

# ***Tanacetum camphoratum* Less. (syn. = *Tanacetum bipinnatum* (L.) Sch. Bip. pro parte): Conservation Assessment on the Tongass National Forest, Alaska Region**

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**Cover Photo:**

*Tanacetum camphoratum*. Photo by B. Kriekhaus (USFS 2014).

## **EXECUTIVE SUMMARY**

In 2009, this species under the name “*Tanacetum bipinnatum* ssp. *huronense*” was added to the Alaska Region Sensitive Species list due to concerns about population viability and impacts from off-road vehicles. Our review of the taxonomy in this group and specimens from the Alaska Region and elsewhere, however, indicates that the plants from the Tongass National Forest are distinct and have been determined to be *Tanacetum camphoratum* Less. The conservation status of *Tanacetum camphoratum* is ranked as imperiled in the state (S1) by the Alaska Natural Heritage Program. It is currently known only from a single site in Alaska; which occurs on the Tongass National Forest, specifically Kruzof Island. The global status of *Tanacetum camphoratum* is considered vulnerable to uncommon (G3G4). The species has a coastal distribution of southeast Alaska to northern California. The species is not listed designated as an Endangered Species or Candidate Species by the US Fish and Wildlife Service.

*Tanacetum camphoratum* is strongly associated with coastal foredunes, which are primarily associated with river outlets, parallel ridges, and prograding shorelines. *Tanacetum camphoratum* is highly associated with open dune habitat and not a strong competitor. Competition from native and non-native species is a threat to the population on the Tongass. Natural ecological succession will likely result in maturation of young spruce trees, shading the remaining *T. camphoratum* plants. Several non-native species near the population and other non-native species present in southeastern Alaska could pose a serious risk to the long-term persistence of the population.

The population in the Alaska Region has been decreasing rapidly in extent due to habitat loss, specifically coastal erosion in recent years. In 2013, the population was estimated to be between 700 and 1000 stems. In 2017, the population was estimated to have 172 stems. Conservation efforts of relocating individual stems originating in eroding soil banks to nearby suitable habitat appear to have safe-guarded the population. However, continual monitoring of translocated individuals at these six sites is needed to track population persistence. Additional translocation sites should also be considered.

This species reproduces by seed and vegetatively through rhizomes. The population on the Tongass National Forest has not been observed producing viable seed. The highly clonal nature coupled with self-incompatibility may be compromising seed production in this population. The population on the Tongass is also under direct threat from ORV activity which degrade the habitat and trample the plants directly. Efforts prior to 2014 to limit ORV activity were not successful; however current efforts are keeping ORV traffic away from the population. Monitoring impacts of both ORV and shoreline erosion occur each year on the TNF.

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## **INTRODUCTION**

This assessment is one of many being produced to support the Amendment to the Tongass Land and Resource Management Plan, USDA Forest Service. *Tanacetum camphoratum* (synonym = *T. bipinnatum* pro parte, *T. douglasii*) is the focus of an assessment because it is a Sensitive Species in the Alaska Region, and has been recommended to be considered as a Species of Conservation Concern. 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 special management so knowledge of their biology and ecology is critical. Rare Species serve as a barometer for species viability at the State level.

This assessment addresses the biology of *Tanacetum camphoratum* throughout its range in the 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 produced as part of the Tongass National Forest Planning Project 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 scientific knowledge accumulated prior to initiating the assessment. 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 must be based. While the assessment does not provide management recommendations, 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 *Tanacetum camphoratum* 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 the southeastern and to a lesser extent, south-central Alaska. Similarly, this assessment is concerned with reproductive behavior, population dynamics, and other characteristics of *Tanacetum camphoratum* in the context of the current environment rather than under historical conditions hundreds to thousands of 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 *Tanacetum camphoratum* 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 Forest Planning, 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.

### ***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, good 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.

Major limitations to this assessment were associated with data gaps in the NRIS database where important population and ecological information were not recorded to USFS protocol, thus limiting the knowledge of the species distribution, abundance, and microhabitat parameters. It is noted when necessary data were missing to come to conclusions or biological opinions. There was limited published data on the taxon, therefore authors relied on biological aspects of closely related species to draw conclusion or inferences. These are explicitly stated in the manuscript. There was difficulty in the determination of the classification and description of the taxon. The authors found significant differences between geographically separated plants based on herbarium material that is accepted by some authority taxonomist but in disagreement with the Flora of North America, the main authority for North America plant taxonomy. The authors outlined their reasoning of recognizing different taxa based on morphological features, but future molecular work can solidify and defend the authors' justification.

The modeled climate data used in this analysis was obtained from Scenarios Network for Alaska and Arctic Planning (SNAP) at University of Alaska Fairbanks. Climate models are downscaled from the five best performing General Circulation Models for Alaska under the A2 emissions scenario. Data modeled into the future is predictive and therefore inherently uncertain. While this represents the best knowledge available at this time, the data should be interpreted at a broad scale representing regional patterns rather than pixel by pixel.

### ***Publication of Assessment on the World Wide Web***

To facilitate use of species assessments in this Project, assessments are being published on the Tongass N.F. and the Alaska Region's 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 importantly, 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**

This section describes the special management classifications assigned by government and non-government organizations in the U.S. and Canada. Existing regulatory mechanisms, management plans, and conservation strategies specific to *Tanacetum camphoratum* are discussed. Management actions and recommendations are reviewed. The information provided in this section is meant to be a historic and current overview of species management. More detailed information on potential future management options tailored to the Alaska Region and Tongass National Forest are provided in the “Conservation: Potential Management of the Species” section.

### ***Management Status***

*Tanacetum camphoratum* is not designated as an Endangered Species or Candidate Species by the US Fish and Wildlife Service. In 2009, this species under the name “*Tanacetum bipinnatum* (L.) Sch. Bip.” was added to the Alaska Region Sensitive Species list due to concerns about population viability and impacts from off-road vehicles. The taxon was more recently proposed as a Species of Conservation Concern in the Alaska Region for these reasons. The Alaska Natural Heritage Program determined the conservation status of “*Tanacetum bipinnatum* ssp. *huronense* (Nutt.) Breitung” to be S4 in the state, uncommon but not rare, and removed it from its tracking list. Our review of the taxonomy in this group and specimens from Kruzof Island and elsewhere, however, indicates that the plants from the Tongass are distinct from “*Tanacetum bipinnatum* ssp. *huronense* (Nutt.) Breitung” and have been determined to be *Tanacetum camphoratum* Less. A review of the taxonomy and determination are below. The conservation status of *Tanacetum camphoratum* is ranked as imperiled in the state (S1) by the Alaska Natural Heritage Program. It is currently known only from a single site in Alaska; which occurs on the Tongass National Forest. The global status of *Tanacetum camphoratum* is considered vulnerable to uncommon (G3G4) due to the tight association with coastal dunes (NatureServe, 2017).

The closely related species, *Tanacetum huronense*, is listed as Endangered by the state of Wisconsin (Wisconsin Department of Natural Resources. 2017.; see <http://dnr.wi.gov/topic/EndangeredResources/>), and Threatened by the state of Michigan (Department of Natural Resources) and is listed as rare in the state (S3) by the Michigan Natural Heritage Program (Michigan Natural Features Inventory. 2007; see: <https://mnfi.anr.msu.edu/explorer/species.cfm?id=13654>). *Tanacetum huronense* is known from few populations in dunes and limestone pavements adjacent to Lake Michigan and threatened by disturbances to the dune habitats.

