loreus* (RYLO70) and *Sphagnum* sp. (SPHAG2) (Figure 7). However, all of these associated plants are generally ubiquitous in old growth forests and cannot be considered indicator species for finding *P. orbiculata* or its habitat. Except for the bryophytes, shrubs and overstory species, the percent cover for most of the associated plants is very low, indicating that the micro- habitat does not contain a high diversity or high forb layer. A few records document this orchid in second growth forests. It is unclear if plants colonized after harvest or are residual plants that survived the overstory removal.

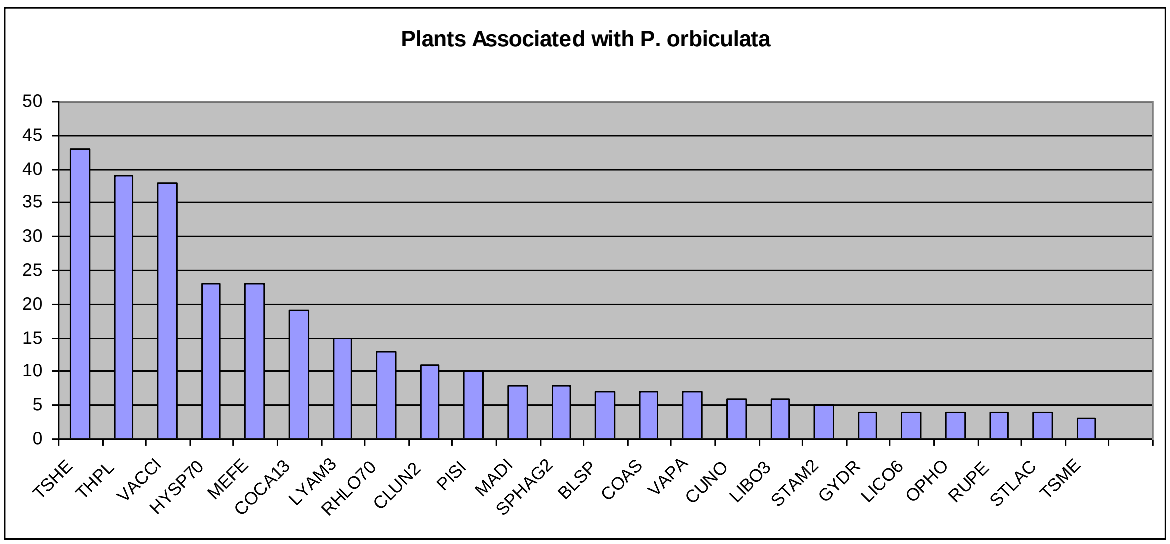

Figure 7. Plants associated with *P. orbiculata* from 49 field records on the Tongass National Forest. X axis is the plant name from USDA PLANTS database and Y axis is number of sightings with the plant associated out of 49 records.

CONSERVATION

Threats

General range-wide threats of *P. orbiculata* include predation, invasion of non-native species, pollinator limitation, absence of fungal symbionts, and timber harvesting (Argue 2012). The occurrences of *P. orbiculata* in Alaska and their distribution concentrated in the southern Tongass National Forest increases the risk of altering the persistence of this species in Alaska. Threats to *P. orbiculata* in Alaska can be operative singly or in combination with others. Threats to rare plants can be considered direct or indirect, biotic or abiotic, and naturally occurring or anthropogenic (CPC 2006) Primary threats to the viability of this plant or its habitat on the Tongass National Forest and in Alaska include direct and indirect effects of: timber harvest; road building; recreation site users; extent of dormancy period; and climate change.

Timber Harvest and Road Development

All of the populations on the Tongass National Forest are located in development LUDs (Land Use Designations) that are past and present timber harvest planning areas (NRIS database 2015). Forest Plan direction in the form of guidelines[1] recommends avoidance through the implementation of buffers or partial cutting of trees near sensitive and rare plants (USDA 2008a) to mitigate impacts of management activities to sensitive and rare plant occurrences. Because this direction is guidance and not considered a 'standard'[2], not all occurrences within harvest units or roads actually received protection. Furthermore, populations discovered prior to the development of these guidelines likely did not received the benefit of protection. For example, some plants in units that were surveyed ten or more years ago were flagged, but it is generally unknown if protection during harvest or unit and road design was given to these plants. Some plants were discovered before GPS technology was available making exact locations unknown and therefore difficult to protect during design and project activities. Long-term monitoring of status and trends of all known occurrences on the Tongass has not occurred and therefore, the impacts of management activities on populations are unknown. The lack of long term continuity of District botanists involved in the planning of timber sales has greatly reduced the botany program ability to maintain a high level of scrutiny of recommendations to protect rare plants.

The level of timber harvest near or directly on the plants will influence the level of effect on succession and competition. The greatest concern during any timber harvest or other

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[1] A guideline is a constraint on project and activity decision-making that allows for departure from its terms, so long as the purpose of the guideline is met (36 CFR section 219.15(d)(3). Guidelines are established to help achieve or maintain a desired condition or conditions to avoid or mitigate undesirable effects, or to meet applicable legal requirements.

[2] A standard is a mandatory constraint on project and activity decision-making, established to help achieve or maintain the desired condition or conditions, to avoid or mitigate undesirable effects, or to meet applicable legal requirements (FSM 1909.12.05)

tree removal is the direct damage to plants during this activity from churning and compacting of soils, burying of photosynthetic parts, and trampling plants. Other activities during timber harvesting that are of concern are construction of roads, heavy machinery movement, skid trails, logging decks, or any activity that greatly disturbs the soil. The alteration of soil and litter layer from timber harvesting has been shown to negatively impact the mycorrhizal fungi by reduced abundance and regeneration ability, even after decades after disturbance (Harvey et al. 1980, Jurgensen et al. 1997, Hartmann et al. 2012).

The second concern is the abrupt change in solar radiation and hydrologic regimes due to the removal of the canopy or other ground disturbing activities near the plants. The microhabitat of *P. orbiculata* is prominently of shady moist soils and the removal of the forest canopy layer would increase the light intensity and temperature therefore significantly altering the microhabitat. One population on the Colville National Forest consisted of 95 individuals and after timber harvest activity only a few individuals remained (Lesher and Henderson 1998). However, the long-term impacts of timber activities on *P. orbiculata* are currently unknown since no monitoring or studies have specifically evaluated these threats to populations or individual plants. Several large scale harvests of mostly mature old-growth timber are currently being planned within the range of this species. If implemented, these projects could impact a substantial amount of habitat and occurrences of this species.

Road construction activity that alters the soil habitat or changes the soil hydrology would create a negative impact on *P. orbiculata* itself and the habitat. Compacting and overturning the soil would negatively impact the mycorrhizal fungi, indirectly negatively impacting *P. orbiculata.* Water runoff from a road and culverts can alter the soil hydrology, increasing the moisture level of the habitat. Additionally, nearby roads increases the chance of road contaminants from runoff to enter the habitat. A road was constructed next to EO 56 (NRIS database: 100554P000431) in 2010. However, this population was not detected until 2011, after the road was built, indicating the population was dormant or surveys did not detect the population prior to road construction. The impact to the population is unknown and revisits have not been recorded to assess any impacts.

Within the Tongass Land Management Plan direction, future findings of this plant (and other rare plants) in timber units and road corridors will consider “providing protection around the plant population that meets the habitat needs of the species” (USDA 2008).

Recreation
A few occurrences are documented near or within recreation areas on the Tongass National Forest. Most are on Revillagigedo Island along trails or near recreation sites. One known occurrence is along a trail leading to a black bear viewing platform which receives 10-50 visitors daily during the summer months. Another sighting is along a trail on Prince of Wales Island leading to a fish pass. Still others are located along a trail off of the Ketchikan road system on Non-NFS lands. Threats to these plants include people

collecting or trampling plants where they are visible from a trail or road. Monitoring the effects of recreation on populations has not occurred.

Off-road motorized recreation and non-motorized recreation can be harmful by exposing plants to trampling (Latham 2001). There is an off-trail campsite within EO 23 (NRIS database: 100522TES090001), but evidence of trampling or picking plants was not apparent. Trash was observed to be dumped within 9 m of *P. orbiculata* plants at EO 1 (NRIS database: 100554P000116) because it was next to a road but no plants were observed to have experienced damage.

