Periodic Status Review for the Island Marble Butterfly

DRAFT

Washington Department of FISH & WILDLIFE

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Draft Status Report for the Island Marble Butterfly in Washington

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The Washington Department of Fish and Wildlife maintains a list of endangered, threatened, and sensitive species (Washington Administrative Codes 220-610-010 and 220-200-100). In 1990, the Washington Wildlife Commission adopted listing procedures developed by a group of citizens, interest groups, and state and federal agencies (Washington Administrative Code 220-610-110). The procedures include how species listings will be initiated, criteria for listing and delisting, a requirement for public review, the development of recovery or management plans, and the periodic review of listed species.

The Washington Department of Fish and Wildlife is directed to conduct reviews of each endangered, threatened, or sensitive wildlife species at least every five years after the date of its listing by the Washington Fish and Wildlife Commission. The periodic status reviews are designed to include an update of the species status report to determine whether the status of the species warrants its current listing status or deserves reclassification. The agency notifies the general public and specific parties who have expressed their interest to the Department of the periodic status review at least one year prior to the five-year period so that they may submit new scientific data to be included in the review. The agency notifies the public of its recommendation at least 30 days prior to presenting the findings to the Fish and Wildlife Commission. In addition, if the agency determines that new information suggests that the classification of a species should be changed from its present state, the agency prepares documents to determine the environmental consequences of adopting the recommendations pursuant to requirements of the State Environmental Policy Act.

This is the Draft Periodic Status Review for the Island Marble Butterfly. It contains a review of information pertaining to the status of the Island Marble Butterfly in Washington. It was reviewed by species experts and will be available for a 90-day public comment period from 27 March 2025 through 24 June 2025. Comments received will be considered during the preparation of the final periodic status review. The Department will present the results of this periodic status review to the Fish and Wildlife Commission at a meeting in Summer 2025.

Submit written comments on this document by 24 June 2025 via email to: TandEpubliccom@dfw.wa.gov or by mail to:

Conservation Assessment Section Manager, Wildlife Program
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This work was supported in part by personalized and endangered species license plates.

Acknowledging the Indigenous People of the Pacific Northwest

Since time immemorial, Indigenous People have lived in the Pacific Northwest and hunted, fished, and gathered natural resources, traditional foods, and medicinal plants to support their diverse cultures. They were the original occupants and stewards of this land that all Washingtonians enjoy today.

The very survival of the Pacific Northwest Tribes is a testament of resiliency of what they have endured and continue to endure throughout generations on this landscape. Through many historical encounters of massacre, renunciation of religious freedom, systemic racism, cultural assimilation of native children through institutional residential schools, and the fight for their inherent rights and liberties, they have prevailed. Throughout this painful history brought by colonization, abrogated treaties, infringement of civil rights, and the salmon protests of the 1960s, the Northwest Tribes and the Washington Department of Fish and Wildlife (WDFW) have founded a commitment of respect, unity, and alliance informed by the realities of the past.

Today, tribal governments and WDFW work collaboratively to conserve and manage aquatic and terrestrial resources statewide and practice sound science to guide management decisions. The Tribes and WDFW work together to ensure the sustainability of fish, wildlife, ecosystems, and culture for the next seven generations and beyond.

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Executive Summary

The island marble butterfly (*Euchloe ausonides insulanus*), a subspecies of the large marble (*Euchloe ausonides*) was designated as a Washington State candidate species in 2002. It was listed as a Species of Greatest Conservation Need in Washington's 2005 and 2015 State Wildlife Action Plans. In 2002, U.S. Fish and Wildlife Service (USFWS) received a petition to emergency list this butterfly as an endangered species filed by The Xerces Society, Center for Biological Diversity, Friends of the San Juans, and Northwest Ecosystem Alliance (Black & Vaughan 2002). The subsequent USFWS 12-month finding concluded that the petition was not warranted (USFWS 2006). The USFWS was petitioned again in 2012 to list the island marble, the subsequent 90-day finding found that the island marble may be warranted for listing. On May 5, 2020, the USFWS issued a final rule listing the island marble as a federally endangered subspecies and designated 812 acres of critical habitat on San Juan Island.

The island marble butterfly is a medium-sized butterfly, with a wingspan of approximately 1.75". The most easily recognized traits are the expanded marbling on the ventral hindwings which are strongly covered with yellow scales and hair-like structures. The island marble butterfly was thought to be extirpated until its rediscovery in 1998 at the American Camp Unit of the San Juan Island National Historical Park (SAJH) on San Juan Island. The rediscovery occurred during a two-year Puget Prairie Butterfly Survey effort led by the Department of Natural Resources (DNR) Heritage Program, Department of Fish and Wildlife (WDFW), and Nature Conservancy (TNC) with funding assistance through U.S. Fish and Wildlife. The island marble was last documented in 1908 on Gabriola Island, British Columbia, Canada prior to its rediscovery. After significant search efforts across historic sites on Vancouver Island and surrounding islands in Canada, the island marble is considered extirpated in British Columbia.

Today, the range of island marble is restricted to a single complex of prairie, coastal dune, coastal bluffs and lagoon habitats located on the southern end of San Juan Island. Island marble uses three annual mustard species as larval host plants, tall peppergrass (*Lepidium virginicum var. menziesii*), a native species and two introduced species, field mustard (*Brassica rapa*) and tumble mustard (*Sisymbrium altissimum*). Island marble produce one brood per year and adults emerge in the early spring through early summer. Larvae (caterpillars) feed and develop on host plants through their last developmental stage, then leave its host plant to pupate (form a chrysalis) and overwinter for 11 months until emerging as adult butterflies in the early spring.

After its rediscovery, approximately 100 sites were surveyed in the San Juan Islands and surrounding mainland areas between 1998 and 2004. No new sites were found. Intensive survey efforts designed to determine the butterfly's range and distribution led by WDFW commenced in 2005 and continued through 2012. Island marble was detected at 52 sites during this time across San Juan and Lopez Island, many of the sites occurring on private land. Island marble was last detected at a single site on Lopez Island in 2012. 2015 survey efforts on San Juan Island (134 surveys across 48 sites) confirmed that the distribution of island marble shrank from its previous expansion, now restricted to the southern end of San Juan Island.

Annual transect monitoring at the American Camp Unit of SAJH has occurred since 2004. Butterfly encounter rates dropped significantly between 2004-2009 and 2013-2014 and have not rebounded on the most consistently monitored transects. The decline of adults in 2013 triggered the need for a formalized captive rearing program to prevent extinction. Since 2014, between 74-248 adult butterflies have been released annually at American Camp Unit of SAJH to augment this last remaining population.

Washington State defines "Endangered" as any wildlife species native to the state that is seriously threatened with extinction throughout all or a significant portion of its range. We conclude that the island marble is at a high risk of extinction given that: 1) only one population remains; 2) annual transect monitoring from 2004-2023 at the core population shows a consistent decline in encounter rate; and 3) local extirpation has occurred at all previously occupied sites on San Juan and Lopez Islands except for the remaining population located on the southern end of San Juan Island. Therefore, it is recommended that the island marble butterfly be classified as an endangered species in Washington state.

Introduction

The island marble (*Euchloe ausonides insulanus*) is a rare subspecies of the large marble (*Euchloe ausonides*) butterfly occupying an extremely limited range. Originally known from a few sites on Vancouver Island and Gabriola Island (Guppy and Shepard 2001) in British Columbia, Canada, the island marble had not been observed since the early 1900s until it was rediscovered in 1998 on the southern end of San Juan Island. Today, only a single population remains. In response, on May 5, 2020 the U.S. Fish and Wildlife Service (USFWS) listed the island marble butterfly as endangered and designated critical habitat for the island marble butterfly under the Endangered Species Act of 1973, as amended (16 U.S.C. § 1531 et seq.) (Act) (85 FR 26786).