## ***Existing Regulatory Mechanisms, Management Plans, and Conservation Strategies***

There is no federal listing of *Tanacetum camphoratum* as an Endangered or Candidate species by the US Fish and Wildlife Service. Sensitive Species status provides some 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 and to ensure that they do not become threatened or endangered because of actions of the USFS (FSM 2670.22). Existing policy calls for avoiding or minimizing impacts to species whose viability has been identified as a concern, or if impacts 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 species is therefore targeted during TESP surveys conducted by Forest Service personnel prior to implementing projects for special uses such as timber sales, mineral resource extraction, or infrastructure development. The occurrence of a sensitive species in a polygon could (but not automatically) halt the intended land application unless impacts to the species can be sufficiently mitigated.

The National Forest System Land Management Planning Rule was revised in 2012 and under the new regulations, the Forest Service addresses species at risk in a slightly different way than the 1982 Planning Rule did through the sensitive species program. Both planning rules are currently being applied to NFS activities on the Tongass N.F. In both cases, each rule addresses the National Forest Management Act which 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. Those species not under federal protection may be listed as a Species of Conservation Concern (SCC). Such species are determined and reviewed to be known to occur in the plan area and for which the best available scientific information indicates substantial concern about the species' capability to persist over the long term in the plan area. While the Tongass N.F. continues to assess species at risk under the provisions of the 1982 Planning Rule (Sensitive Species), transitioning to SCC is anticipated to occur within the next 3 to 5 years. Other than controls by the Convention on International Trade in Endangered Species that pertain only to international trade (CITES 2005), regulatory protections that apply to this species only affect occurrences on National Forest System land.

## ***Biology and Ecology***

### *Classification and Description*

The taxonomy of subgenus *Eutanacetum* has been circumscribed in multiple ways in North America. Christian Friedrich Lessing originally described *Tanacetum camphoratum* in 1831 from specimens collected by Chamisso in California, and in 1837 de Candolle described *Tanacetum douglasii* in *Prodromus Systematis Naturalis Regni Vegetabilis* as an herbaceous, bipinnatifid-leaved, multi-headed species from western North America. From

the Latin diagnoses, which is especially abbreviated in de Candolle's publication, these descriptions are likely to address the same taxon. In addition, de Candolle's publication included, *Tanacetum huronense* (also a multi-headed, bipinnatifid species), from near the Great Lakes (sandy banks along Michilimakinak Lake) originally described by Nuttall. Thus there was an initial recognition that the plant from the Pacific Coast and from the Great Lakes were indeed separate species, despite subsequent authors merging the two.

Hultén (1950) transferred all of the native *Eutacetum* species to the genus *Chrysanthemum* in his treatment of the Flora of Alaska and Yukon and included both *Chrysanthemum bipinnatum* L. and *Chrysanthemum huronense* (Nutt.) as separate taxa. Additionally, he introduced the new combination of *Chrysanthemum douglasii* (DC.) Hultén that was relevant for plants of British Columbia south along the Pacific Coast, although he had not observed specimens from Alaska. *Chrysanthemum bipinnatum* L. was described as a single to few-headed plant with involucral bracts with dark margins of sandy habitats in the Arctic, while *Chrysanthemum huronense* (Nutt.) was described as a multi-headed taxon with light-colored involucral bracts and shorter ligules in the interior Alaska and Yukon and with clear associations to plants of the Great Lakes region. However, Hultén noted substantially more variation in Alaska-Yukon plants and hypothesized a case of subsequent hybridization between *Chrysanthemum huronense* and *Chrysanthemum bipinnatum*. In his 1968 treatment, Hultén relegated these two taxa to subspecies (*Chrysanthemum bipinnatum* subsp. *bipinnatum* and *Chrysanthemum bipinnatum* subsp. *huronense*), but no specimens from southeastern Alaska were known to him at that time.

Hitchcock et al. (1955) recognized *Tanacetum douglasii* DC. as a native Pacific Northwestern coastal sand-dune associate and commented that other authors have mistakenly confused *Tanacetum douglasii* with *Tanacetum huronense*, a species that is northern and eastern in its distribution relative to *Tanacetum douglasii*. In addition to distribution differences, Hitchcock viewed *T. douglasii* to have ultimate leaf segments more narrowly pointed and with fewer heads and somewhat more developed rays. Hitchcock et al. (1955) suggested that *T. camphoratum* was a tomentose species restricted to the San Francisco Bay area while *T. douglasii* was a more widespread, less hairy species that extended from northern California to the B.C. coast. Mickelson and Iltis (1966) discount the eastern North American varieties that had been described within *T. huronense* (var. *bifarium*, var. *terrae-novae*, and var. *johannense*), but recognize the arctic species, *T. bipinnatum*, and the Pacific Coastal species, referred to as *T. douglasii* in their treatment. These authors suggest there is a mixture of *T. bipinnatum* and *T. huronense* along the Arctic Coastal Plain and in the central interior of the state, as well as suggesting the plants from southern Vancouver Island align with *T. huronense* rather than *T. douglasii*, and emphasize that *T. huronense* is the primary taxon spreading into the post-glacial habitats of North America.

Plants that had been called *T. camphoratum* Less. and *T. douglasii* DC. from the California coast were determined to not be distinguishable by a constant set of characters from studies of Raven in the early 1960s (Kyhos and Raven 1982). Kyhos and Raven (1982) also state

that the plant from the Pacific Coast should probably not be regarded as specifically distinct from *T. huronense*, nor the circumpolar *T. bipinnatum* Schultz Bip. Chromosome number of all three species was  $2n = 54$  (Kyhos and Raven 1982). Kartesz (1994) and more recently (pers. comm. 25 September 2017) argues that the hairier plants from San Francisco Bay are not appreciably different from coastal plants to the north and should be treated as a single taxon. Hence, Lessing's 1831 name (*Tanacetum camphoratum*) takes priority if Pacific Coastal plants are treated as a single taxon.

More recently, Watson (2006) in her treatment of the genus *Tanacetum* in the Flora of North America, synonymized all native *Eutanacetum* from North America taxa under one polymorphic species, *Tanacetum bipinnatum*. Elven et al. (2011) in the Pan-Arctic Flora disagree with this aggregation and recognize *Tanacetum bipinnatum* and *Tanacetum huronense* as distinct species. Based on the perspectives of Elven et al., it is likely they would recognize *Tanacetum camphoratum* as a distinct species as well if their region of interest extended south of the Arctic and into the Pacific Northwest.

After reviewing the material from Kruzof Island on the Tongass National Forest, other specimens available to the authors at UAAH (UAAH 9915, 9918), and through high resolution online databases (CPNWH 2017), we recognize three distinct native members of *Eutanacetum* in Alaska. There is a small, typically single-headed plant, with narrow and acute-tipped leaflets, without sunken punctate glandular hairs, and with dark-margined and floccose phyllaries, and relatively large ligules; this plant is associated with coastal arctic habitats and is widely recognized as *Tanacetum bipinnatum*. In Alaska it appears to range from the Alaska Peninsula, along the western Bering Sea coast to the Arctic Coastal Plain. In interior Alaska there is a plant that is taller and more erect, often branching, typically with 3–5 heads, often somewhat taller than in *T. bipinnatum*, with modestly darkened phyllary margins, and somewhat pubescent herbage and involucrae. Sunken punctate glands are weakly scattered on stems and leaves. This plant corresponds to *Tanacetum huronense* (sensu Hultén, 1950; Elven et al., 2011) and is normally associated in sandy habitats in interior boreal regions of the state, such as along the Yukon, Tanana, Kuskokwim rivers, Great Kobuk and Little Kobuk sand dunes (CPNWH 2017). Last there are plants from Kruzof Island that correspond well to specimens from coastal Washington to Northern California. This plant is quite tall, multi-headed, often branched, with more rounded leaflet apices, weakly pubescent, with dense sunken punctate glands on the stems and leaves, and with large heads, with light-colored phyllaries that are weakly pubescent.