Orchids are charismatic and well known for their beauty. Collection from the wild for horticultural or medicinal use is probably a minor threat to *P. orbiculata* since the flowers are small and the plant can be difficult to see in the dark shade forested habitat. Orchids are often either plucked off at ground level or are dug up for garden transplant. The extent of collection depends on the accessibility of the population and the intensity and method of collection. There have been several observation where leaves and inflorescences have been plucked and removed from the ground, however it's not indicative of human or animal activity (NRIS database). Elaborated below, significant leaf damage can kill the plant or regress it into a previous life history stage. A similar scenario would most likely occur for picked flowers. Additionally, flower removal would eliminate fecundity and pose a threat to population persistence if the population is small. Some orchid roots are used for medicinal purposes; however there has been no documented use of any orchid species by Alaska Natives (Garibaldi 1999) and there are no reports on the edibility of *P. orbiculata*. Given the data gaps of this species, there are no current threats associated with the scientific study of the species.

The same Forest Plan guideline mentioned above in relation to timber harvest and roads is applicable to mitigate the effects of recreation activities on rare plant populations by providing opportunities to avoid impacts through adaptive management (USDA 2008a).

Dormancy

This plant may exhibit dormancy during certain period in its life cycle. This has been observed in several locations on the Tongass, as large populations have appeared to change from one year to the next. An exact population census has not been performed to accurately conclude that dormancy is a factor. Although dormancy is a natural feature of some orchids, it may be a threat in broad terms because plants may not be found during a particular year's survey for a project area. The area surveyed may be cleared for management activities without knowing the plants exist resulting in inadequate protection of plants that may appear later.

Herbivory and Competitors

Insect and deer-mediated seed predation and herbivory occur in *P. orbiculata* and the impact can be significant. When *P. orbiculata* experienced greater than 25% leaf area damage, the individual died the following year (Cleavitt et al 2016). Individuals that experienced between 15 to 25% leaf damage reverted into an earlier demographic stage. Lower levels (<15%) of leaf damage did not appear to alter the demographic stage of *P. orbiculata* (Cleavitt et al 2016). On an individual plant scale, severe herbivory can remove all photosynthetic parts and disrupt the carbon balance by reduce the amount of carbohydrate production needed for root, tuber, and shoot regeneration. Bud, leaf, and root generation are determined in the year prior, but if leaf tissue is removed then resources may not be available for sustaining new growth.

Slug and fungal infections were the primary agents of leaf damage observed by Cleavitt et al. (2016). Grouse have been observed to dig up and remove the plant entirely and there is evidence of deer exhibiting the same behavior in the Tongass (NRIS 2015). With 53% of the populations on the Tongass National Forest having less than ten individuals, removal of a single individual could have a significant to the population with losing genetic variance.

There is no information of non-native species competitors interacting with *P. orbiculata*. The dark and shady habitat may not be as suitable for many non-natives, however a removal of over story and disturbance of the soil would create favorable conditions for non-native species to infest *P. orbiculata* habitat. Non-native species are more common on the road system within the Tongass National Forest. Of the *P. orbiculata* populations in Alaska, 63% of them have a non-native plant species occurrence within the EO (AKEPIC 2015). On Prince of Wales Island, where the largest number of populations of *P. orbiculata* occur, occurrences of non-native species is frequent on and off the road system, especially in close proximity to human infrastructure. The invasive grass, *Phalaris arundinacea* is very common on Prince of Wales Island along roadsides and is known to establish and form monotypic stands in wetlands displacing native vegetation and altering the soil hydrology and has expanded into muskegs elsewhere in southeastern Alaska (Carlson et al. 2008). It is found at EO 1 (NRIS database: 100554P000441Y12) in the vicinity of *P. orbiculata* and noted to be spreading into the muskeg. *Hieracium aurantiacum* (orange hawkweed) was found near EO 44 (NRIS database: 100554P000334) but on the road. The proximity of roads to *P. orbiculata* populations increases the chance of invasion of any non-native species because roads commonly serve as vectors for their spread. A summary of invasive species that occur within *P. orbiculata* EOs is in Table 5.

Table 5. Invasive species that occur within *Platantherea orbiculata* EOs on the Tongass National Forest. Invasive ranks are scaled from 0 to 100, with ‘0’ representing a plant that poses no threat to native ecosystems and ‘100’ representing a plant that poses a major threat to native ecosystems (Carlson et al. 2008).

Species Name	Common Name	No. of Occurrences	Invasive Rank
Cirsium arvense	Canada thistle	4	76
Cirsium vulgare	bull thistle	21	61
Cytisus scoparius	Scotch broom	1	69

Species Name	Common Name	No. of Occurrences	Invasive Rank
Hedera helix	English ivy	1	73
Hieracium aurantiacum	orange hawkweed	61	79
Hieracium caespitosum	meadow hawkweed	2	79
Leucanthemum vulgare	oxeye daisy	79	61
Lupinus polyphyllus ssp. *polyphyllus*	bigleaf lupine	1	71
Melilotus albus	white sweetclover	1	81
Phalaris arundinacea	reed canarygrass	209	83
Schedonorus phoenix	tall fescue	17	63
Senecio jacobea	tansy ragwort	1	63
Sonchus arvensis	perennial sowthistle	4	73
Tanacetum vulgare	common tansy	4	60

Climate change

As changing climates are already recognized to be affecting habitats and species worldwide (e.g., Parmesan 1996) and the rate of temperature increase in Alaska is approximately double the global average (Chapin et al. 2014), concern over the future status of rare species in the Tongass is warranted. Climate change vulnerability of a species is recognized to be a function of the exposure to (or degree of) climate change that populations will experience, the sensitivity of the species, and the capacity to adapt to the changes (Turner et al. 2003). A number of vulnerability assessment tools have been developed that incorporate all three elements (exposure, sensitivity, and adaptive capacity) such as NatureServe Climate Change Vulnerability Index 2.1 (Young et al. 2011), the U.S. Forest Service System for Assessing the Vulnerability of Species (Bagne et al. 2011), and the Climate Change Sensitivity Database (CCSD 2016). However, these systems require substantially more information than is available on the sensitivity and adaptive capacity of the species, are not appropriate for plants and lichens, or require environmental data not developed for Alaska. Further these three methodologies often do not produce similar vulnerabilities for the same species (Lankford et al. 2014). Due to these limitations, we focus on estimations of the degree of climate change expected in the species' current range (i.e., "exposure") in the Tongass in a qualitative manner and discuss any known or suspected sensitivities and adaptive capacities of the species in a light of the degree of expected change.

"Climate" incorporates a vast array of factors, such as mean annual temperature, summer precipitation, and maximum wind speed for example, of differing importance for any one species. It is impractical to attempt to review all potential factors that compose the climate and we therefore focus on two factors: average summer temperature and average annual precipitation and compare current and predicted 2060 conditions. For most plants and lichens at higher latitudes, summer warmth (or mean July temperature) is well correlated with their distribution (Young 1971, and see Walker et al. 2005), indicating a strong association of the measure with biological limitations. Additionally plants, lichens, and the habitats they are found in are well-known to be sensitive to soil/substrate and air moisture, and mean annual precipitation as a climate variable is expected to be most correlated with substrate and air moisture.

The current and predicted 2060 climates were developed for Alaska and western Canada by the **Scenarios Network for Alaska & Arctic Planning** (SNAP) at University of Alaska Fairbanks (UAF). Climate data generated by SNAP is downscaled using the Parameter-elevation Regressions on Independent Slopes Model (PRISM) from the five best-performing General Circulation Models (GCMs) for Alaska. The data selected for this analysis is derived from the A2 emissions scenario, which represents a realistic future emissions projection based on current trends. Data is available at a 771 m grid. While this resolution is relatively fine-scale, interpretations are restricted to broad regions. Interpretations of micro-climate at population-sized sites for sensitive species are not appropriate. To avoid generalizing trends based on stochastic annual climate events, SNAP has provided decadal averages for all data (Fresco et al. 2014). The decade 2010-2019 is selected to represent the current time frame. The 2060s decade is selected to represent the future time-frame because 50 years in the future is far enough to observe meaningful trends without being so far in the future that it cannot be meaningfully compared to current management objectives.