This status report summarizes biology, population and habitat status, factors likely affecting the island marble, research, management, and conservation actions. We assess whether the State of Washington should classify this butterfly as endangered, threatened, or sensitive (WAC 220-610-110). We review the best available science and information to assess a listing recommendation in Washington State. Our intent is to review information that best informs our listing recommendation rather than serving as a comprehensive review of information over the last 27 years since its rediscovery at the American Camp unit of San Juan Island National Historical Park (SAJH) on San Juan Island, WA.

Taxonomy, Legal Status, Description

Euchloe ausonides insulanus (island marble; Figure 1) is in the Order Lepidoptera (moths and butterflies), Family Pieridae (whites, marbles, and sulphurs) and Subfamily Pierinae (whites and marbles). It is one of seven subspecies of large marbles (*Euchloe ausonides* (Lucas 1852)) across the Western U.S. and Canada and one of two subspecies in Washington State (Pelham 2023). The subspecies *E. ausonides insulanus*, hereafter island marble, was first described by Guppy and Shepard (2001) soon after its rediscovery in 1998. The subspecies name *insulanus* is Latin for islander, referring to the butterfly's locations in both the U.S. and Canada. Island marble adults (Guppy and Shepard 2001) and larvae (Lambert 2011) differ morphologically from other large marble subspecies in several ways (see below in description section). Mitogenome phylogeny for *Euchloe ausonides* subspecies, including *insulanus* using extant samples from San Juan Island and museum specimens from Vancouver Island, showed that *E. ausonides insulanus* specimens formed a monophyletic clade with *E. ausonides insulanus* most closely (sister species) related to *E. ausonides mayi* (Jones et al. 2024).

The island marble was designated as a state candidate species in 2002 and was listed as a Species of Greatest Conservation Need (SGCN) in Washington's 2005 and 2015 State Wildlife Action Plans (WDFW 2005, 2015). The island marble has not been recorded in British Columbia since 1908, despite significant search efforts by the Canadian government following the rediscovery in the United States. The island marble is now considered extirpated in British Columbia (COSEWIC 2010). In 2002, U.S. Fish and Wildlife Service (USFWS) received a petition to emergency list this butterfly as an endangered species (Black & Vaughan 2002). The subsequent USFWS 12-month finding concluded that the petition was not

warranted (USFWS 2006). The USFWS was again petitioned to list the island marble in 2012 (Jordan et al. 2012). After subsequent review, in 2016 the USFWS published its 12-month finding that island marble was warranted for listing as endangered under the Endangered Species Act but precluded by other higher priority actions. The USFWS listed the island marble butterfly as endangered on May 5, 2020 (USFWS 2020).

Figure 1. Male and female adult island marble butterflies

Left image: Male and female adult island marble butterfly mating. Ventral hindwings show distinct yellow-greenish marbling. Center image: Male island marble butterfly. Right image: Female island marble butterfly. Dorsal hindwings are white in males and buttery yellow in females as shown in the center and far right images. Photos by J.K. Combs

The island marble is a medium-sized butterfly, with a wingspan of approximately 1.75". The most easily recognized trait is the expanded marbling of the ventral hindwings which are strongly suffused with yellow scales and setae (hair-like structures) (Figure 1). These yellow markings are also prevalent on the ventral apical and subapical forewing. The dark markings of the dorsal forewing are expanded and the wing bases are suffused with black scaling (Guppy and Shepard 2001). At slightly less than 1.75", the wingspan of other large marbles is smaller than that of the island marble. The yellow scales and setae present on adult island marble ventral hindwings and the black scales along dorsal wing bases are not present on other large marbles. Additionally, the yellow-green marbling on ventral wing faces and the black patterning on the dorsal forewing are more extensive on the island marble than on other large marbles (Guppy and Shepard 2001). The dorsal hindwing coloration of island marble males is white. In contrast, females are buttery yellow (Pyle and LaBar 2018).

The following morphological descriptions of island marble eggs, five larval instars (caterpillar stages) and pupae (chrysalis) are based on field research conducted by Lambert (2011). Eggs are bluish-white when oviposited (laid), turn orange within 24–48 hours (Figure 2), and eventually turn red then brown just before hatching. Egg stage lasts approximately 10 days. Larvae undergo five instars (larval growth stages separated by molting), during which they grow from approximately 2 mm to 25 mm and progress in colors from yellow to greenish grey with yellow and white stripes (Figure 2). Mean development in each stage is approximately 4-6 days. Pupal coloration mimics senesced vegetation; the overall pupal color is light paper-brown with bands of darker brown and grey. Pupae are about 17–20 mm in length with a slender, streamlined shape tapered on both ends (Figure 2). Third through fifth instar larvae show

distinct white laterals, in contrast to other subspecies of large marbles which display a purple-grey lateral stripe (Opler 1974, Lambert 2011, James and Nunnallee 2011).

Figure 2. Egg, larvae and pupa of the island marble butterfly

Images from left to right: 1) orange egg on flower bud of host plant (Sisymbrium altissimum; SIAL), 2) second instar feeding on flower bud tissue of SIAL, 3) newly molted fifth instar larvae resting on elongated SIAL fruit and 4) island marble pupa (chrysalis) suspended from a silk girdle attached to a senescent stalk of shepherd's cress (Teesdalia nudicaulis). Photos 1-3 by taken by J.K. Combs and photo to far right of pupa taken by A.M. Lambert at American Camp on June 25, 2006.

Distribution

Island marble formerly inhabited coastal grasslands in southeastern Vancouver Island and adjacent Gabriola Island, British Columbia (Figure 3), but are considered extirpated from Canada as this subspecies has not been documented since 1908 (COSEWIC 2010). Island marble was thought to be globally extinct until 1998 when the first record of the subspecies was documented at the American Camp on San Juan Island during a 2-year Puget Prairie Butterfly Survey effort led by the Department of Natural Resources (DNR), Department of Fish and Wildlife (WDFW) and The Nature Conservancy (TNC) (Fleckenstein and Potter 1999; Figure 3). In 2003, surveys in or near American Camp expanded the known range of the island marble to include nearby private lands outside of American Camp and the adjacent Cattle Point Natural Resource Conservation Area (Pyle 2003). Between 1998 and 2004 approximately 100 sites were surveyed in the San Juan Islands and the surrounding areas, and no new sites where found. The term "site" may be locations that are directly adjacent to one another and does not imply a separate population. Site locations are based on land ownership and/or several locations within the same ownership unit (e.g., Potter et al. 2011, Miskelly and Fleckenstein 2007). Many of the survey sites were out of range and/or in unsuitable habitat (Miskelly and Fleckenstein 2007).

In 2005, WDFW and USFWS initiated reconnaissance surveys to further investigate the potential range and distribution of island marble. Surveys were conducted at 110 sites in Clallam, Jefferson, Island, San Juan, Skagit, and Whatcom counties; however, island marbles were only encountered at sites in San Juan County on San Juan and Lopez Island (Miskelly and Potter 2005).

The 2005 surveys identified additional detections on private lands surrounding American Camp extending north along the west coast of San Juan Island to False Bay, within the San Juan Valley, and on a single site in northwestern San Juan Island (Miskelly and Potter 2005). In 2005, island marbles were also found on neighboring Lopez Island for the first time, at Fisherman's Bay tombolo, and at three sites near Center Road (Miskelly and Potter 2005). Searches for new island marble sites were led by WDFW (Hanson et al. 2009, 2010, Miskelly and Potter 2009, Potter et al. 2011) and DNR (Miskelly and Fleckenstein 2007) and continued through 2010. Host plant abundance and butterfly occurrences were also monitored on previously identified island marble occupied sites. Monitoring efforts continued through 2012 (WDFW, unpublished data).