We adopt the name *Tanacetum camphoratum* Less. as per Kartesz (1994; and pers. comm. 2017) for the plants on the Tongass. Listed synonyms for *T. camphoratum* are in Table 1. More careful taxonomic review and inclusion of morphological and molecular approaches for plants within Alaska and more broadly in the Russian Far East and in North America, however, are warranted to more appropriately describe the variation and apply appropriate nomenclature. More detailed review is outside the scope of this assessment.

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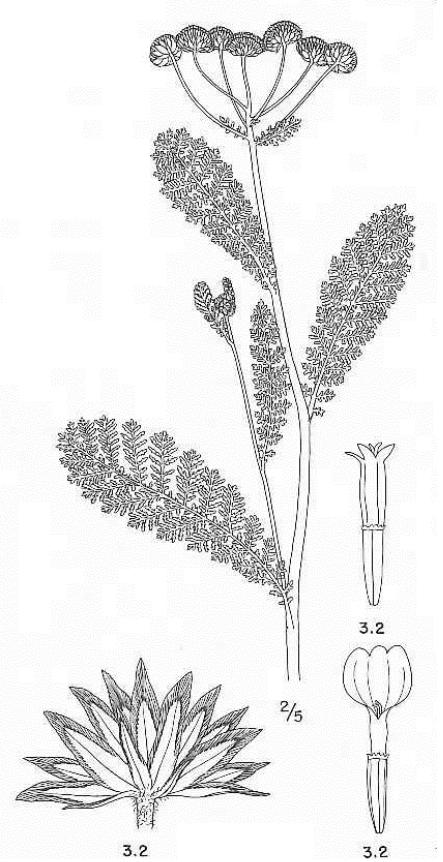
**Table 1.** Synonyms and misapplied names of *Tanacetum camphoratum* Less.

List of Synonym of <i>Tanacetum camphoratum</i> Less.
<i>Chrysanthemum bipinnatum</i> (L.) pro parte
<i>Chrysanthemum bipinnatum</i> subsp. <i>huronense</i> (Nutt.) Hultén
<i>Tanacetum bipinnatum</i> (L.) Sch. Bip. pro parte
<i>Tanacetum bipinnatum</i> subsp. <i>huronense</i> (Nutt.) Brietung
<i>Tanacetum douglasii</i> de Candolle
<i>Tanacetum huronense</i> Nutt.

### Species Description

Species descriptions and illustrations can be found in regional floras including: Hitchcock et al. (1955), Hitchcock and Cronquist (1973), Douglas et al. (2001), Peck (1961) (see Figure 1 and Figure 2).

**Perennial**, 20–60 cm tall, stout, usually decumbent, rhizomatous. **Leaves**: oblanceolate, moderate to thinly villous with sunken punctate glands; well-developed basal leaves, cauline leaves reduced, 5–20 cm long, bipinnatifid or tripinnatifid, ultimate segments blunt. **Inflorescence**: dense corymbiform inflorescence of 3–20 heads. **Heads**: heads 8–15 mm wide, margin of involucral bracts light-colored; rays short and numerous, pappus a minute crown.



**Figure 1.** Illustration of *Tanacetum camphoratum*, (from Hitchcock et al. 1955), John Rumely illustrator.



**Figure 2.** Photo of *Tanacetum camphoratum* on Kruzof Island (photo by Brad Krieckhaus, USFS) above; and photo of a plant from northern California (photo by Jim Popenoe: <http://pages.suddenlink.net/popenoe/plants/dune-tansy.htm>) below.

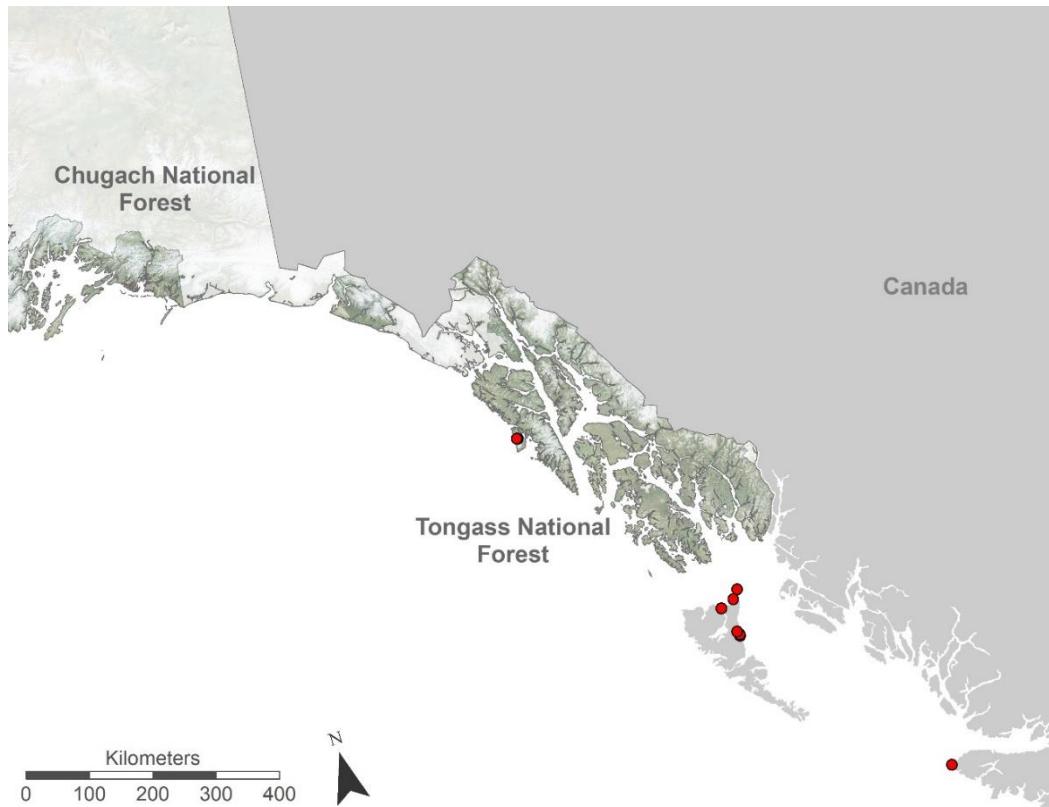


**Figure 3.** Distribution of *Tanacetum bipinnatum* sensu lato, including *T. camphoratum*, *T. huronense*, and *T. bipinnatum* sensu stricto based on herbarium records. Because most herbaria aggregate these taxa it is difficult to accurately describe the species' respective distributions. We include approximate range boundaries for these three taxa in Alaska after a review of specimens.