Southeastern Alaska has a strong Pacific Maritime climate with low variation and relatively warm temperatures and high precipitation, much of which falls as rain at low to mid elevations. Both total annual precipitation and mean annual temperature generally decrease along a south to north gradient through the Tongass National Forest. Mean July temperatures is predicted to increase in the Tongass National Forest from the 2010s to the 2060s by between 1.0 to 2.0°C (**Error! Reference source not found.**). Areas around *Platantherea orbiculata* populations are expected to increase by between 1.6 to 2.1°C in 50 years. The percent change is expected to remain largely constant throughout the region. Mean July temperature is predicted to increase 10 to 20% within the majority of the Tongass National Forest by the 2060s relative to the current mean July temperature (**Error! Reference source not found.**). The populations on Revillagigedo Island are projected to experience the greatest increase in mean July temperature by 2060s.

Annual precipitation is predicted to increase across the Tongass National Forest by the 2060s, but no regional gradients are apparent, largely because of competing patterns for summer and winter precipitation (Figure 9). Annual precipitation is predicted to increase by 9 to 12% for most of the Tongass National Forest. Precipitation is predicted to increase around known populations by between 206 mm at a Prince of Wales location to 430 mm at a Revillagigedo Island location; all populations are expected to experience an increase in annual precipitation of between 9 and 11%. The populations on Revillagigedo Island are projected to experience the greatest increase in precipitation by 2060s.

The physiological limits of *Platanthera orbiculata* are unknown. Additionally, the physiological limits of associated mycorrhizal species is unknown. It is unknown if the species is directly affected by stochastic climatic events such as drought, flooding, or wind. Such events that significantly alter the habitat are more likely to indirectly affect the species. For example, wind throw events that fell trees and open light canopy would alter soil moisture regimes previously discussed. The disturbance of soil around fell trees would lightly impact soil mycorrhizae but not to the extent of large equipment overturning soil from various anthropogenic activities.

It is unknown if the lack of insulating snow at lower elevations that function as protection for plants during winter and spring frosts will affect plants at low elevations. Other plant species on the Tongass exhibit adverse growth and mortality as a result of changes in snow insulation. Hennon and Shaw (1997) hypothesized that Alaska yellow cedar is on the decline due to warmer temperatures in the winter and resulting lack of snow at low to mid elevations. In the Rocky Mountains glaciers are melting and changes in snow melt period change the flowering period of some high altitude plants (Inouye 2008).

Changes in temperature affect phenology as well as the synchronicity of pollinators. With warmer temperatures, flowing may occur earlier when pollinators are not yet present. Overall, the effects of a changing climate on the forest ecosystems of southeast Alaska is under investigation. However, the general threats include increased predation by insects due to increases in pest outbreaks under warmer conditions; increased competition of exotic species; changes in flowering times and synchronicity with pollinators; and decrease or absence of fungal symbionts due to increased soil temperature and moisture regimes, (Argue 2012).

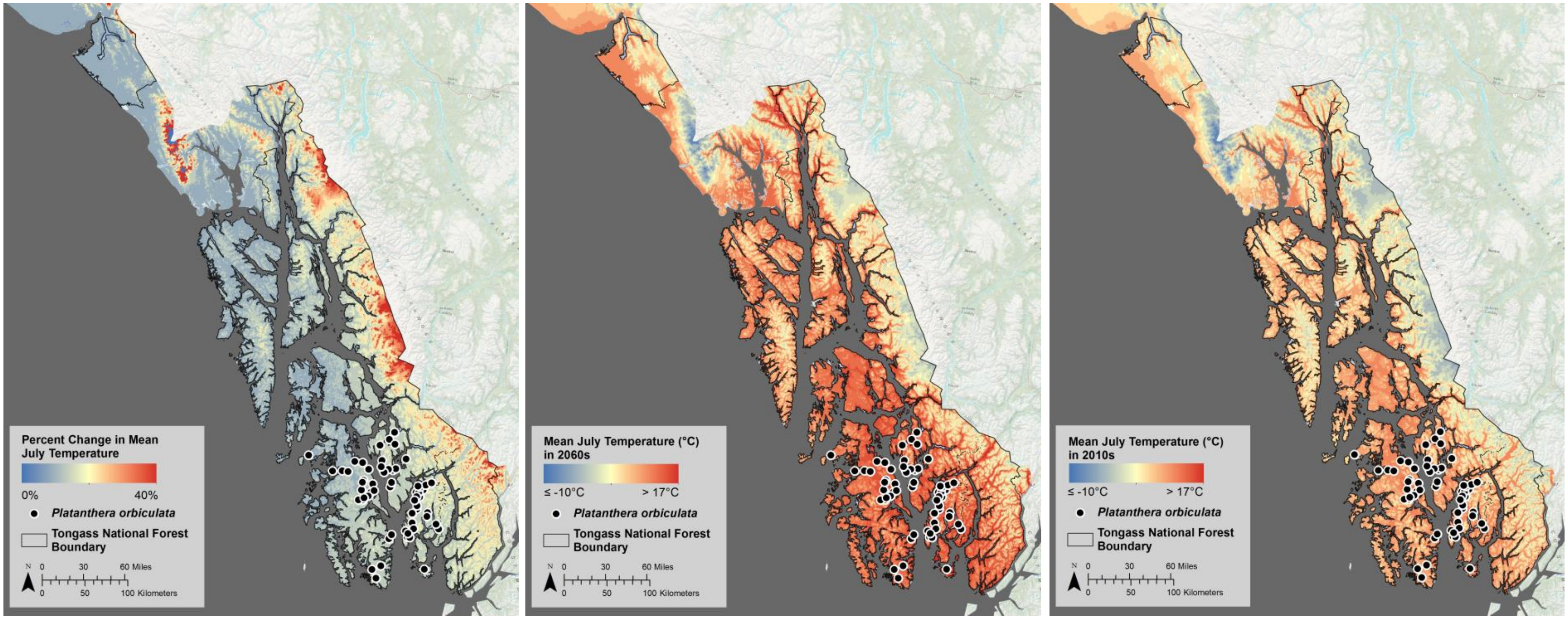

Figure 8. Current (top left), predicted 2060 (top right) and percent change (bottom right) in mean July temperature (˚C) in the Tongass National Forest. Locations of *Platanthera orbiculata* populations are shown as black dots.

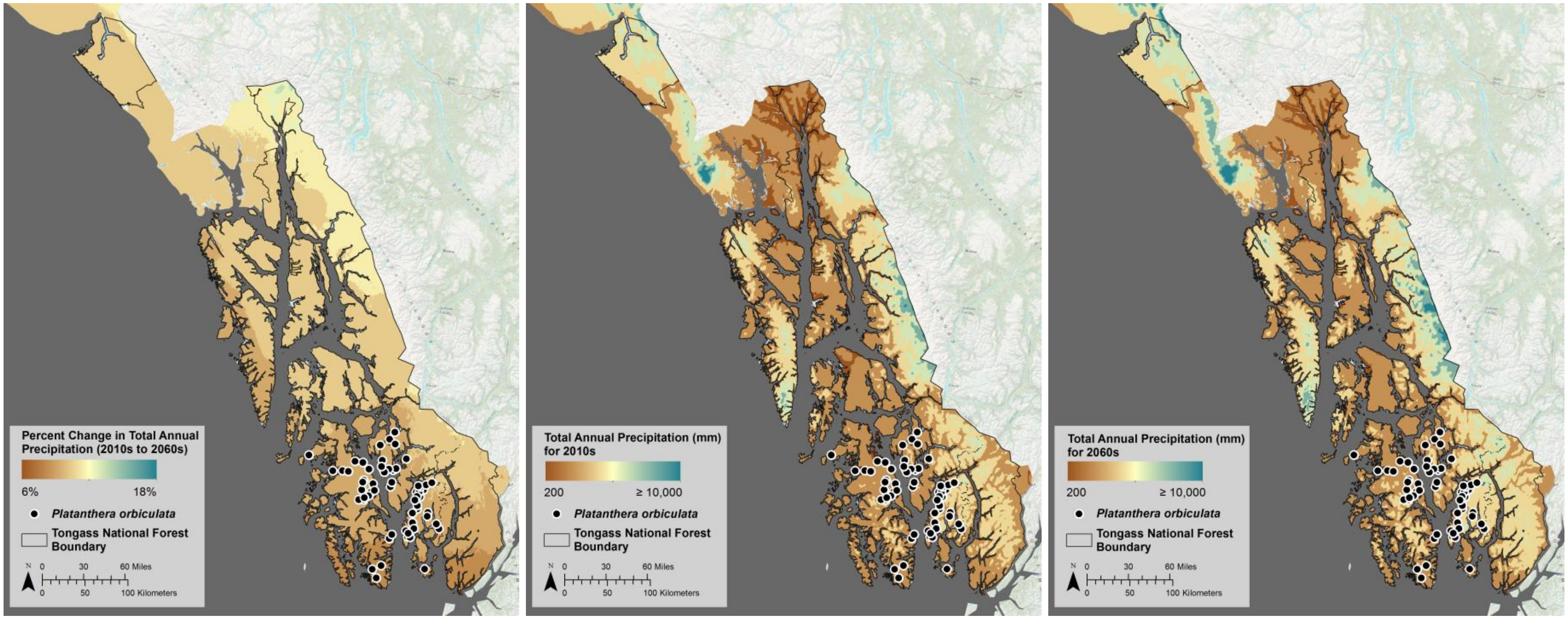

Figure 9. Current (top left), predicted 2060 (top right) and percent change (bottom right) in mean annual precipitation (mm) in the Tongass National Forest. Locations of *Platantherea orbiculata* populations are shown as black dots.