In 2015, Vernon (2015a) conducted 134 surveys on San Juan Island across 48 sites. Sites included all locations where island marble was previously detected (outside of American Camp) and new sites where suitable habitat occurred. Survey results from Vernon 2015a and previous surveys show that the island marble's known distribution is restricted to a single population on southern San Juan Island, between Eagle Cove and Cattle Point, with most of the occupied range within American Camp (Vernon 2015a). The known distribution of island marble has decreased substantially since the mid-2000s, and today only one core population remains located at the southern end of San Juan Island (Miskelly and Potter 2005, 2009, Miskelly and Fleckenstein 2007, Hanson et al. 2009, 2010, Potter et al. 2011, Vernon 2015a, WDFW unpub. data).

The last survey efforts across Lopez Island were conducted in 2012, when only a single larva was detected. In 2021, WDFW visited historically occupied sites on Lopez Island, viewing sites on private land from public roads and searching host plants on two public land sites, and found no detections where island marble had been previously detected. During this survey it was also noted that host plants were no longer present at several previous locations, a key factor in the decline of island marble on Lopez Island (WDFW unpub. data). Additional monitoring will be needed to determine if island marble persists or is extirpated from Lopez Island. The only long-term (>8 yrs) population of island marble persists at the southern end of San Juan Island. Long-term persistence here is likely due to a combination of factors such as a large, open landscape with suitable habitat supporting all three host plants and habitat types in tandem with the ongoing annual release of captively reared butterflies at American Camp, SAJH.

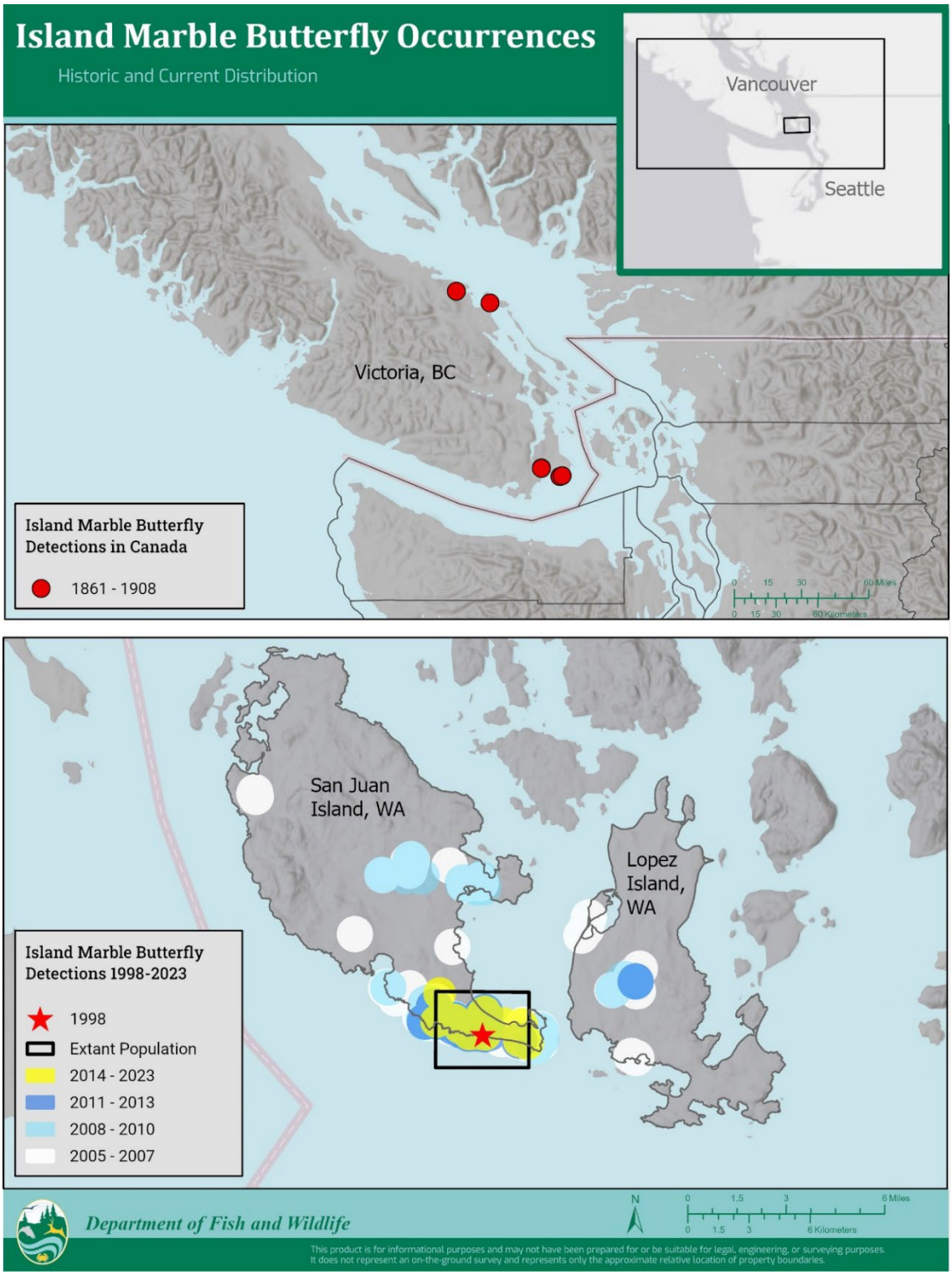

Figure 3. Historic and current distribution of the island marble butterfly

Historic and current distribution of the island marble. Euchloe ausonides insulanus). The southern end of San Juan Island is the only location where island marble has persisted since it was rediscovered by John Fleckenstein, DNR zoologist, in 1998.

Natural History

Reproduction and Life Cycle

Island marble is univoltine, completing a single life cycle and producing one brood per year. Their life cycle consists of four distinct developmental phases: egg, larva (caterpillar), pupa (chrysalis), and butterfly. Adult butterflies eclose (emerge) from overwintering pupae in early April through mid to late June with males emerging 4–7 days before females (Lambert, 2011; Peterson, 2010). Lambert (2011) documented a phenological shift in adult flight period from early April to late April (approximately 10 days) from 2004 to 2008. The remaining information in this subsection comes from Lambert 2011, unless otherwise cited.

Island marble butterflies oviposit (lay) eggs mainly on flower buds (sometimes on stems and pedicels and rarely one leaves) of three mustard species. One is a native species, tall peppergrass (*Lepidium virginicum* var. *menziesii*) and the others are introduced mustards, field mustard (*Brassica rapa*) and tumble mustard (*Sisymbrium altissimum*) (Pyle 2003, Lambert 2011). Host plants will be referred to as "*Lepidium*", "*Brassica*", and "*Sisymbrium*". *Brassica* is found in grassland habitat, *Sisymbrium* is found in grassland and dunes and *Lepidium* is found in coastal strand vegetation zone in lagoon and shoreline habitat.

Upon locating a female, males perform an aerial courtship which may entail the male hovering above a resting female and/or both sexes fluttering in tight circles. If a female is receptive to a courting male, mating occurs on nearby low-lying vegetation perched on forbs such as field chickweed (*Cerastium arvense*), fiddleneck (*Amsinckia menziesii*), yarrow (*Achillea millefolium)* and the three mustard host plants.