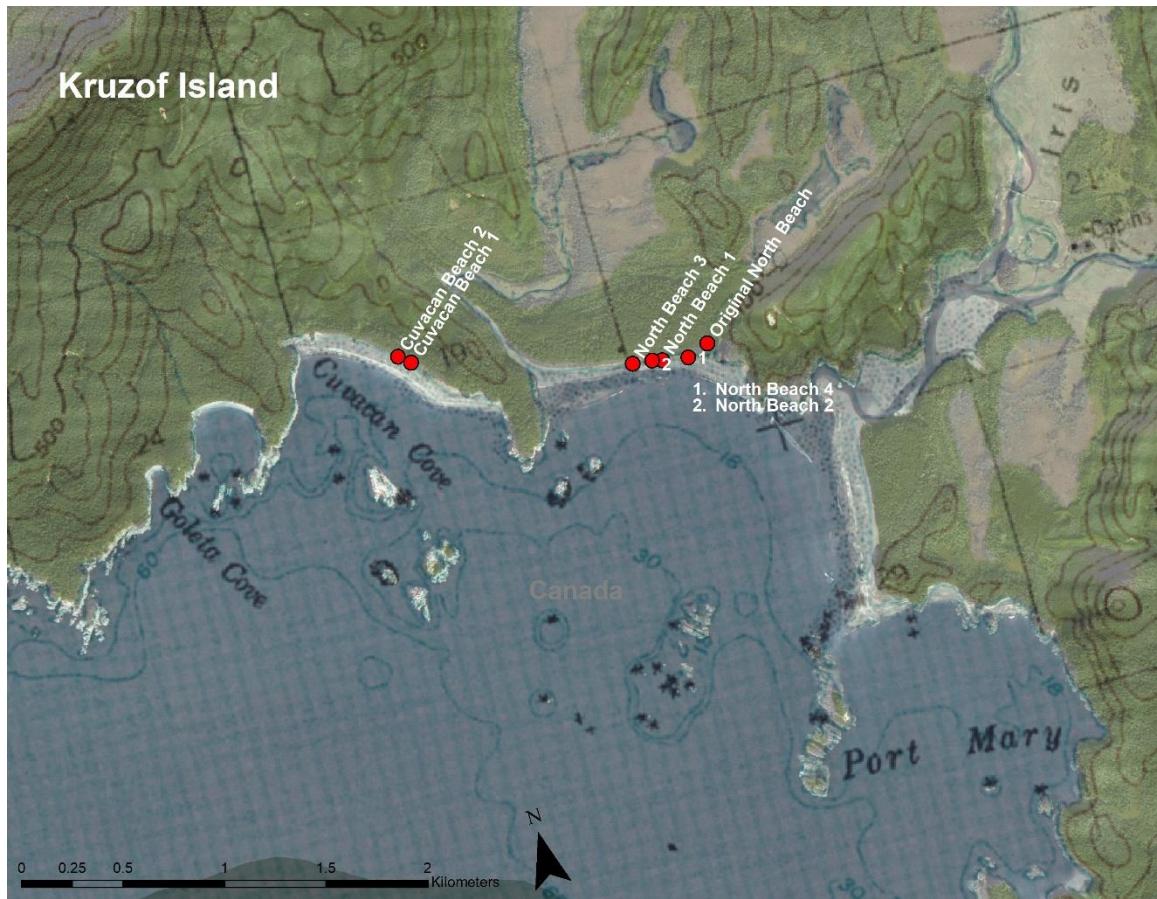
### Distribution

This species occurs from Monterey Bay north intermittently to Cape Mendocino, where it increases in frequency around Humboldt Bay and north through Oregon and Washington, to Vancouver Island and disjunct to northern Haida Gwaii and Kruzof Island in Alaska (Figure 3). Numerous records of *Tanacetum camphoratum* are found through the coastal beach margin of Oregon to the Quinault River in Washington (CPNWH 2017). There are specimens of *Tanacetum bipinnatum* sensu lato scattered in interior California, Washington, and Oregon in roadsides and waste places. Careful review of these specimens are warranted to determine if they represent *Tanacetum camphoratum* or *T. huronense*, which are often confused. *Tanacetum huronense* occurs from Newfoundland, through the Great Lakes region, Canadian prairies, and west to interior Alaska (Figure 3). Additionally, these determinations would assist in gauging the likelihood that populations of *Tanacetum camphoratum* are due to anthropogenic dispersal.

In Alaska, this plant is known from a single location on the Tongass National Forest in Shelikof Bay, Kruzof Island (USFS 2014, USFS 2017; Figure 4). This population is disjunct by 400 km from the nearest populations on Haida Gwaii. Initial collections were recorded in 2003 (CPNWH 2017), and subsequently in 2005, 2013, 2014, 2016, and 2017. This species is unlikely to be overlooked and while focused botanical inventories along the upper beach margin have not occurred throughout southeastern Alaska and the Gulf of Alaska Coast, it appears to be extremely geographically restricted in the state. The USFS directed surveys in what would appear to be suitable habitat in other beach meadows in the region, including Cuvacan Cove in 2008 and 2011, Shoal's Point in 2003 and 2008, Shelikof Bay in 2008, and Sea Lion Cove in 2008 and *T. camphoratum* was not encountered, however other regionally rare beach species were found such as *Ambrosia chamissonis* (Kriekhaus 2014). *Tanacetum camphoratum* was not observed in previous floristic treatments (e.g., Hultén 1941–1950, Hultén 1968, Welsh 1974). It is not clear if *T. camphoratum* has been present on Kruzof Island, or other regions of the state, for a long period of time, or if it is a more recent arrival. The beach meadow habitat that is occupied at North Beach is believed to have formed recently and it is suggested that *T. camphoratum* has only recently colonized the ephemeral habitat (USFS 2014). *T. camphoratum* is recognized as an early colonizer of beach fringe habitats on the Oregon coast (Wiedemann 1998). It may be possible that this population is recently established from anthropogenic dispersal (USFS 2014).



**Figure 4.** Distribution of *Tanacetum camphoratum* in FS Region 10 and neighboring Canada.



**Figure 5.** *Tanacetum camphoratum* occurrences in Alaska are found on Kruzof Island. Individual stems from the original population on North Beach were moved to other parts of North Beach and to Cuvacan Beach to save the original population from habitat loss.

#### *Population Trend and Abundance*

The population at North Beach, Kruzof Island has been decreasing rapidly in extent due to habitat loss, specifically coastal erosion in recent years (USFS 2014, USFS 2017). In 2003 the population consisted of 700 stems and occupied 900 ft<sup>2</sup> (USFS 2014, Krieckhaus 2014). By 2012, the population area had expanded to cover about 1600 ft<sup>2</sup> and in 2013 coastal erosion had eliminated some of the population and the spatial extent was decreased to an estimated 11250 ft<sup>2</sup> (Krieckhaus 2014). In 2013, the population was estimated to be between 700 and 1000 stems. By 2016 beach erosion was continuing and threatening the persistence of the entire population (USFS 2017). In May of 2017, 172 stems were counted and the threat of continued erosional loss of plants was reduced due to a change in stream channel. Stems of *T. camphoratum* that were eroding into the stream were salvaged and relocated in 2013 to four nearby sites on North Beach; and in 2014 stems were also transplanted to four sites at Cuvacan Beach (Figure 5; Table 2). Two of the North Beach and two of the Cuvacan Beach transplanted populations could not be relocated, potentially due to errors in recording GPS coordinates (USFS 2017). In 2016 approximately 150 stems

were transplanted from the original site to the four North Bend sites. Table 2 shows the estimated number of stems for the six extant sites in Shelikof Bay.

**Table 2.** Number of stems found *Tanacetum camphoratum* sites (from USFS 2017).

Site	2013	2014	2016	2017
Original North Beach	100-700	unknown	unknown	172
North Beach 1	6	8	5	41
North Beach 2	2	4	2	84
North Beach 3	-	-	10	6
North Beach 4	-	-	15	13
Cuvacan Beach 1	-	6	7	5
Cuvacan Beach 2	-	2	4	2

This plant is rhizomatous and a single genetic individual may give rise to numerous partially and completely physiologically independent stems. It is not clear how many genetically distinct individuals the approximately 172 stems encompass. The related taxon *Tanacetum huronense*, has been shown to vary rather dramatically in the number of flowering individuals over a few years (Reed and Mahan 2004).