Conservation Status of Platanthera orbiculata on the Tongass National Forest

Long term and established population monitoring of *Platanthera orbiculata* has not been conduction on the Tongass National Forest. Site revisits to *P. orbiculata* are infrequent and inconsistent. Overall, population trend and abundance of *P. orbiculata* on the Tongass National Forest is a data gap.

The limited population trend data that are available suggests a significant downward trend of the species on the Tongass. However, there are limitations to the data to draw conclusions. For example, one occurrence on the Ketchikan Ranger District first reported to contain over 1000 plants in 2004 but a revisit two years later documented roughly only 100 plants (Trimble 2005, Stensvold 2006). The decrease in population size is unknown, but it could be attributed to dormancy, flawed survey methods, or actual population decline. The population fluctuation could be attributed to the dormancy period of the species, where it is cryptic by being below ground and showing no visible signs above ground. However, it would be unlikely for over 90% of the population to go into dormancy at the same time frame unless the population experienced significant herbivory. Additionally, dormancy of *P. orbiculata* in eastern U.S. forests was rarely observed and unknown for the Tongass populations. The initial survey may have made errors in population estimation or data recording. Alternatively, the population did significantly decrease during that time and another population census is warranted. A single population revisit is insufficient for population trend analysis or meaningful conclusions of cause and effect relationships of the species to its environment.

To resolve this limitation, a small pilot monitoring effort was made on Prince of Wales Island. The study found a 57% decrease in population density (individuals/ha) over a three year period (USFS 2013, 2014). The density decreased with a reduction first by 42%, and then followed by an additional 26% decrease (USFS 2013, 2014). The cause for the trend is unknown; however one monitoring plot was directly affected by timber harvesting practice (USFS 2013, 2014). The pilot study provides more consistent data than NRIS data, but lacks statistical power and methodology to draw meaningful conclusions. Future population studies should incorporate methods described below.

Platanthera orbiculata is moderately associated with wetland habitat and forested wetlands and also found in old growth forests. The variability of *P. orbiculata* habitat indicates that this orchid can survive in multiple habitats and it may survive at one location long enough for a plant community to change through succession. Forest stands where the species is found is often suitable for timber harvest and substantial timber harvest and road construction has occurred across the range of the species distribution on the Tongass National Forest. This has likely resulted in a long-term downward trend in habitat quality and quantity as these activities significantly impact *P. orbiculata* habitat, specifically soil-mycorrhizae and light requirements. The amount and distribution of compatible mycorrhizal, sufficient carbon supply, and favorable seed germination are limiting factors for orchids. These impacts generally last for several decades as the necessary mycorrhizae fungi that orchids require to survive take many years to regenerate and recover from such impacts. This would inhibit the growth of current individuals, but also any new potential recruits. Additionally, since orchids can absorb additional carbon and carbohydrate sources from neighboring trees, the removal of the tree community would have an additional indirect impact on the vitality and vigor of *P. orbiculata*. The species is not visible during the dormancy cycle does, making finding and identifying the species in a given location during TESP survey difficult and possibly leading to erroneous negative-presence data.

These life history aspects make *P. orbiculata* sensitive to changes in the habitat. All of the populations on the Tongass National Forest are located in development LUDs within past and present timber harvest planning areas and may place some pressure on the species.

Potential Management of **Platanthera orbiculata** *on the Tongass National Forest*

With the added protection of rare plants in the recent Tongass Land Management Plan (USDA 2007 and USDA 2016), future occurrences of this plant and other rare plants in timber units and road right of ways will receive greater protection. The recent (2016) management plan has a broad recommendation of avoiding or minimizing adverse effects to rare plants and their populations. Additionally, the plan suggests protecting the habitat needs of the species around the population. Although Forest Plan standards and guidelines include recommendation for protection around known occurrences of sensitive and rare plant species, implementation of this protection is not a requirement (USDA 2008a). The National Forest System Land Management Planning Rule was revised in 2012 and under the new regulations, the Forest Service The National Forest Management Act requires that plans provide for diversity of plant and animal communities (16 USC 1604 (g)(3)(B)). The new regulations mandate plans to provide the ecological conditions necessary to contribute to the recovery of federally listed threatened, endangered, or candidate species.

Currently on the Tongass National Forest, all *P. orbiculata* populations are within or overlap with development land-use designations (LUDs) and non-development LUDs. However, of the total acres occupied by *P.orbiculata* populations, 56% of the acres occur in development LUDs (Table 6). If some of the largest populations (e.g., EO 1) suffered a 57% decrease in population size due to development LUD activity (as observed in pilot monitoring), the population would suffer a significant loss of over 500 individuals. Depending on the specific activity, these large populations may be broken into smaller and fragmented subpopulations. With over half of the populations having less than ten individuals, these small populations would be at a greater risk to extinction from development and other activities due to the smaller occupied area. Even the loss of a single individual would greatly impact the genetic variability of such small populations. Small populations are inherently subjected to loss of genetic variability in the short term that affect individual fecundity and population demography (inbreeding depression), but also the long term viability is affected by a loss of adaptability to environmental changes or other selection pressures.

Table 6. Populations of *Platantherea orbiculata* occurring within land-use designations (LUDs) on the Tongass National Forest. All populations of *P. orbiculata* occur within a development or non-development LUD.

No. Pops on Tongass N.F.	Total Pop Acres Within Development LUDs	% Acres Within Development LUDs	Total Pop Acres Within Non-Development LUDs	% Acres Within Non-Development LUDs
60	56,490	56	44,305	44

Due to the variable habitat requirements, there is no particular population on the Tongass that is inherently vulnerable to land management. However, concern would be highest in locations with a documented low number of individuals, those populations on the periphery range of the regional distribution, or those in uncommon habitats. These populations may contain diverse genetic material that contributes to the species distribution and warrant greater protection.

Considerations should be made to mitigate management activities that overturn and alter the soil or remove overstory canopy cover in areas with known *P. orbiculata*. While there are no direct or specific studies on anthropogenic effects to *P. orbiculata*, land use activities that significantly alter the habitat would likely have negative consequences to the species. As mentioned earlier, *P. orbiculata* populations that experienced clear cut logging activities within and in adjacent habitat, experienced significant population declines.

The recent (2016) Tongass Forest Management Plan for Sensitive species recommends avoiding known rare plant populations during project activities, directional falling of trees away from rare plants, and/or partial retention of forest structure (25 to 50 percent of the basal area) in the area around rare plants in forested habitats. Given what is known about the fragility of associated soil mycorrhizae, avoiding known rare plant populations during land use activities would create the strongest protection of *P. orbiculata* populations on the Tongass National Forest. Directional falling of trees may directly protect the species, partial removal of the forest canopy layer would indirectly negatively affect *P. orbiculata* populations. The increased amount of light affect soil moisture and increase competition of associated plant species. Additionally, any land use activity provides a pathway for non-native plant species and disturbed habitat enhances their establishment.

Insecticide spraying has the potential to harm mutualist pollinator species, indirectly harming *P. orbiculata*. The misapplication or mis-targeted spraying of insecticide may harm the pollinators of *P. orbiculata*, specifically nocturnal moths. Herbicide spraying could directly harm *P. orbiculata*, if precautions are not made. Current guidelines require a 60 foot buffer for ground application and 600 foot for aerial application near Sensitive species in their habitat (USDA 2016). The required buffer is likely sufficient in protecting *P. orbiculata* from accidental spraying, but manufacture’s recommendations should also be followed if larger buffers are needed.