After mating, gravid females search for host plant patches suitable for egg and larval development. When a host plant is selected, the female will usually oviposit a single egg, typically on an unopened terminal flower bud clustered near additional buds. Positioning the egg near clustered buds ensures early instar larvae have access to palatable food resources. Eggs are oviposited singly, and, like other Pierid butterflies, females may oviposit a few hundred eggs over their lifespan (Boggs and Watt 1981, Scott 1986). Erlich and Erlich (1978) found that large marbles (*Euchloe ausonides*) have about 70 eggs in each of their eight ovarioles.

Females preferentially oviposit on robust plants in patches with low to moderate host plant densities (0.25–0.75 plants/m^2) (Lambert 2011, 2017). Plants selected for egg and larval development often occur on the periphery of host plant patches. Before ovipositing, females assess plants for additional eggs and larvae and will generally avoid ovipositing on occupied plants. Host plants can receive multiple eggs if host plant availability is low relative to gravid female abundance and is amplified when phenological asynchrony occurs (Lambert 2011, 2015).

Eggs hatch approximately 10 days after they are oviposited. Larvae undergo five instar phases, molting between each instar, and increasing in size, mobility, and foraging ability. First and second instar larvae movements are limited to approximately one to two centimeters from where the egg hatches and are typically constrained to the same inflorescence on which the egg was oviposited. Due to their limited mobility and ability to feed only on tender buds and flowers, early instar larvae are often found on or

near terminal flower clusters, on the uppermost portions of the host plant. Third instar larvae will move among racemes and fourth instar larvae will forage between host plant branches and may move to nearby host plants in search of edible flowers, buds and tender fruits. Fifth instar larvae may be located along the entirety of the host plant consume whole fruits, pedicles and stems (Lambert 2011).

Larvae pupate (form a pupa or chrysalis) after maturing. In the field, Lambert (2011) observed three late instar larvae transitioning to pupae. Larvae moved between host plants and 'wandered' several meters (up to approximately four meters) through nearby standing vegetation, in search of a suitable pupation site. Wandering larvae avoided moving on the ground, instead, they traveled through vegetation at lower to mid-canopy height along the stems of grasses, forbs, and rushes. Wandering larvae selected slender, rigid stems in the lower canopy of moderately dense ground vegetation for pupation (Figure 2). Larvae then fashion a silk girdle to attach themselves to the selected stem. Once attached to the selected stem they become sedentary and enter the "pre-pupal" stage where larvae undergo pupation (form a chrysalis). Extensive open sand habitat in some areas may be a hostile environment for late instar larvae searching for safe pupation sites (pers. comm. A. Lambert).

In the field, pupae length is approximately 17-20mm. Pupae overwinter in a diapause (suspended development) stage for approximately 11 months (n=1; 334 days;) until the following spring. Development from egg to pupa takes approximately 38 days. Island marble larvae pupate between May and early July. The diapause stage (pupa) accounts for the longest period in the island marble's life cycle; the maximum recorded length is 334 days (≈11 months). Butterflies emerge from pupae from mid-April to June.

Diet and Foraging

The majority of butterflies in the subfamily Pierinae, including the island marble, feed on mustards (Brassicaceae) (Pyle and LaBar 2018). *Euchloe* species select host plants based on plant chemistry (i.e., mustard plants that contain glucosinolates (Renwick and Chew 1994)), plant phenology (e.g., available buds at oviposition) and structural features (e.g., host plant size) (Shapiro 1985, Karban and Courtney 1987, Lambert 2011). Island marble larvae have been observed to feed and develop successfully on *Lepidium, Brassica and Sisymbrium*.

Females have been observed to oviposit eggs on other mustard species such as, hedge mustard (*Sisymbrium officinale)*, charlock mustard (*Sinapis arvensis*), sea rocket (*Cakile* spp.), and wild cabbage (*Brassica oleracea*) (Lambert 2005, Miskelly and Fleckenstein 2007, Hanson et al. 2009). However, observations showed that none of these species supported the development of island marble due to various morphological and phenological plant traits that prevented development of immature stages (Lambert 2011).

Suitable host plant phenology is essential for successful island marble reproduction. Host plants provide nectar resources for adults upon emergence, suitable oviposition sites, and edible plant material required for each stage of larval development. In addition, phenology must be synchronous with adult eclosion and able to support development from eggs to instar V. For example, Lambert (2011) found that most eggs are oviposited on host plants in phenological stage 2 (plants that have <50% buds and > 50% flowers). Therefore, early instar larvae (I-II) on host plants with advanced phenology (phenological stage 3-4) are susceptible to starvation as host plant vegetation senesces, becoming inedible before

pupation occurs. Senescent host plant material led to the desiccation of 104 island marble larvae out of 1617 tracked (Lambert 2011).

Historically, native mustards, such as tower mustard (*Turritis glabra*; formally *Arabis glabra*) and hairy rockcress (*Arabis eschscholtziana*; formally *Arabis hirsuta*) may have supported the development of the island marble (Shepard 2000, Lambert 2011). Both species are native to the San Juan Islands and could serve as potential additional native host plants in the future to benefit the recovery of the species. Preliminary research by Lambert (2011), shows that *T. glabra* may be a good candidate as an additional native host plant but further research is needed to determine if *T. glabra* can support the development of larvae under field conditions (Lambert 2011). Under the right conditions *A. eschscholtziana* may serve as a viable host plant but like *T. glabra*, research studies testing survivorship from egg to late instar should be employed before these two native mustards are considered as additional host plants in recovery efforts to ensure they can support the development through all life stages. Both species are infrequent across the San Juan Islands and when encountered are found in low densities. *Turritis glabra* may be subject to heavy deer herbivory (Lambert 2011, herbarium record data, WDFW unpub. data 2024). For example, in a seeding experiment Lambert (2011) found that 73% of *T. glabra* plants were damaged by deer and below-ground herbivores and 63% were damaged solely due to deer (28 out of 44 plants). Therefore, future testing of *T. glabra* as an additional host plant should consider protecting plants from deer herbivory to decrease incidental predation of eggs and larvae of the island marble.

Adult island marble butterflies primarily use host plant species as nectar resources (Miskelly 2000, Miskelly and Potter 2005) and but have also been observed nectaring on sixteen other forb and vine species (Appendix A), of which they most frequently nectar on yellow sand verbena (*Abronia latifolia*), small-flowered fiddleneck (*Amsinckia menziesii*), and field chickweed (*Cerastium arvense*) (Miskelly 2000, Pyle 2004, Miskelly and Potter 2005, Lambert 2011, Vernon and Weaver 2012). See Appendix A for a list of observed nectar plants.

Habitat Requirements

Island marble is reliant on both biological and physical habitat attributes to maintain long-term persistence that include both biological (i.e., host plant availability/suitability and nectar resources) and physical components (i.e., topography, slope, disturbance, habitat heterogeneity and safe sites for pupation) (Table 1) (Lambert 2011).

Table 1. Plant community, host plants, and habitat attributes that support island marble at American Camp, San Juan Island National Historic Park (adapted from Lambert 2011).