#### Habitat

*Tanacetum camphoratum* occurs in sandy substrates in the upper beach zone. The population on the Tongass is found below the storm tide log deck and co-occurs with *Leymus mollis*, *Castilleja unalaschensis*, *Achillea borealis*, *Lathyrus japonicus*, *Fragaria* sp., and young *Picea sitchensis*. Throughout its range along the Pacific Coast, *Tanacetum camphoratum* is strongly associated with coastal foredunes (see Wiedemann 1998), which are primarily associated with river outlets, parallel ridges, and prograding shorelines. The introduction of the beach grass, *Ammophila arenaria*, for beach stabilizations beginning in the 1930s has dramatically effected the physiognomy and associate plant communities of Pacific Coastal habitats (Wiedemann 1998); however *Tanacetum camphoratum* still occurs along Oregon foredunes as pioneer species, capable of sand burial along with *Leymus mollis*, *Abronia latifolia*, and *Ambrosia chamissonis*.

#### Reproductive Biology and Autecology

This species reproduces vegetatively through rhizomes belowground and it reproduces by seeds. The population on Kruzof Island has not been observed producing viable seed (Kriechbaus 2014). The highly clonal nature coupled with self-incompatibility may be compromising seed production in this population; although manipulative studies would be necessary to determine this. Seed viability of *T. camphoratum* is low with less than 10% germination success (Went and Munz 1949), likewise, *Tanacetum huronense*, has been observed to have a very low germination rate (Marshall 2011). However, seed germination appears to increase with burial and associated sandy beach or dune expansion (Marshall 2014).

### *Demography*

We are not aware of any information about the demography of *Tanacetum camphoratum* on the Tongass or elsewhere in its range. It is widely regarded as a pioneer species of foredunes and dynamic upper beach meadows, and such species typically are characterized by reaching reproductive maturity rather quickly, producing numerous seeds with low maternal investment, having high mortality rates, and are often poor competitors. We suspect that this species is capable of expansion within a site through vegetative spread, once established.

### *Community Ecology*

The nature and scope of interactions of *Tanacetum camphoratum* with other species on Kruzof Island is unknown. Species noted to co-occur with *T. camphoratum* are common to sandy upper-beach habitats of southeastern Alaska. These species may be competitors for resources; in particular *Leymus mollis* can form dense, nearly monospecific stands. Additionally, young *Picea sitchensis* trees have been noted to co-occur with *T. camphoratum* and if these tree mature the formation of a dense canopy and development of a more acidic, organic substrate would likely negatively impact *T. camphoratum*. Natural ecological succession is causing the herbaceous upper beach meadow in North Beach, Kruzof Island to convert to a more closed Sitka spruce forest that presents a loss of habitat (USFS 2017). Currently *T. camphoratum* plants are only found in small open areas of moss and forbs between young spruce trees (USFS 2017). Similarly, *T. huronense* is highly associated with open active dunes and appears to be a poor competitor in vegetated stabilized dune habitats (Marshall 2014).

A few non-native species are known to occur in close proximity to *Tanacetum camphoratum* on Kruzof Island that may represent a source of competition. *Senecio jacobaea* that is considered moderately invasive was recorded a “short distance” from the sensitive species location (AKEPIC 2017). These four plants were hand-pulled and may have been eliminated. Other non-native species recorded from Shelikov Bay include: *Cerastium fontanum*, *Phalaris arundinacea*, *Plantago major*, *Poa annua*, *Poa pratensis*, *Trifolium hybridum*, *Trifolium repens*, *Phleum pretense*. These species are currently restricted to roadsides of logging roads (e.g., FR 7591) and either tend to be weak competitors or are unlikely to occur in well-drained sandy habitats. In the related *Tanacetum huronense* from the Great Lakes, competition from the invasive *Centaurea stoebe* was suspected, however, the authors could not detect a negative impact of the abundance of *Centaurea stoebe* on the rare native species (Girdler et al. 2016). This was likely due to it being the early stage of an invasion.

We do not know if pollinators are necessary for seed production and which species may visit *Tanacetum camphoratum*. Additionally, we are not aware of information about the potential for herbivore, seed predators, or other antagonistic ecological interactions.

## **CONSERVATION**

### ***Threats***

#### ***Recreation – Damage by ORVs***

Impacts to the original *Tanacetum camphoratum* population on Kruzof Island due to Off-Road-Vehicle (ORV) use has been documented in a number of USFS reports (Kriechhaus 2014, USFS 2014, USFS 2017, see Figure 6.). The network of logging roads on Kruzof Island were converted to ORV access and in 1993 a USFS recreational cabin was built on North Beach that is generally accessed by ORVs (Kriechhaus 2014).

Recreational ORV use was extensive along the lower beach and the upper beach meadow where the *Tanacetum camphoratum* population was located. The majority of off-trail areas, including the upper beach meadow of North Beach, were closed to ORV use in 2007 with the completion of an Access and Travel Management Plan. Existing trails through the beach meadow continued to be used, despite the area being officially closed. However, the majority of the *T. camphoratum* population is reported to have been partially protected from adverse impacts by unauthorized ORV use by the presence of storm logs and small spruce trees. In 2013 barriers were erected to limit ORV use in the unauthorized areas (Kriechhaus 2014). After 2006, the upper beach meadow began eroding quickly, which caused ORV users to ride further into the meadow and eventually over the plants; ORV ramps off of the meadow to the lower beach also impact the population (Kriechhaus 2014; Figure 7). Attempts were made to re-route the ORV trail through the forest, to build more substantial barricades, and to provide a law enforcement presence; however ORVs continued to ride over the population. In the spring of 2013 substantial exclosures were constructed to limit ORV impacts to the population (Kriechhaus 2014; Figure 7, Figure 8). These barriers to ORV use are monitored by the USFS each year. A continued risk of damage to both the North Beach and Cuvacan Beach transplant populations from ORV use remains. Direct impacts from ORV included loss of beach meadow habitat and trampling of *T. camphoratum* plants (Kriechhaus 2014).



**Figure 6.** ORV and erosion impacts of *Tanacetum camphoratum* beach meadow habitat North Beach, May of 2011. Some ORV use continued in areas with access prohibited. Photo by Brad Kriekhaus, USFS.



**Figure 7.** Barriers to prevent access to the closed portion of North Beach were constructed in May of 2013. This trail was closed because access to the lower beach was unsafe due to erosion. Photo by Brad Kriekhaus, USFS.

### Erosion

In 2006 the outlet stream running into North Beach changed course and began eroding the upper beach. By 2012 the erosion front reached the edge of the *T. camphoratum* population and the ORV trail developed through the middle of the population. In 2013 fifteen clumps of *T. camphoratum* eroding into the stream (Figure 8, Figure 9) were transplanted further back on the beach meadow (Kriekhaus 2014). More than 50% of the *T. camphoratum* population was lost in two years. The extent of the erosion has now limited ORV use, however erosion continues to undercut the bank and threaten the remaining 172 plants (USFS 2017; Figure 10). In 2014 and in 2016 additional plants that were at risk of erosional loss were transplanted to sites within North Beach and Cuvacan Beach. By 2017 the stream had changed courses again and erosion at the *T. camphoratum* population had nearly stopped. The erosion risk has lessened dramatically since the stream channel has changed course. However, the bank is continuing to stabilize and smaller scale erosion is likely and the stream may change courses again and threaten the remaining population (USFS 2017). Erosion can be exacerbated from tsunamis. Kruzof Island is open to the Pacific Ocean and would sustain a direct impact since there are no islands to act as a buffer compared to islands of the Inside Passage.