Management Recommendations from Other Regions
This orchid was part of the Survey and Manage Pacific Northwest Forest Plan in the 1990's (USDA 1994). It is presently not considered sensitive in Region 6, but was previously considered a monitor species by the state of Washington in the late 1990's (WNHP 1997). At that time, large areas of forested lands along I-90 were planned to be commercially thinned, and *P. orbiculata* was found to occur in these areas (Fuentes et al 2002). Buffers were recommended around existing populations of *P. orbiculata* that were twice the height of the average tree on the site. This was prescribed in order to maintain the microclimate for the orchid such as the associated duff layer, and the shade and hydrological regime. The ecology program managers planned to monitor the effectiveness of these recommendations (Fuentes et al 2002).

The management practices in the Black Hills of South Dakota are unlikely to affect the habitats of *P. orbiculata* in this region. Habitats are too steep for logging and the overstory trees are less desirable timber product (Hornbeck et al 2003). However, road building has a potential to indirectly affect the orchid and its habitat. The birch stands where this orchid tends to occur, act as natural fire breaks. Prescribed burning, patch cutting and selective thinning of dense conifer stands are used to create a mosaic of seral stages. This results in patches of paper birch that provide firebreaks, and potential habitat of the orchid.

Tools and Practices
Occurrence documentation of *P. orbiculata* and other Sensitive species of interest use The Threatened, Endangered and Sensitive (TES) Plant Protocol where data are collected and entered in the NRIS database (USDA 2008b). The TES Plant Protocol is a robust method for documenting TES species and their habitat and follows a similar protocol by NatureServe and the Heritage Program Networks. The protocol is thorough in gathering population delineations, using consistent Site IDs for occurrences, canopy cover, population size, site morphometry, soil characteristics, vegetation classification, habitat quality, and associated species. These data are essential for understanding biology, ecology, distribution, and rarity of the species. These data were essential for the writing of this assessment. The TES data collected on the Tongass can be improved by having biologists trained on the TES Plant Protocol and emphasize completely filled out TES forms. Many occurrence records had incomplete records or incorrect data such as wrong or inconsistent dates, population sizes information missing, no associated species or vegetation classification missing, or various incomplete site morphometry data.

Documenting changes in the stability of populations over time is a central component to Sensitive species management. Continual population monitoring of *P. orbiculata* has not been conduction on the Tongass National Forest. Clearly there is a need for a systematic population monitoring plan to determine population trends on the Tongass National Forest and to identify the significance of dormancy to the species. As mentioned earlier, only a few populations have been revisited and NRIS data has not been consistently recorded. The population on Revilla Island appears to fluctuate drastically from 1800 individuals to just a few hundred in follow up visits years later. Dormancy of *P. orbiculata* in eastern U.S. forests was rarely observed, but appears to occur in Tongass populations or dramatic population declines are occurring. Without a monitoring program in place, population persistence and effects of land use will continue to be a data gap.

Conducting habitat and population monitoring at the same time would efficient and provide data on the population and habitat as a whole. A pilot monitoring program started in 2011 was in effect for one population on Prince of Wales Island and has provided some important baseline population trend data. However this study had a small sample size, therefore limiting the statistical significance to draw meaningful conclusions.

A non-standard way of a monitoring practice, element occurrence revisit, is currently occurring on the Tongass National Forest as recommended by TES Plant Protocol. These revisits are useful in providing additional data such as population sizes and demography as well as notes on ecological and habitat disturbances. Site visits and revisits are problematic, however, in that biologists do not always collect the same information or complete information and therefore do not allow for making valid comparisons between the observations. The number of site revisits is also relatively small with less than five populations being revisited on the Tongass.

A standardized monitoring program across several populations would help confirm effective management practices, identify baseline trends that can be used to predict future changes, learn how different management practices affect the land, and confirm current management practices. Trends and changes in population may be linked to management practices or changes in climate. Monitoring of the habitat would show indicators of change more quickly than just monitoring of the *P. orbiculata* only. This would capture changes to the habitat such as management practices, disturbances of natural causes (e.g., windthrow or herbivory), presence on non-native species, and anthropogenic disturbances (e.g., off-road vehicle, trail and recreational use). The exact habitat parameters of *P. orbiculata* are not well understood and gathering baseline habitat data in a standardized way between many populations would show trends in occupied habitat by using statistical analyses such as ordination techniques. An effective monitoring program should include multiple populations across the Tongass for statistical purposes. Specific efficient inventorying and monitoring methods of rare plants and habitat are discussed elsewhere (*see* Noss 1990, Manley et al. 2006, Vesley et al. 2006).

A monitoring program would be beneficial to land managers by providing data to determine demography and conduct a Viability Analysis. Monitoring of *P. orbiculata* is challenged by its dormancy phase and aerial stems are not produced every year, but leaves may be visible. Monitoring would be best performed during the peak flowering time of the species in early-July, but can be generally done in June or July and can extend to August if necessary. Flowering is not necessary for identification, but helpful in finding the species in the population. While there are multiple methods for rare plant monitoring, implementing a program to track individual plants would provide the most data that fills current data gaps of *P. orbiculata*. Small fixed labels or pins on a random sample of individuals in the population would be one of the most beneficial aspects to a monitoring program and start a demography study for the species. This would allow the tracking of the dormancy of individuals that would provide better estimate population sizes than relying on fluctuating data. It would also allow the tracking of flowering and reproductive success for a few individuals in addition to the population as a whole. Lastly, tracking the plant in various life history stages would further train individuals on identification. Alternatively, established line intercept transects can capture similar data of *P. orbiculata* population census with a less chance of losing samples due to not being able to find specific individuals again but loses the resolution of individual life cycles. Line intercept transects can also be used to monitor changes in vegetation and hydrology. However without fully understanding the dormancy cycle or physical attributes of dormancy stages of *P. orbiculat*, population estimates may have a high rate of error.

Habitat modeling of *P. orbiculata* can be performed, however the models would likely be coarse in nature and the model limitations can be easily overlooked and taken out of theoretical context when applied to land management needs. Environmental variables of greatest predictive value are not available on a regional scale for Alaska and mapping scale may be too broad of habitat categories. GIS data from occurrences mapped in the Tongass National Forest database are available, but not all occurrences contain sufficient data for to confidently identify the orchids' affinity to a particular habitat. For example, there is no GIS data that maps bryophyte cover on the forest floor, or availability of decaying wood, both of which have shown to be associated with *P. orbiculata*. These particular microhabitats create difficulties in creating robust habitat models. Simple broad scale data of climate such as temperature, precipitations, elevation, and vegetation classification data can create suitable habitat maps, though lower in confidence and robustness.

Increasing awareness among USFS personnel and educating field staff in identifying the species would increase identification accuracy and survey efficiency. A rare plant field guide targeted to Region 10 would be beneficial to USFS staff to aid in Sensitive Species identification. A Sensitive Species guide made of laminated cards and field notebook size were developed by the USFS Region 10 in 1995 (USDA Forest Service 1995) for southeastern Alaska, however this should be updated with accurate information and be more encompassing to include similar species. The Alaska Natural Heritage Program developed the Alaska Rare Plant Field Guide (Nawrocki et al. 2014), however species were concentrated for BLM lands but some Region 10 species are included in the guide. The manual includes illustrations of plants and habitat, physical descriptions, habitat descriptions, flowering/fruiting times, taxonomic guides, and known locations.

Seed banking conservation may not be practical for *Platanthera orbiculata*. Seeds of terrestrial orchids are often difficult to germinate in controlled settings (Arditti et al. 1981). Additionally, *P. orbiculata* has very low success rate of germination and seedling establishment success (Smreciu and Currah 1989, Zettler et al. 2005). Furthermore, on the rare chance germination is successful in *P. orbiculata*, less than 3% of seeds develop into leaf-bearing seedlings (Smreciu and Currah 1989). Low successful germination has attributed to lack of required mycorrhizal fungi. Specific species of mycorrhizal fungi must be present to germinate and grow orchids in a greenhouse, and the transfer of greenhouse grown orchids to occurrence sites will disrupt the mycorrhizal associations. Seed survival is variable for orchid species but a short time span of 1-3 years is typical, but up to seven years has been observed for select species (Wigham et al 2005). Given the low germination success, seedling survival, relatively short seed life span, a cost-benefit analysis would be warranted before seed banking of *P. orbiculata* is implemented.