Plant Community/ Habitat Type	Host Plant(s)	Attributes	Topography	Disturbance
Coastal lagoon and shoreline	*Lepidium virginicum var. menziesii (Menzies' pepperweed)*	Tidal saturation and saline; low nutrient rocky/sandy soils	North-facing shoreline, driftwood berms	Active – tidal, wind, seasonal flooding

Plant Community/ Habitat Type	Host Plant(s)	Attributes	Topography	Disturbance
Grassland/Prairie	*Brassica rapa (field mustard) & Sisymbrium altissimum (tall-tumble mustard)*	Strong winds; dense non-native grasses; moderately deep sandy soils over clay till	North and south-facing slopes, shrub and tree edges, banks, bluffs	Intermittent – human or small mammals
Sand dune	*Sisymbrium altissimum (tall-tumble mustard)*	Open sand; microclimate conditions caused by varied topography	North and south-facing sand banks, swales, and bluffs	Active – wind

Island marble uses open landscapes in grassland/prairie, sand dune, coastal lagoon, shoreline, agricultural, and disturbed soil habitats. Disturbance plays a critical role in shaping the conditions suitable for the colonization and persistence of larval host plants in each habitat type. *Brassica* and *Sisymbrium* are dependent on ground disturbances from active prairie management, digging by small mammals, and wind shifting sandy substrates. *Lepidium* persists in the nearshore zone, an area subject to natural disturbance by driftwood and sand deposition during periodic tidal events and seasonal flooding (Lambert 2011). Observational data on flight behavior suggest that topography (e.g., slope and aspect) and offshore winds play a role in short and longer distance dispersal between host plant patches (up to 500 meters) and flight behaviors such as mate searching activity (Lambert 2011).

Female island marbles have been observed to lay eggs on more robust host plants (e.g. taller, multiple racemes) in patches with low to moderate host plant densities (0.25–0.75 plants/m^2) (Lambert 2011, 2017). For example, 88% of eggs were found on host plants (*Brassica*) growing in relatively low densities (1 plant/m2) compared to high densities patches (>1 plant/m2) (Lambert 2011). Host plant phenology and abundance is influenced by microsite conditions and vary among host plant patches as a result of physical site features (e.g., site aspect, soil substrate). At local and landscape scales, host plant phenology and density are dynamic and fluctuate based on interacting physical site features, annual changes in precipitation, temperature, and larger climatic patterns (i.e., La Niña/El Niño, global climate change) (pers. comm Lambert). See the Diet and Foraging section for more information concerning host plant suitability.

Adult Dispersal

At a range-wide scale, the island marble may exhibit a metapopulation dynamic with individuals rarely moving between spatially separated and largely independent populations such as historic Lopez Island populations and San Juan Island populations (Hanson et al., 2009; Lambert, 2011; Peterson, 2010). On a local scale, the island marble exhibits patchy population dynamics, which best describe the movement of individuals between suitable habitat patches. Specifically, the island marble tends to occupy multiple habitat patches within a larger, heterogeneous area, with some movement between suitable habitat patches (Lambert 2011).

Short and long-distance butterfly movements are driven by behaviors such as feeding, mating (and mate location), oviposition and dispersal (Scott 1985, Courtney 1986, Scott 1986). Miskelly (2000) found that

adult island marbles can fly 300 meters or more without landing and Lambert (2011) observed that gravid females will move between host plant patches and habitat types separated by more than 100 meters in search of oviposition sites. Island marbles will fly several hundred meters outside of host plant habitat in search of mates (Lambert 2011). When dispersing, adults fly more than one meter above the ground in a generally linear fashion across open ground and along edges and corridors (e.g., fences, forest edge, roads) (Lambert, 2011). Mild topographic relief—where adults can take advantage of upwelling breezes—aids adult flight, thus, dispersal often occurs along ridgelines and shorelines (Lambert 2011).

Recorded island marble adult long-distance dispersal events are estimated to be 0.6 km (0.4 mi) and the maximum recorded dispersal distance documented is 1.9 km (1.2 mi) (Peterson 2009, 2010). However, it is likely that adults will disperse at much greater distances based on previous studies of related subspecies. For example, Scott (1975) found that the large marble (*Euchloe ausonides*) laid eggs on *Brassica* host plants 3 miles (4828m) from the nearest colony. Conclusions from Scott's observations (1975) and patterns of past occupied island marble locations suggest that island marble females can disperse long distances in search of unoccupied nectar and host plants similar to patterns of other *Euchloe* species (Scott 1975, Watt et al. 1979). All three island marble host plants are early succession species, and as a result dispersal and colonization is driven by annual cycles of host plant successional patterns (Lambert 2011).

Survivorship and Mortality

To determine survivorship and mortality factors of immature stages (egg and larval stages) of the island marble, Lambert (2011) conducted a four-year field study tracking the fate of 1,617 individual eggs through all immature stages until death or disappearance on all three host plants (*Lepidium* n = 117, Brassica n = 894 and *Sisymbrium* n = 606). Overall, across all sites and host plant species, average survivorship from egg to instar IV was 12%. *Lepidium* supported the slightly higher percent survivorship (14.2%) from the egg stage to larval instar IV. However, this habitat is susceptible to offshore storms and tidal flooding that likely contributed to an observed local population extinction of island marble from one research site over the course of the four-year study (Lambert 2011). Eggs laid early in the season have a higher chance of survival compared to eggs laid later in the flight season. In a 2015-2017 study, tracking survivorship of egg to instar IV-V (n=392), it was found that only 1% of eggs oviposited after June 3rd survived (Lambert 2017). Trampling likely impacts eggs and larvae as well, especially at the *Lepidium* lagoon sites. These sites experience high recreation and the low height of *Lepidium* makes it easy to tread on. *Lepidium* also grows directly adjacent to the trail.

Survivorship studies from other pierid butterflies (*Pieris rapae* and *Pieris virginiensis*) show similar survivorship rates for a common species, *Pieris rapae* (15.5%; Parker 1970) and a rare species, *Pieris virginiensis* (16%; Cappuccino and Kareiva 1985). Lambert (2011) found the highest sources of egg and larval mortality of island marble are from direct predation by spiders and wasps (average 47%), followed by incidental predation via deer herbivory (average 26%) (Figure 4).

Starvation, largely due to asynchronous host plant phenology, is also an important source of larval mortality, accounting for about one-quarter of immature stage mortality. Finally, host plant damage (e.g., wilted plants due to below ground herbivory, physical damage due to wind, floral damage due to other insect herbivores) as also documented, but not as prevalent (less than 10%) as other mortality

factors (Lambert 2011). See Appendix C in Lambert 2011 for full descriptions of direct and indirect factors that contribute to island marble egg and larval mortality. Pupal mortality and survivorship during the 11-month period of diapause is unknown because pupae are cryptic and therefore difficult to study. Several factors likely impact survivorship at the pupal stage, including but not limited to predation by small mammals (e.g., mice and voles), vegetation management and residential activities (e.g., mowing), trampling (recreational activities, animals), and extreme weather events (e.g., flooding caused by storm surges).