**Figure 8.** Erosion of the North Beach meadow from May of 2013 (top) to April 2014 (bottom). The ORV trail visible in the center on the top panel and was previously located where the stream channel runs prior to the beach erosion. Photos by Brad Kriekhaus, USFS.



**Figure 9.** Erosional loss of habitat and of *Tanacetum camphoratum* plants along North Beach, Kruzof Island. Pin flags mark young dune tansy plants. Photo by Brad Kriekhaus, USFS.



**Figure 10.** Remainder of the original *Tanacetum camphoratum* North Beach population in 2017. Plants are visible in foreground of the small leaning spruce tree. Photo by USFS

### *Ecological Succession*

*Tanacetum camphoratum* is a coastal foredune and beach meadow associate that is found in open habitats without a canopy. A very similar species, *Tanacetum huronense*, is highly associated with open habitat and found to be a poor competitor with increasing vegetation (Marshall 2014). Much of the original North Beach upper meadow and associated *T. camphoratum* population has been lost to erosion and remaining plants are found at the spruce treeline. Natural ecological succession is occurring at the site and spruce trees are recruiting and growing at what is now the edge of the beach meadow. *Tanacetum camphoratum* plants are restricted to openings between the maturing spruce trees. It is assumed that eventually the canopy will close and the *T. camphoratum* will not persist in the shade (USFS 2017). The presence of the spruce trees undoubtedly reduces the pace of erosion and has limited impacts from ORV use (USFS 2017).

**Table 3.** Non-native species recorded from Kruzof Island. 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
<i>Cerastium fontanum</i>	big chickweed	10	36
<i>Digitalis purpurea</i>	purple foxglove	3	51
<i>Matricaria discoidea</i>	pineappleweed	4	32
<i>Phalaris arundinacea</i>	reed canarygrass	26	83
<i>Phleum pratense</i>	timothy	12	54
<i>Plantago major</i>	common plantain	11	44
<i>Poa annua</i>	annual bluegrass	49	46
<i>Poa pratensis</i> ssp. <i>irrigata</i>	spreading bluegrass	3	52
<i>Phalaris arundinacea</i>	reed canarygrass	209	83
<i>Ranunculus repens</i>	creeping buttercup	3	54
<i>Schedonorus arundinaceus</i>	tall fescue	3	63
<i>Senecio jacobaea</i>	tansy ragwort	1	63
<i>Senecio vulgaris</i>	common groundsel	2	36
<i>Taraxacum officinale</i>	common dandelion	4	58
<i>Trifolium hybridum</i>	alsike clover	4	57
<i>Trifolium repens</i>	white clover	9	59

### *Competition – Invasive Species*

In addition to competition from native species, if non-native species populations continue to expand, they may be another source of competition that threatens for the long term persistence of *Tanacetum camphoratum* on Kruzof Island. A small population of tansy ragwort (*Senecio jacobaea*) was eliminated from near the *T. camphoratum* population in 2013 (Kriechhaus 2014). In addition, a number of other non-native species are established along the nearby road system and in Iris Meadow (AKEPIC 2017, Kriechhaus pers comm).

16 October 2017; Table 3). Elsewhere in southeastern Alaska, *Sonchus arvensis* ssp. *uliginosus*, *Galium tetrahit*, *Fallopia japonica*, and *Fallopia ×bohemica*, have formed rather dense stands in upper beach meadows and would be the most likely candidates to threaten *T. camphoratum*.

### *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 Alaska Region 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) and the U.S. Forest Service System for Assessing the Vulnerability of Species (Bagne et al. 2011). 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 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 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 are 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). 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 (Figure 11). Areas around the North Beach *Tanacetum camphoratum* population are expected to increase by between 1.5 to 2.0 °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 (Figure 11).

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 12). Annual precipitation is predicted to increase by 9 to 12% for most of the Tongass National Forest. Precipitation is predicted to increase around the known population by approximately 260 mm; an increase in annual precipitation of approximately 10%.

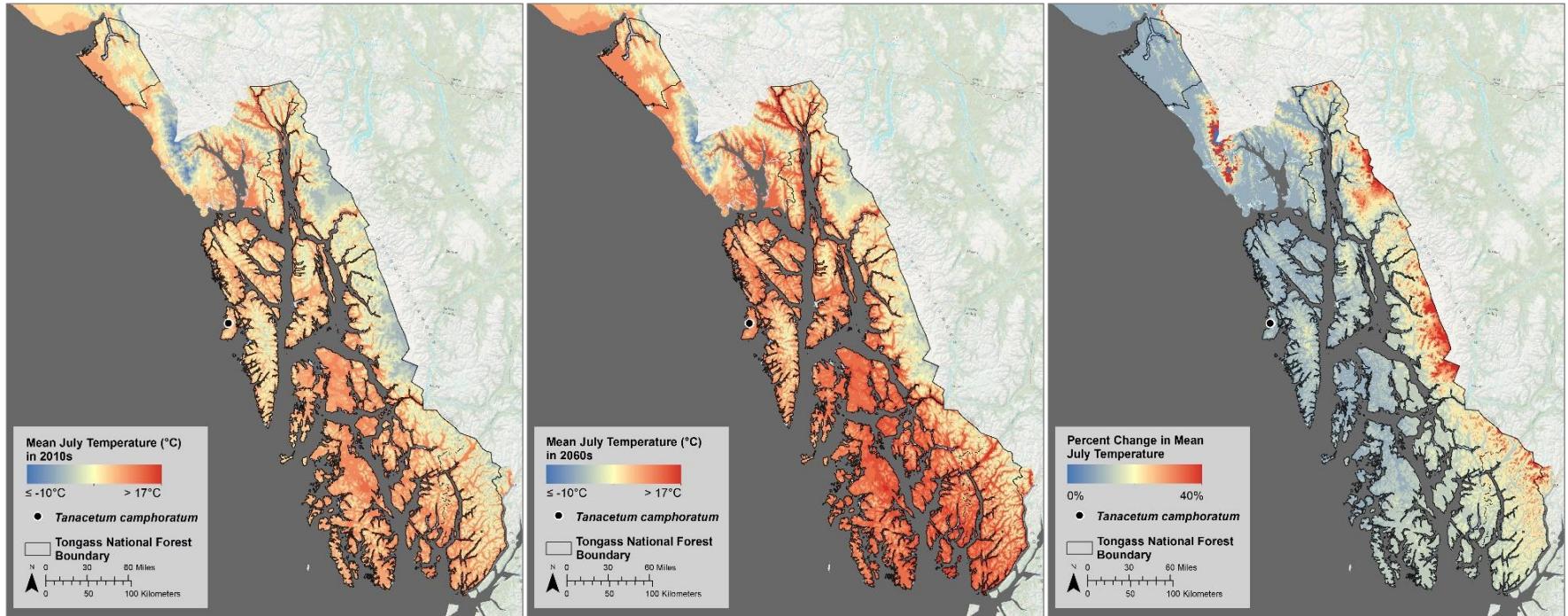


Figure 11. Current (left), predicted 2060 (center) and percent change (right) in mean July temperature ( $^{\circ}\text{C}$ ) in the Tongass National Forest. Location of the *Tanacetum camphoratum* population is shown as a black dot.