Information Needs

The Tongass National Forest supports nearly all of the known occurrences of *Platanthera orbiculata* in Alaska. Its long term persistence on the Forest and in Alaska is difficult to evaluate or predict. Little is known about the plant's demographics, threshold level for viability, and specific habitat requirements in Alaska. This assessment summarizes habitat data from roughly 50% of the field notes taken from known occurrences. The remaining field notes were not available during the preparation of this document. GIS data from occurrences mapped in the Tongass database are available, but not all occurrences contain sufficient data for all the environmental variables to confidently identify the orchids' affinity to a particular habitat. Furthermore, the environmental variables derived from GIS inventories (e.g., soils, landform, slope, geology, and climate) and their associated mapping scale may be too general to accurately model the preferred habitat.

While dormancy was found to be rare in a northeastern forested population (Cleavitt et al 2016), the disappearance or drastic fluctuations observed in populations on the Tongass support the hypothesis that dormancy is prevalent in the Tongass populations. Little information exists as to the degree of dormancy this orchid displays in the temperate rainforest of Alaska. In some cases it may not be detected during botanical surveys, yet may become visible after surveys are completed and activities begin years later. Known occurrences have not been monitored on a regular basis to determine the percent of dormancy. Temporal variation in the degree of dormancy in a given population probably depends on climatic cues that are unpredictable and immeasurable at this time.

In summary, the information needs for *Platanthera orbiculata* are the following:

1. What are the habitat requirements and how can they accurately be mapped?
2. Does habitat limit the distribution and abundance of this species on the Tongass N.F., or in significant portions of the range in the Alaska Region?
3. What spatial or temporal factors preclude this orchid to be found across all of southeastern Alaska?
4. What dominant factors influence the distribution and abundance of this species at different scales over time and space, especially on the Tongass N.F?
5. What is the overall viability threshold of this species across the planning area (e.g., the Tongass N.F.)?
6. How do habitat conditions influence the environmental capacity to support important species and their interactions with this species?
7. What are the important differences among habitats that will allow land managers to predict habitat quality for this species?
8. What are the physiological limits of the species and associated mycorrhizal species?
9. What is the dormancy period for individuals in a population?

10. What are the pollinator species of *P. orbiculata* on the Tongass?
11. In the Alaska Region, is the abundance of this species declining?
12. What life history characteristics significantly influence changes in distribution and abundance? (e.g., dormancy)
13. Are broad scale dispersals especially important to the demography or distribution of this species?
14. Are laws and regulations clearly inadequate to conserve the species?
15. Is enforcement clearly inadequate to contribute toward conservation of the species?
16. Are regulatory mechanisms and their enforcement inadequate to conserve the species?
17. What types and sizes of buffer zones around the species are adequate for protection?
18. Does disease or predation threaten persistence of the species in Region 10 or the Tongass?

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DEFINITIONS

Capsule – dry, dehiscent fruit.

Effectiveness monitoring – monitoring that determines if management activities are effective in producing desired conditions.

Hummic -–

Implementation Monitoring – monitoring that determines if management activities are designed and carried out in compliance with forest plan direction and management requirements.

Labellum – the pouch or lip of the orchid flower derived from a modified petal.

Mycorrhizae – symbiotic relations of plant roots and fungi.

Perennial – a plant that normally lives for more than two seasons.

Phenotypic plasticity – the capacity for marked variation in the morphology of an organism as a result of environmental influences.

Protocorm – a pre-rhizoid structure that develops from the germinating embryo putatively with a fungal symbiont and from which roots and shoot eventually develop.

Ramet – a member of a clone such as rooted cuttings or rhizomatous shoots that are identical genetically but can live independently.

Rhizomatous – possessing underground stems that often produce roots and shoots.

Self-sustaining populations – populations that are sufficiently abundant, interacting, and well distributed in the plan area, within the bounds of their life history and distribution of the species and the capability of the landscape to provide for their long-term persistence, resilience, and adaptability over multiple generations.

Sensitive species – those species for which population viability is a concern and identified by a regional forester as requiring special management as directed in FSM2670.

Seral – pertaining to an early stage of succession.

Symbiont – an organism that interacts in a relation with another organism − maybe, but not always, to their mutual benefit.

ACKNOWLEDGEMENTS

This assessment was originally authored by Karen Dillman who complied habitat and population data for this assessment. The authors would like to thank peer review from the Tongass National Forest Botanists and Ecologists who comments greatly improved this manuscript. We thank the Tongass National Forest for supplying necessary data to complete this assessment. We thank the Flora of North America Association and illustrator Barbara Alongi for allowing the use of the *Platantherea orbiculata* illustration in this assessment. Timm Nawrocki created Figures 3, 4, 8, and 9.

AUTHORS BIOGRAPHIES

The current version of the *Platanthera orbiculata* Conservation Assessment was revised by the Botany Program of Alaska Natural Heritage Program (AKNHP), University of Alaska Anchorage (UAA). The AKNHP collects, synthesizes, and validates information on Alaska's animal and plant species of concern and their habitats, ecosystems of concern, and invasive species. This information is provided by AKNHP to government, business, land managers, scientists, conservation groups, and the public.

The botany program conducts research on the biology of rare and invasive plant species and participates in citizen science initiatives. The program is directed under Dr. Matthew Carlson, who also teaches in the Department of Biological Sciences at UAA. Areas of research expertise for the botany program include habitat modeling, biogeography of rare and invasive plants, reproductive ecology and evolution, and ecological impacts of non-native plants. The botany program also offers a wide range of related services including field surveys, monitoring studies, mapping, and conservation planning services. The AKNHP botany program also manages the University of Alaska Anchorage Herbarium (UAAH) which holds an extensive representation of Alaska's flora, including rare Alaskan plants, non-native plants, and cryptograms. Over 14,000 specimens are in the collection and can be viewed online at: http://www.pnwherbaria.org/

The botany program has extensive experience with rare plant conservation in Alaska and is an authority figure for assigning state level conservation ranks. Notably, the Alaska Rare Plant Field Guide has been published to aid in the identification, distribution, and ecology for plants of conservation concern in Alaska. The botany program is also the central repository of biological information on Alaska's rare and invasive plant species and tracks over 600 plant species. Lists of vascular plants and lichens of conservation concern of selected rare plants of Alaska are located on the Rare Plant**s** page. AKNHP works closely with botanists across Alaska in an effort to ensure the most comprehensive and accurate data sets.

Appendix A

List of *Platanthera orbiculata* Element Occurrence records on the Tongass National Forest.' NRIS Site_ID' is the Site ID code in the NRIS database that associates data point. 'EO #' is the population number assigned by AKNHP to track rare plant records. Populations are defined by occurring ≤ 1 km from each other (NatureServe 2002). The NRIS database was projected into GIS and each polygon of *P. orbiculata* was extracted. A buffer of 1 km was created for each *P. orbiculata* record. Records that overlapped were merged and assigned an EO # to distinguish the population.