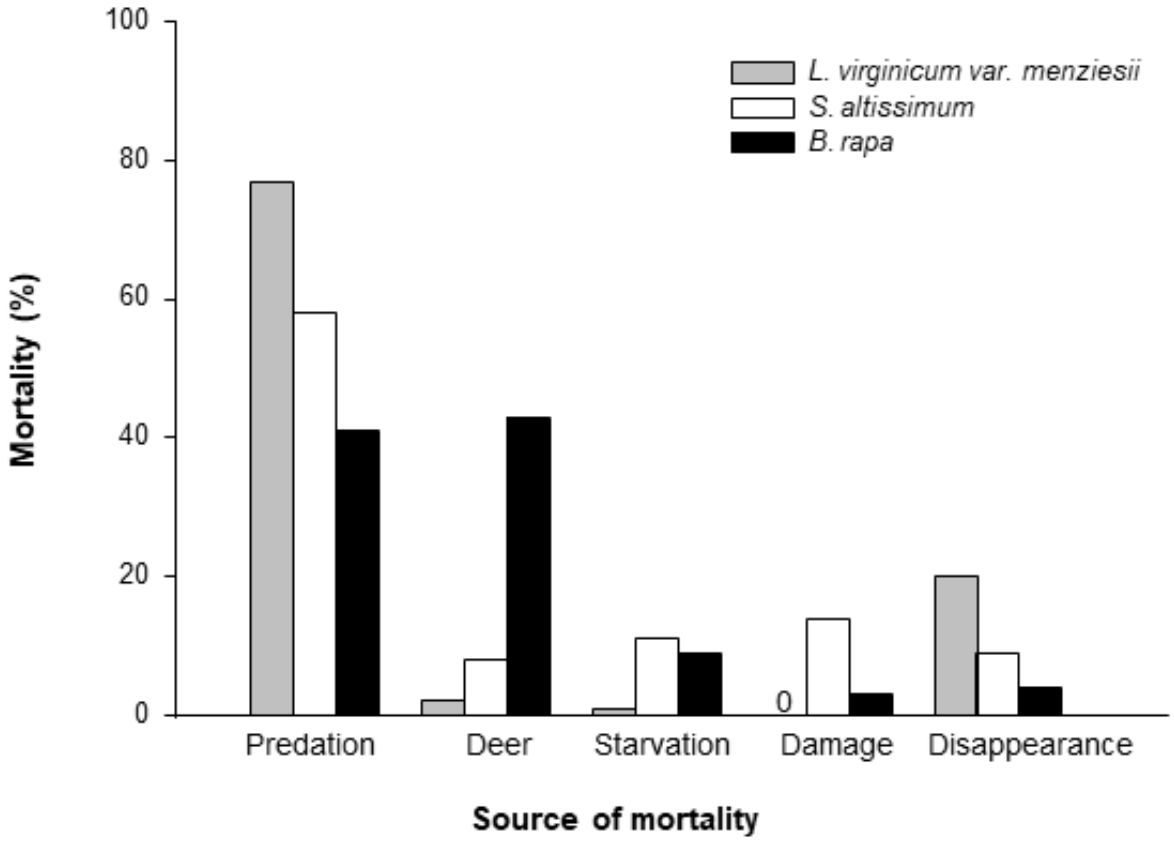

Figure 4. Sources of island marble mortality at all live stages on three host plants (2005-2008)

Sources of island marble mortality at all live stages (n=1515) three host plants from 2005-2008 (n=1515) across sites at American Camp SAJH. From Lambert 2011.

Population Status

In 2006, the USFWS estimated the total abundance of island marbles to be "probably less than 500 butterflies, and possibly as low as 300 individuals" (USFWS 2006) but this estimate was based on limited data (USFWS 2023a). In 2006, the island marble was thought to occupy five areas, then identified as "populations", across San Juan and Lopez Island (Miskelly and Fleckenstein 2007 and USFWS 2023b). In 2007, an additional area was identified at Pear Point on San Juan Island. The island marble was observed at a recently retired gravel pit and on nearby private land (Miskelly and Potter 2009). Today, the island marble's only known population is restricted to a single complex of habitats on southern end of San Juan Island, with most of the occupied range within American Camp Unit of SAJH (Lambert 2017, USFWS 2023a). Island marble may occur in undetected locations, but the probability is low.

Standardized transect counts using modified Pollard and Yates (1997) methods have been conducted at American Camp for over 20 years (2004-present). From 2004 to 2008, Lambert (2011) conducted weekly counts of adult butterflies along transects (14 transects in 2004 and 16 in 2005-2008) across American Camp and documented a consistent and substantial decline in the number of adults observed from 270 adults in 2004 to 63 adults in 2008. Since 2008, transect monitoring has been conducted by the National Park Service (NPS) with support from WDFW and USFWS.

Butterfly encounter rates along transects dropped significantly between 2004-2009 and 2013-2014 and have not rebounded on the most consistently monitored transects (USFWS 2023a). Figure 5 shows a continuous downward trend in relative encounter rate from 2004-2023. This estimate is coarse but is considered an accurate reflection of declining numbers of island marble adults at American Camp SAJH. The increase in island marble relative encounter rate after 2013 is a result of the island marble captive rearing program, where 40 adults were released in tandem with implementation of a habitat restoration research project aimed at increasing host plant availability and native prairie plant communities at American Camp SAJH (Lambert 2014, 2015, 2016, 2017). Since 2014, when a formalized rearing program began, 74-248 adult butterflies have been released annually at American Camp SAJH to support the only island marble population.

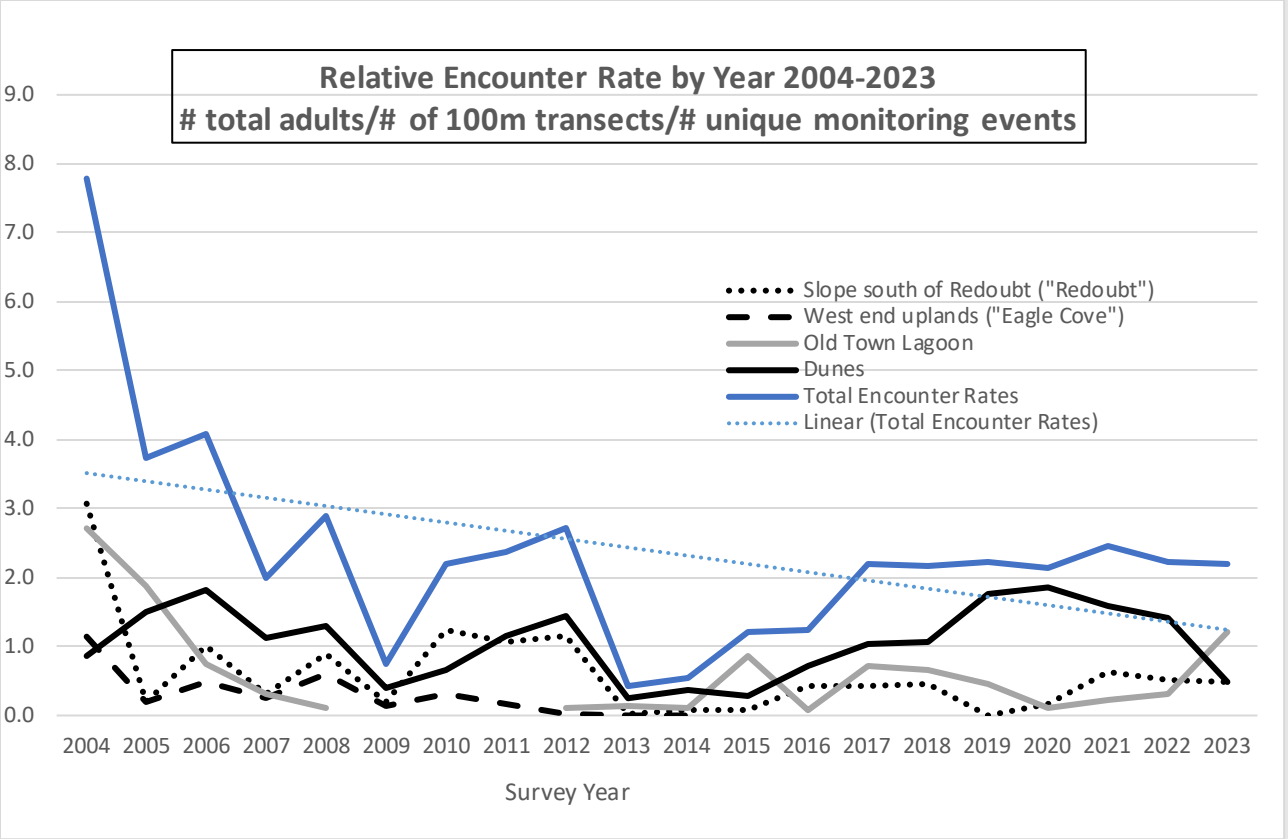

Figure 5. Adult island marble butterfly relative encounter rate (butterflies per 100 m transect) at four locations in American Camp between 2004-2023.