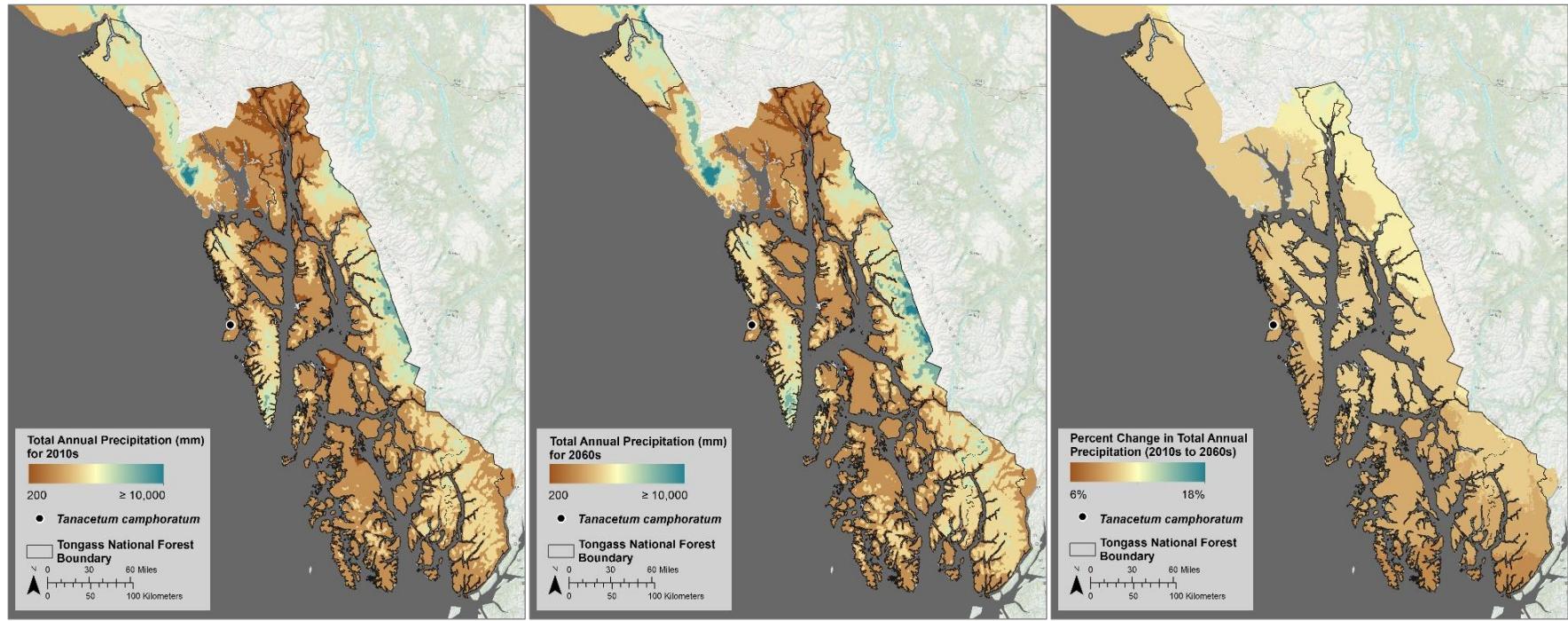


Figure 12. Current (left), predicted 2060 (center) and percent change (right) in mean annual precipitation ( $^{\circ}$ mm) in the Tongass National Forest. Location of the *Tanacetum camphoratum* population is shown as a black dot.

Vulnerability of *T. camphoratum* to climate change is likely low in the near term. The predicted increases in summer temperature could increase evaporative stress, but when coupled with increased precipitation this danger seems low, especially considering that the range of this taxon includes areas that are considerably warmer than predictions for Kruzof Island. Precipitation for all seasons is projected to increase and snow-day fractions (the fraction of days per month where precipitation falls as snow) are expected to decrease (McAfee et al. 2014).

One suspected deleterious consequence of climate change is the indirect effect of an increase in storm intensity and/or frequency, resulting in higher wind speeds and larger storm swells accelerating coastal erosion. Specifically, wind speed is projected to increase 2–4% by 2050 (Abatzoglou and Brown 2011). Such conditions, and associated erosion events, pose a continued threat to the original *T. camphoratum* and transplant populations along the Shelikof Bay beaches. Additionally, increased precipitation may continue flooding and shifting of the neighboring stream, continuing the habitat loss of the *T. camphoratum* population.

### ***Conservation Status of the Species in the Alaska Region and on the Tongass National Forest***

With the protection of rare plants in the Tongass Land Management Plan (USFS 2008 and 2016), occurrences of this plant and other rare plants may receive greater protection. 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 (USFS 2008). The National Forest System Land Management Planning Rule was revised in 2012 and under both the old (1982) and new regulations, the Forest Service implements the intent of the National Forest Management Act which 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.

Additionally, Executive Order 11644, requires federal agencies to develop and implement procedures that will ensure that the use of off-road vehicles on public lands will be controlled and directed so as to protect the resources of those lands, to promote the safety of all users of those lands, and to minimize conflicts among the various uses of those lands. (37 FR 2877, February 9, 1972). Amended by E.O. 11989 issued May 24, 1977 and E.O. 12608 issued September 9, 1987.

There is evidence that the abundance of *Tanacetum camphoratum* in the single known location in the Alaska Region, has declined dramatically in the last decade. Since its initial discovery in 2003, the single known site has been revisited with some frequency. The populations declined in the spatial extent and number of stems by approximately 75%, primarily due to coastal and stream erosion. Attempts have been made to transplant individuals that would have otherwise been lost to erosion and these small subpopulations

are persisting from the last census, but not increasing. The vulnerability of this taxon in the Alaska Region lies in both its extremely narrow geographic range and habitat loss. On the Tongass National Forest, this plant is restricted to a narrow upper beach meadow margin at a single location on Kruzof Island. Similar habitats occur elsewhere in southeastern Alaska, but additional populations have not been detected. The most acute threat to the persistence of this population in the Alaska Region is stream and coastal erosion and habitat loss due to ORV use. Additional threats include competition with native species, particularly maturing Sitka spruce, and competition with non-native species.

There are some aspects of this plant's life history and ecology that suggests that it is vulnerable to population extirpation. Most notably, viable seeds have not been observed and it is likely that the population at North Beach is a single clone (genetically a single individual). This indicates that it has limited opportunities for establishment of new populations and if in fact it is a single genotype, limited genetic diversity to promote longer term ecological resilience. The highly clonal nature, however may be an asset to expansion into new terrain once established, as well as making *ex situ* conservation efforts easier.

### ***Potential Management of the Species on the Tongass National Forest and the Alaska Region***

Persistence of viable *Tanacetum camphoratum* populations in the Alaska Region depend on protecting the existing population and promoting the establishment of additional populations. Desirable environmental conditions for conserving *Tanacetum camphoratum* include sufficiently large areas where the natural ecosystem processes on which the species depends can occur.

There is evidence the population on Tongass National Forest is vulnerable to effects associated with ORV-use, in which the National Forest has some management authority. The only ORV-accessible USFS cabin is near the *Tanacetum camphoratum* population. While areas were closed to off-road ORV use in 2007 and signs put in place, the population continued to be impacted by ORVs. Damage to the population was exacerbated by beach erosion, forcing the ORV trail closure to the forest beach interface. Exclosures were erected to limit ORV damage. Some disapproval of beach closures have been expressed by recreational ORV users (Kriekhaus 2014). In a similar exclosure situation to protect a Candidate species from ORVs, stakeholders were resentful of limited access and threatened to enact a 'weed eradication program' to destroy the Candidate species that limited ORV use (*pers. obs.*; see Fulkerson and Kinter 2013). Protecting data from sensitive species is one method for reducing the chance of negative stakeholder response. Forest Service law enforcement was used to help implement the trail closure (Kriekhaus 2014) but the impact or effectiveness are unknown.