SITE_ID	EO#	DATE_COLLECTED	SITE_NAME
100554P000046	1	5/25/1996	
100554P000042	1	5/26/1996	
100554P000122	1	6/3/2009	Big Thorne Unit 136
100554P000121	1	6/3/2009	Big Thorne Unit 136
100554P000110	1	6/9/2009	Big Thorne Units 93, 94
100554P000058	1	6/12/2009	
100554P000111	1	6/17/2009	Big Thorne Unit 70
100554P000133	1	6/19/2009	
100554P000059	1	6/26/2009	Big Thorne Unit 113
100554P000062	1	6/26/2009	Big Thorne Unit 116
100554P000061	1	6/26/2009	Big Thorne Unit 113
100554P000063	1	6/26/2009	Big Thorne Unit 114
100554P000060	1	6/26/2009	Big Thorne Unit 113
100554P000124	1	6/27/2009	Big Thorne Unit 130
100554P000127	1	6/27/2009	Big Thorne Unit 129
100554P000125	1	6/27/2009	Big Thorne Unit 129
100554P000128	1	6/27/2009	Big Thorne Unit 129
100554P000123	1	6/27/2009	Big Thorne Unit 130
100554P000126	1	6/27/2009	Big Thorne Unit 129
100554P000116	1	6/30/2009	South of Big Thorne Unit 121, off of 3015050
100554P000118	1	6/30/2009	
100554P000117	1	6/30/2009	Big Thorne Unit 121
100554P000119	1	6/30/2009	Control Creek, South of Campground Road
100554P000120	1	6/30/2009	Balls Lake Boardwalk Trail
100554P000114	1	8/17/2009	Big Thorne Unit 70
100554P000115	1	8/17/2009	Southeast of Beavertail TS
100554P000112	1	8/17/2009	Big Thorne Unit 69
100554P000137	1	8/17/2009	South of Big Thorne 128
100554P000136	1	8/17/2009	South of Big Thorne 128

SITE_ID	EO#	DATE_COLLECTED	SITE_NAME
100554P000113	1	8/17/2009	Between Big Thorne Units 69 and 70
100554P000354	1	5/11/2010	N. Thorne muskeg
100554P000350	1	5/12/2010	Rush Peak 110
100554P000351	1	5/12/2010	Rush Peak 111
100554P000352	1	5/12/2010	Rush Peak 107
100554P000353	1	5/12/2010	Rush Peak 107 stream
100554P000318	1	6/8/2010	Big Thorne unit 52
100554P000317	1	6/8/2010	Big Thorne unit 51
100554P000319	1	6/8/2010	Big Thorne unit 52
100554P000314	1	6/9/2010	Big Thorne Unit 48 PLOR
100554P000313	1	6/9/2010	Big Thorne Unit 48
100554P000321	1	6/14/2010	Big Thorne Unit 141 PLORa
100554P000322	1	6/14/2010	Big Thorne Unit 141 PLORb
100554P000179	1	6/15/2010	BT Unit 92
100554P000177	1	6/15/2010	BT Unit 93
100554P000176	1	6/16/2010	Big Thorne Unit 92
100554P000312	1	6/16/2010	Big Thorne unit 83
100554P000341	1	6/17/2010	Thorne Bay Unit 124
100554P000304	1	6/17/2010	Big Thorne Unit 124 PLORa
100554P000355	1	6/17/2010	North Thorne BT Unit 124
100554P000305	1	6/17/2010	Big Thorne Upper unit 123
100554P000310	1	6/17/2010	Big Thorne Upper Section Unit 123
100554P000324	1	6/20/2010	Big Thorne units 139-140
100554P000325	1	6/20/2010	Big Thorne units 139-140
100554P000323	1	6/20/2010	Big Thorne units 139 - 140
100554P000308	1	7/1/2010	Big Thorne unit 106
100554P000326	1	7/2/2010	Big Thorne Units 118, 119
100554P000311	1	7/8/2010	Thorne River MP2
100554P000303	1	7/9/2010	Big Thorne units 100-104
100554P000175	1	7/13/2010	BT unit 146-147
100554P000301	1	7/14/2010	Big Thorne unit 120
100554P000199	1	7/14/2010	Big Thorne Units 142, 143 PLOR
100554P000302	1	7/14/2010	Big Thorne unit 120
100554P000300	1	7/14/2010	Big Thorne unit 120
100554P000196	1	7/16/2010	
100554P000192	1	7/16/2010	Big Thorne Units 160-1,174-6
100554P000184	1	7/20/2010	Big Thorne Unit 123
100554P000188	1	7/20/2010	Big Thorne Unit 123

SITE_ID	EO#	DATE_COLLECTED	SITE_NAME
100554P000189	1	7/20/2010	Big Thorne Unit 123
100554P000185	1	7/20/2010	Big Thorne Unit 123
100554P000187	1	7/20/2010	Big Thorne Unit 123
100554P000194	1	7/21/2010	Rio Roberts Ext. PLOR
100554P000190	1	7/23/2010	Thorne River Bridge
100554P000197	1	8/3/2010	East of Eagles Nest PLOR1
100554P000198	1	8/3/2010	East of Eagles Nest PLOR2
100554P000166	1	8/11/2010	North Rio Roberts PIUN
100554P000167	1	8/11/2010	North Rio Roberts pt PLR 9
100554P000171	1	8/11/2010	North of Rio Roberts PLR1 and 2
100554P000168	1	8/11/2010	North Rio Roberts pts PLR8, 8-2, 8-3
100554P000169	1	8/11/2010	North Rio Roberts pts PLR5, 6, 7
100554P000170	1	8/11/2010	North rio Roberts PLR3, 3-2, 3-2, 3-3, 4
100554P000160	1	8/20/2010	South Thorne River estuary
100554P000156	1	8/25/2010	
100554P000182	1	8/25/2010	Cuthroat Lakes pts PLOR2
100554P000183	1	8/25/2010	Cuthhroat Lakes PLOR
100554P000153	1	8/25/2010	3005200 muskegs
100554P000152	1	8/25/2010	3005200 muskegs
100554P000435	1	5/17/2011	
100554P000274	1	6/22/2011	POW Big Thorne 502
100554P000273	1	6/22/2011	POW Big Thorne 502
100554P000275	1	6/22/2011	POW Big Thorne 502
100554P000277	1	6/23/2011	POW Big Thorne 421
100554P000279	1	6/30/2011	
100554P000291	1	7/20/2011	
100554P000292	1	7/20/2011	
100554P000401	1	8/6/2011	
100554P000402	1	8/6/2011	
100554P000400	1	8/12/2011	POW Big Thorne unit 516
100554P000299	1	8/12/2011	POW Big Thorne unit 516
100554P000436	1	10/4/2011	POW, Rio Beaver, Big Thorne #501
100554P000441Y12	1	5/24/2012	
100554P000447Y12	1	7/12/2012	Thorne Bay LTF
100554P000509Y13	1	8/14/2012	Prince of Wales, North Thorne Drainage, Near BT 77
100554P000508Y13	1	7/25/2013	POW, North Thorne Drainage, Access to BT unit 77

SITE_ID	EO#	DATE_COLLECTED	SITE_NAME
100554P000408	2	8/23/2011	
100554P000406	2	8/23/2011	
100554P000287	3	7/8/2011	
100554P000286	3	7/8/2011	
100554P000346	4	5/26/2010	Big Thorne units 183-189
100554P000345	4	5/26/2010	Big Thorne units 183-189
100554P000348	4	5/26/2010	Big Thorne units 183-189
100554P000347	4	5/26/2010	Big Thorne units 183-189
100554P000142	4	7/28/2010	PLOR North BT Unit181
100554P000144	4	7/29/2010	PLOR-E181A
100554P000445Y12	4	8/15/2012	Sandy Beach Coastal Mountain
100554P000149	5	8/11/2010	Anderson Creek PIUN
100554P000151	5	8/11/2010	Anderson Creek PLOR
100554P000051	6	8/10/2005	
100554P000155	6	8/10/2010	PLOR-Karta
100554P000173	6	8/12/2010	Karta Lake Trail
100554P000172	6	8/12/2010	Salmon Lake to Rush Peak Road
100554P000420	7	5/27/2011	
100554P000416	7	5/31/2011	
100554P000442	7	5/31/2011	Unit 52
100554P000131	8	6/11/2009	Big Thorne Unit 252
100554P000138	8	5/26/2010	Muskeg North of Luck Lake, Big Thorne 253
100554P000281	8	7/11/2011	POW Big Thorne 469-472
100554P000294	8	7/28/2011	Big Thorne unit 572
100554P000295	8	7/28/2011	POW Big Thorne unit 465
100554P000296	8	7/28/2011	POW Big Thorne unit 465
100552P000067	9	7/21/1998	
100552P000083	9	6/25/1999	
100552P000084	9	7/6/1999	
100552P000088	9	7/14/1999	
100552P000082	9	8/9/1999	
100552P000142	9	7/14/2000	
100552P000269	9	8/15/2006	
100552PT00014	9	7/24/2008	Gravina edge cent gravina u132
100552PT00016	9	7/25/2008	Gravina vallenar ck unit 130
100552PT00015	9	7/25/2008	Gravina, Vallenar Creek. near unit 130
100552PT00027	9	7/31/2008	Gravina near unit 16
100552PT00018	9	7/31/2008	Gravina Vallenar Creek Unit 130