Trend line shows consistent decline in relative encounter rate (proxy for abundance) over time.

Since 2004, encounter rates of island marble have consistently declined. It is likely that this population remains viable because of population augmentation through the captive rearing program.

Habitat Status

Historically, grasslands were comprised of native prairie, however, historic agricultural and ranching practices and the lack of prescribed fires transformed the prairies at American Camp and drastically changed their composition from native prairie vegetation to non-native grass dominated plant communities. Coast Salish management of prairie lands included fire as a management tool to maintain open prairie (Avery 2004). *Brassica* and *Sisymbrium* were likely introduced with other agricultural crops and other non-native grasses in the early 1850's by the Hudson Bay Company and later by homesteading families (Griffin 1852 as cited in Lambert 2011). Transformation of the prairies also occurred due to the presence of abundant cattle, horses and sheep which trampled fragile plants and lichens (Avery 2004). Non-native species such as bentgrass (*Agrostis* sp.), velvet grass (*Holcus lanatus*), Kentucky bluegrass (*Poa pratensis*), quackgrass (*Elymus repens*) and American vetch (*Vicia americana*), form large monocultures across the grasslands (Lambert 2006, Rochefort and Bivin 2010).

The condition and the amount of suitable host plant habitat changes from year to year depending on many interacting factors (e.g., disturbance patterns, management actions, annual weather patterns) which lead to changes in available suitable habitat at local to landscape scales. For example, *Lepidium* lost 3.9 acres of cover from 2004 to 2007 due to a tidal surge that deposited large volumes of gravel on the three lagoon sites that island marble occupied (Lambert 2011). In addition, *Brassica* dramatically increased from 2013 to 2017 (average 17 acres) partially due to habitat enhancement efforts designed to increase *Brassica* habitat at American Camp for the island marble (Lambert 2017).

American Camp encompasses the majority of habitat for island marble, but surrounding adjacent sites on state, county, and private land provide habitat patches where island marble is currently found. As a result of intensive survey efforts from 2005-2010, island marble was documented short-term (i.e. one to six years) at 52 sites across San Juan and Lopez Island, most of which occurred on private land (Potter et al. 2011). Subsequent declines in areas outside of the south end of San Juan Island were the result of habitat loss due to development, plant succession inhibiting host plant growth, host plant damage (e.g., by deer, grazing by domestic animals, and snails), landscaping, mowing, cultivation and other land use changes (Miskelly and Potter 2005, Miskelly and Potter 2009, Hanson et al. 2010, Potter et al. 2011). See more discussion in the Habitat Loss and Degradation Section.

In 2020, the USFWS designated 812 acres (329 hectares) of critical habitat located on the southern end of San Juan Island (USFWS 2020). The majority of critical habitat (718 acres) lies within the boundaries of American Camp. The park also harbors all three habitat types (open prairie/grassland, lagoons, dunes) and provides both the biological (e.g., host plants, nectar resources) and physical attributes (e.g., open landscape, topographical heterogeneity) that the butterfly needs to persist (Table 1). American Camp consists of 1,223 acres (NPS 2008). Grasslands dominate the landscape and harbor a mosaic of plant community types such as freshwater wetlands, dunes, lagoons, dry forests, and shrub zones (Rocchio et al. 2012).

Factors Affecting Continued Existence

Adequacy of Existing Regulatory Mechanisms

Federal protections. In 2020, the USFWS listed the island marble as a federally endangered species and designated 812 acres on southern San Juan Island as critical habitat (USFWS 2020). In 2023, the USFWS published the Species Biological Report, Recovery Plan and Recovery Implementation Strategy for the island marble butterfly (USFWS 2023abc). The recovery plan goals aim to improve: 1) resiliency, by increasing occupied suitable habitat and reduce threats such that core occurrence populations (core OC) can withstand stochastic events; 2) redundancy, by establishing enough core OC's across the species range to withstand catastrophic events; and 3), representation, by expanding the ecological diversity and preserving genetic diversity (USFWS 2023b). Core OC's are defined as spatially clustered, locally patchy populations that are demographically independent of each other (see USFWS 2023b for full definition). The Recovery Implementation Strategy outlines prioritized actions and activities aimed at meeting recovery goals (USFWS 2023c) such as actions that increase and protect island marble habitat, reduce threat factors, increase captive rearing capacity.

Before the federal listing, enacted regulatory mechanisms were largely unable to adequately protect the species across most of its previously occupied range. Currently, the island marble receives additional protections and conservation management because its core area is on NPS land. Activities on NPS land at American Camp have been coordinated with the USFWS under a conservation agreement from 2006 until the island marble's listing in 2020, and since listing through Interagency Coordination under Section 7 of the Endangered Species Act to promote suitable habitat and to minimize the adverse impacts of park activities.

State, county and city protections. The island marble has been a Washington State candidate species since 2002. All state-listed and candidate species are also classified as Priority Species in WDFW's Priority Habitats and Species program (PHS; WDFW 2008). The PHS program provides the best available science and is used by local jurisdictions to guide development of critical areas ordinances to conserve PHS-listed species and habitats. County and/or municipal critical area ordinances require environmental review and habitat management plans to protect the species from development proposals in areas that have a primary association with the species. Jurisdictions generally consult with WDFW, and may impose conditions on development to avoid, minimize, and mitigate impacts to PHS species.

Under the Washington Growth Management Act, counties are required to designate and protect several types of critical areas including fish and wildlife habitat conservation areas. Fish and wildlife habitat conservation area designation requires that each county preserve and protect the fish and wildlife habitat associated with each habitat conservation area by developing policies and regulations to protect the functions and values of critical areas. In 2012, San Juan County, through the San Juan County Critical Areas Ordinance (section 18.35.110), designated the island marble as a species of local importance, extending critical areas protections to the butterfly. With this designation, development applications for areas determined to be occupied by the island marble are required to develop a habitat management plan consistent with County recommendations for the conservation of the island marble before permitting.

Habitat Loss and Degradation

Habitat loss and degradation at local to landscape scales are driven by multiple interacting factors. Factors that limit and degrade island marble habitat include land use changes on San Juan and Lopez Island (e.g., residential development, road construction/maintenance, agricultural cultivation), management practices (e.g., roadside maintenance and lack of active management), deer herbivory, plant succession, and competition with introduced and native species that can limit host plant growth and disturb overwintering sites. Activities associated with agricultural lands such tilling, mowing, haying and livestock grazing can decrease host plant availability (Miskelly and Potter 2009).

Collectively, survey efforts and site assessments show that it is likely that these interacting factors (in addition to the factors below) led to the collapse of the previously occupied sites across San Juan and Lopez Island (Miskelley and Potter 2009 and Potter et al. 2011) and contraction in range to a few areas on the southern end of San Juan Island. Stress factors limit larval host plant availability and therefore impact survival and population growth. Active management of grassland and sand dune habitats is needed to reduce competition by nonnative perennial and annual grasses and forbs, shrubs, and Douglas-fir (*Pseudotsuga menziesii*) encroachment. (Lambert 2011, Weaver and Vernon 2014, Vernon 2015a, Lambert 2017). Introduced grasses and invasive plants such as Canada thistle (*Cirsium averse*)

outcompete and displace larval host plant habitat via succession and soil stabilization in grassland and dune habitats (Lambert 2011, Lambert 2017, Vernon 2015a). In 2012, Vernon and Weaver (2012) attributed *Brassica* decline at American Camp primarily due to competition with introduced grasses and deer herbivory. Additionally, Canada thistle displaced *Sisymbrium* in the dunes and stabilized previously sandy soil necessary for host plant establishment (Weaver and Vernon 2014). Habitat enhancement research shows restoration practices such as reduction of annual grasses and seeding of host plants is necessary to create the suitable conditions for host plants and native plants (seeds and plugs) to establish (Lambert 2016 & 2017; See Habitat Status section).