Competition from native and non-native species is the second activity that could impact the *Tanacetum camphoratum*. Natural ecological succession will likely result in maturation of young spruce trees, shading the remaining *T. camphoratum* plants at North Beach. Thinning of immediately surrounding spruce trees and natural vegetation will likely

maintain the open canopy required by *Tanacetum camphoratum*. Non-native species have been identified near the North Beach population and there are other non-native species present in southeastern Alaska that could pose a serious risk to the long-term persistence of the population. Survey and control efforts on biennial-basis would likely be effective in minimizing impacts from non-native species to this population. Though not yet found nearby, the non-native *Tanacetum vulgare* can be easily confused with *T. camphoratum*. Proper identification of the target species will help to limit accidental harm to *T. camphoratum*.

The primary risk to the population on North Beach however, is stream and coastal-erosion of the habitat (USFS 2014, USFS 2017). When the stream outlet changed course on the beach, erosion of the beach meadow occurred at a very rapid rate, and when the stream changed course again the erosional losses nearly stopped (USFS 2017). The feasibility of employing measures to limit or control erosion on the beach and stream is not clear. Additionally, it appears unfeasible and too costly to reengineer and move the direction of the stream that has a shifting nature. Relocation of the population may continue to be a viable option as relocated satellite populations appear to be persisting (Table 2). Continual monitoring of these efforts are needed.

#### *Tools and Practices*

Monitoring has occurred in a somewhat regular fashion for *Tanacetum camphoratum* on Tongass lands. The timeframe between late June and early August are best suited for monitoring of *T. camphoratum*, as the species is in full flower and more easily recognizable. A more standardized monitoring program, including of transplanted 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. Specific efficient inventorying and monitoring methods of rare plants and habitat are discussed elsewhere (see Noss 1990, Manley et al. 2006, Vesely et al. 2006).

A monitoring program would be beneficial to land managers by providing data to determine demography and detect any potential recruitment. Monitoring of *T. camphoratum* is challenging due to its highly rhizomatous nature. Determining the spatial extent of the population with high accuracy (survey grade) GPS and carefully counting all above ground stems and flowering stems within the polygon would be beneficial. This would allow the tracking changes in the spatial extent and number of physiologically independent individuals. Additionally, it would also allow the tracking of flowering and reproductive success of the population.

In addition to population monitoring, habitat monitoring is warranted given the degree of habitat loss from natural causes and disturbance from ORV's. Documenting the scope and degree of disturbance to the habitat is critical for long-term conservation of the species. Currently, permanent reference point photos with habitat measurements are for habitat monitoring. This is an effective tool for documenting disturbances and shrinking habitat

but also alerting managers to when threshold levels of disturbance occur. Management plans may need to change in quick response to new or accelerated disturbance. For example, clear documentation of ORV disturbance was continuing despite posting of signs and new signage with larger fences were placed to circumvent threats to the population (USFS 2014).

*Ex situ* conservation may be an option for *T. camphoratum*. In 2008, cuttings of plants were transplanted to the Sitka Native Plant Garden and cooperatively managed by the University of Alaska Cooperative Extension Service and USFS (Kriekhaus 2014). The plants were growing well on a sand and compost mixture as late as 2013, but their future was uncertain due to fewer personnel able to devote time to their cultivation. Additionally, plants were salvaged from the original population and transplanted to other areas on North Beach and the adjacent Cuvacan Beach, and appear to be persisting. These examples suggest that the plant is resilient and easy to cultivate in a garden setting.

Habitat modeling of *T. camphoratum* is of limited value because only a single population is known for Alaska and the likely environmental variables of greatest predictive value are not available on a regional scale for Alaska and mapping scale may be too broad for habitat categories. This makes habitat models and predictions with low confidence and potentially confuses the understanding of the distribution on the Tongass National Forest. Identifying supra-tidal forb graminoid meadows above sandy beaches in southeastern Alaska should be possible from aerial photography or other remote sensed products, and could serve as a starting point for additional targeted surveys or translocation efforts, especially within the surrounding area. Surveys targeting upper beach meadows on Kruzof Island near North Beach did not detect more *T. camphoratum* populations (Kriekhaus 2014).

With the protection of rare plants in the Tongass Land Management Plan (USFS 2008 and 2016), future occurrences of this plant and other rare plants in timber units and road right of ways may receive greater protection. 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 (USFS 2008). 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.

### ***Information Needs***

While the primary threats of erosion, destruction of habitat due to ORVs, and competition with other species are clear threats with sufficient information to inform management action, a number of factors would benefit from greater understanding. The degree to which a closing spruce canopy impacts growth and persistence of *T. camphoratum* is not clear. Additionally, it is not clear if keeping the meadow open by cutting maturing spruce trees would have a net benefit outcome on the rare plant.

Our knowledge of the reproduction of this species, and of this population in particular, is not strong. No viable seeds have been observed and mating system studies could be employed to understand the basis for this observation. Also, the degree and capacity for asexual reproduction appears to be strong, but directed research could determine the annual growth and fate of rhizomes.

Detailed systematic studies combining genetics and morphology is necessary to understand the relationship of this broader group of *Tanacetum* species that range from Arctic Alaska south along the Pacific to Mexico, and west to Newfoundland. A directed systematic study would also elucidate the likely ancestry of this widely disjunct population on the Tongass National Forest. It is likely that this population on the Tongass National Forest represent a unique and isolated lineage. This species is quite obvious and it is hard to imagine that it is in fact more widely distributed in the Tongass, but has gone undetected. Recent surveys in likely habitat have not revealed more populations; however, additional focused surveys in likely locations such as beaches along the Yakutat forelands would help establish its actual distribution in the state.

Establishing a more consistent monitoring program for *Tanacetum camphoratum* would provide insight into the plant's population trends. By establishing baseline population numbers and monitoring these populations over time, land managers could better evaluate the population-level effects of natural disturbance and management activities. However, with a single original population and smaller sized transplant populations, it is unlikely to be able to effectively measure changes in population size in relationship to management activities.

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## **DEFINITIONS**

**Bipinnatifid** – twice pinnately cleft, a lobe of a leaf that is also lobed

**Extirpation** – to destroy or remove completely

**Involucral bracts** – whorl of bracts bunched and immediately below a flower head

**Ligule** – strap shaped flattened organ of a ray flower in the Asteraceae, sunflower family

**Phyllary** – a single involucral bract

**Pinnate** – a leaf cleft like a feather, lobed almost but not reaching the midrib.

**Punctate glands** – translucent sunken pits or glands

**Sensu lato** – Latin meaning of ‘the broad sense’, includes a loose definition of the taxon distinction and can include other taxa or groups

**Taxon** – a taxonomic group that is recognized as distinct from other groups and should be treated as a separate unit.

**Tomentose** - short matted wooly hairs

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The current version of the *Tanacetum bipinnatum* Conservation Assessment was revised by the Botany Program of Alaska Natural Heritage Program (AKNHP), University of Alaska Anchorage (UAA). 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 Plants](#) page. AKNHP works closely with botanists across Alaska in an effort to ensure the most comprehensive and accurate data sets.