SITE_ID	EO#	DATE_COLLECTED	SITE_NAME
100552PT00028	9	7/31/2008	Gravina near unit 16
100552PT00023	9	7/31/2008	Gravina Unit 16
100552PT00026	9	7/31/2008	Gravina near Unit 16
100552PT00019	9	7/31/2008	Gravina Vallenar Creek Unit 130
100552PT00029	9	7/31/2008	Gravina near unit 16
100552PT00021	9	7/31/2008	Gravina, Unit 16
100552PT00024	9	7/31/2008	Gravina Unit 16
100552PT00020	9	7/31/2008	Gravina Near Unit 16
100552PT00030	9	7/31/2008	Gravina near unit 16
100552PT00032	9	8/1/2008	Gravina betw unit 30,33
100552PT00035	9	8/1/2008	Gravina E of unit 33
100552PT00031	9	8/1/2008	Gravina near unit 35
100552000295	9	6/18/2009	cent grav unit 15
100552P000292	9	6/18/2009	cent gravina unit 15
100552P000291	9	6/18/2009	Central Gravina Unit 15
100552P000293	9	6/18/2009	cent grav unit 15
100552P000295	9	6/22/2009	
100552P000297	9	6/22/2009	
100552P000298	9	6/26/2009	
100552P000299	9	6/26/2009	
100552P000300	9	6/26/2009	
100552P000304	9	7/14/2009	
100552P000313	9	7/14/2009	
100552P000305	9	7/14/2009	5
100552P000303	9	7/14/2009	
100552P000086	10	4/1/1999	
100552P000085	10	7/8/1999	
100552PT00004	10	6/13/2008	Gravina I central near Unit 134
100552PT00003	10	6/13/2008	Gravina I central near unit 134
100552PT00005	10	6/13/2008	Gravina I central near unit 134
100552P000089	11	7/28/1998	
100552P000091	11	7/29/1998	
100552P000092	11	7/29/1998	
100552P000267	12	7/27/2006	
100552P000268	12	7/27/2006	
100552PT00007	12	7/17/2008	Lunch creek lower trail up hill
100552PT00012	12	7/17/2008	lower lunch ck trail up hill
100552P000006	12	7/17/2008	Luch Creek Lower Trail by beach
100552PT00011	12	7/17/2008	lower lunch ck trail uphill

SITE_ID	EO#	DATE_COLLECTED	SITE_NAME
100552PT00010	12	7/17/2008	Lunch Creek lower trail up hill
100552P000004	12	7/17/2008	Lunch Creek
100552PT00008	12	7/19/2008	Lunch creek lower trail uphill
100552PT00009	12	7/19/2008	lower lunch ck trail uphill
100552P000281	13	9/6/2006	
100552P000282	13	9/6/2006	
100552P000283	13	9/6/2006	
100552P000284	13	9/6/2006	
100552P000285	13	9/6/2006	
100552P000276	14	9/5/2006	
100552P000277	14	9/5/2006	
100552P000278	14	9/5/2006	
100552P000174	15	7/29/2004	
100552P000175	15	7/29/2004	
100552P000179	16	6/22/2004	
100552P000171	16	7/20/2004	
100552P000170	16	7/20/2004	
100552P000172	16	7/22/2004	
100552P000176	16	9/3/2004	
100552P000245	16	7/6/2006	
100552P000246	16	7/6/2006	
100552P000247	16	7/18/2006	
100552P000248	16	7/18/2006	
100552P000249	16	7/18/2006	
100552P000250	16	7/18/2006	
100552P000251	16	7/18/2006	
100552P000252	16	7/19/2006	
100552P000253	16	7/19/2006	
100552P000254	16	7/19/2006	
100552P000270	16	8/17/2006	
100552P000271	16	8/17/2006	
100552P000123	17	7/25/2002	
100552P000169	17	6/17/2004	
100552P000188	17	5/24/2005	
100552P000287	17	6/29/2006	
100552P000241	17	7/5/2006	
100552P000242	17	7/5/2006	
100552P000243	17	7/5/2006	
100552P000255	17	7/20/2006	

SITE_ID	EO#	DATE_COLLECTED	SITE_NAME
100552P000256	17	7/20/2006	
100552P000257	17	7/20/2006	
100552P000258	17	7/20/2006	
100552P000259	17	7/20/2006	
100552P000260	17	7/20/2006	
100552P000261	17	7/20/2006	
100552P000262	17	7/20/2006	
100552P000263	17	7/20/2006	
100552P000264	17	7/20/2006	
100552P000265	17	7/20/2006	
100552P000266	17	7/20/2006	
100552P000178	18	6/15/2004	
100552P000177	18	8/19/2004	
100552P000194	18	7/11/2005	
100552P000195	18	7/12/2005	
100552P000198	18	7/12/2005	
100552P000196	18	7/13/2005	
100552P000197	18	7/14/2005	
100522P000080	19	8/11/2009	
100522P000082	19	8/11/2009	
100522P000081	19	8/11/2009	
100522P000083	19	8/11/2009	
100522P000084	19	8/11/2009	
100522P000086	20	8/11/2009	
100522P000087	20	8/11/2009	
100522P000088	20	8/12/2009	
100522P000089	20	8/12/2009	
100522P000090	20	8/12/2009	
100522P000016	21	7/26/2006	
100522P000095	21	8/12/2009	
100522P000096	21	8/12/2009	
100522P000091	21	8/12/2009	
100522000100	21	8/12/2009	
100522P000102	21	8/12/2009	
100522P000070	22	8/5/2006	
100522P000071	22	8/6/2006	
100522P000069	22	8/6/2006	
100522TES090001	23	12/4/2009	Turn Island Campsite
100522P000103	23	6/18/2010	Wrangell Isl, Turn Isl Point

SITE_ID	EO#	DATE_COLLECTED	SITE_NAME
100522P000104	23	6/19/2010	Wrangell Island
100522P000105	23	6/19/2010	Wrangell Isl, Turn Isl Point
100522P000106	23	6/20/2010	Wrangell Island
100522P000107	23	6/21/2010	Wrangell Isl, Turn Isl Point
100522TES090001	23	7/3/2010	Wrangell Isl, Turn Isl Point
100522P000109	23	7/3/2010	Wrangell Isl, Turn Isl Point
100522P000110	23	7/4/2010	Wrangell Isl, Turn Isl Point
100522P000130Y12	23	6/20/2012	
100522P000017	24	1/1/1900	
100551P000022	25	7/18/1996	
100554P000032	26	8/14/1996	
100551P000032	26	6/10/1997	
100552P000048	28	7/29/1997	
100551P000069	29	7/8/1998	
100552P000090	30	8/9/1999	
100552P000121	31	7/2/2002	
100552P000173	32	7/23/2004	
100552P000232	33	8/3/2005	
100552P000244	34	7/6/2006	
100552P000272	35	8/18/2006	
100552PT00039	35	8/14/2008	Revilla near CCC campground
100552P000274	36	8/24/2006	
100552P000275	37	8/31/2006	
100552PT00006	38	7/31/2007	Revilla Klu Bay
100552PT00001	39	6/26/2008	Duke Mineral pad 13
100554P000146	40	6/12/2009	Davidson Landing Picnic Area
100522P000085	41	8/11/2009	
100522P000099	42	8/12/2009	
100522P000101	43	8/13/2009	
100554P000334	44	5/19/2010	Kos 690 road prism
100554P000328	45	6/30/2010	Slake Unit 62
100522P000108	46	7/2/2010	Wrangell Island
100552P000307	47	8/5/2010	Cleveland Peninsula, Union Bay
100554P000174	48	8/12/2010	Salmon Lake to Rush Peak Road
100554P000161	49	8/18/2010	PLOR-SChuck
100551P000336	50	8/18/2010	Hunter Bay PLOR4
100551P000163	51	8/23/2010	
100552P000308	52	6/29/2011	Revillagigedo Isl, Shelter Cove
100522P000093	53	7/16/2011	Warngell Isl, Thoms Creek

SITE_ID	EO#	DATE_COLLECTED	SITE_NAME
100522P000093	53	7/11/2012	Warngell Isl, Thoms Creek
100554P000272	54	7/19/2011	POW Big Thorne 430
100554P000293	55	7/26/2011	POW Big Thorne unit 461
100554P000431	56	8/24/2011	
100552P000315Y12	57	6/21/2012	Saddle lakes TS unit 67
100552P000401Y12	58	7/11/2012	
100554P000536Y13	59	5/26/2013	Mainland, Cleveland Peninsula, Vixen Harbor
ALA (26386)	60	7/19/1982	