Predation

Predation by spiders and wasps is the leading cause of juvenile mortality, accounting for 49–55% of overall juvenile mortalities (Lambert 2011, 2014a, 2015, 2017). Predation rates are highest during the earliest stages of life (egg to first instar) and increased dramatically after the first week of June (Lambert 2011, Lambert 2017). Several species of crab and other spiders (e.g., *Misumena vatia*) and paper wasps (e.g., *Polistes dominula*) have been documented to consume eggs, larvae, and adults of the island marble (Lambert 2011, WDFW unpub. data). Direct juvenile predation rates vary by host plant species, resulting from the host plant location (i.e., dune, grasslands, lagoons) and structure and growth forms which permit varying levels of access by predators (Lambert 2011).

Larval predation by spiders and wasps intensifies as the season progresses (Lambert 2011, 2015, 2017) and likely contributes to the pattern of extremely low survivorship beginning in early June. For example, during the 2015-2017 field season only one egg laid after June 3 (n=329) survived to instar IV (Lambert 2017). While late season mortality is caused by multiple factors (e.g., starvation, plant damage) predators play the most significant role (Lambert 2011).

Figure 6. Examples of spider predators of the island marble butterfly.

From left to right: Two introduced invasive species the Candy-striped spider (Enoplognatha ovata; Theridiidae), European crab spider (Xysticus cristatus; Thomisidae) and a native flower crab spider (Misumena vatia; Thomisidae). All Photos taken on June 7, 2023 by J.K. Combs during island marble egg and larval monitoring.

Incidental Predation by Deer, Rabbits, Snails (Herbivory)

Deer herbivory. At American Camp, herbivory by deer has affected 95% of *Brassica* plants in some years (Lambert 2011). Habitat loss attributable to deer herbivory is ongoing and extensive throughout the current and former range of the island marble and may be increasing, with substantial impacts to the butterfly (Lambert 2011, 2014, 2015). Like rates of direct predation, each species of larval host plant is correlated with differing levels of mortality attributable to deer browse (Figure 4). Deer browsing pressure is generally greatest on *Brassica* and lowest on *Lepidium* (Lambert 2011). Incidental predation through deer herbivory typically accounts for about one-quarter of juvenile mortalities (Lambert 2011, 2014, 2015). In addition to egg mortality due to incidental predation, the effect of deer browse on larval host plants is three-fold: (1) it destroys suitable egg-laying habitat; (2) it stimulates rapid growth of lateral (side) stems on the plant, resulting in high rates of larval starvation; (3) and continued browsing of the plant's flowering portion reduces seed production, resulting in fewer larval host plants over time (Lambert 2011, 2014a, 2015).

Impacts of deer herbivory outside American Camp were documented by Miskelly and Potter (2009) who observed deer browsing as a potential threat at all 43 IMB occupied sites from their 2005-2007 survey effort. Also, Martin et al. (2011) showed that deer herbivory significantly changed and regulated vegetation structure and reduced vegetation cover across several Gulf and San Juan Islands.

Rabbits. European rabbits (*Oryctolagus cuniculus*) have occupied American Camp for more than a century, following their introduction to San Juan Island during the late 1800's (Couch 1929). European rabbit populations have been highly variable at American Camp. Monitoring between 1985 and 2015 indicated a high of 1,750 rabbits in 2006 and fewer than 100 between 2009 and 2012. In 2015 the previously low population had again grown to about 500 rabbits (West 2013). Following an outbreak of rabbit hemorrhagic virus last documented in 2019 the rabbit population declined; however, no recent population studies have been conducted so current population size is unknown. Incidental observations of rabbit herbivory indicated that rabbits consume young host plants near warrens but have not been quantified, so it is difficult to assess local and landscape level impacts.

Snails. The nonnative brown garden snail (*Cornu aspersum*) is a generalist herbivore that feeds on *Brassica* and *Sisymbrium* host plants and has overpopulated and impaired habitats previously occupied by the island marble (e.g., Pear Point Gravel Pit and San Juan Valley) (Hanson et al. 2010, Potter et al. 2011). Biologists removed hundreds of snails that were feeding on larval host plants at Pear Point in 2010 when the island marble still occupied this site (Potter et al. 2011). In 2015, the brown garden snail was observed in San Juan Valley, and in 2016, the brown garden snail was documented in the South Beach area at American Camp and now appears to be well established within American Camp (Vernon 2015), raising the likelihood that herbivory by the brown garden snail will result in host plant damage which may result in mortality of eggs and larvae on occupied plants. Although there are no documented accounts of snails directly consuming island marble eggs or larvae, the brown garden snail poses a threat by consuming occupied or unoccupied larval host plants (USFWS 2023).

Phenological Asynchrony, Starvation, Climate Factors

Phenological asynchrony, starvation and climate factors can be interrelated. Starvation, largely due to asynchronous timing between host plant availability and larval feeding requirements, was the third

highest source of mortality behind direct predation and incidental predation primarily due to deer browsing (Figure 4; Lambert 2011, 2015, 2017). Rates of mortality fluctuate from year to year depending on interacting factors and management actions.

Temperature directly affects development, survival, range, and abundance of insects. Species with small geographic ranges will be more affected than species with large geographic ranges (Bale et al. 2002). Forister et al. (2021) shows that population trends have declined in over 50 butterfly species across the western United States, including the large marble (*Euchloe ausonides*) and that downward trends are significantly correlated with warming and drying landscapes. Warmer than usual patterns can impact host plant availability and quality. Bauerfeind and Fischer (2013) examined a pierid butterfly-mustard feeding system and showed that temperature effects due to warming reduced body mass, led to longer development time and reduced efficiency of converting food into body matter, indicating poor host quality. It is currently unknown how climate factors will impact island marble. Lambert (2011) suggests that higher than normal temperatures can increase the rate of flower and fruit development which can lead to starvation of island marble first and second instars that require buds and young fruit in the early stages of feeding. More research is needed to understand what these changes will be and how responses will vary under different site and host plant conditions.

Along with an increase in warm and dry conditions, patterns of unusually cold and wet springs have been observed on San Juan Island. Colder temperatures in combination with higher than normal precipitation may impact the island marble in several ways. For example, Lambert (2011) documented a phenological shift in adult flight period from early April to late April (approximately 10 days) from 2004 to 2008 likely due to an increase in cold wet springs. Additionally, wetter cooler conditions in early spring may reduce the amount of time females have to lay eggs (Lambert 2011). More research to understand potential mismatches between oviposition timing and food-plant available in a suitable phenological stage (i.e., flower buds and flowers) is needed.

Sea-level rise associated with climate change is expected to continue as polar ice melts and seawater thermally expands, leading to an increase in ocean volume (Adelsman et al. 2012, Dalton et al. 2013). Rising sea level and warming will increase the impacts of storm surges and flooding events in low-lying areas, such as the nearshore lagoon strand habitat of the island marble (MacLennan et al. 2013, Vose et al. 2014). Climate-driven disturbance likely caused the local extinction of island marble at Jakle's Lagoon in February 2006, when a high tide windstorm shifted driftwood and deposited large volumes of gravel. Transect data at this *Lepidium* site shows a continues decline in adult abundance after the storm surge event (11 in 2005, 4 in 2006 and 1 2007 and 1 in 2008; Lambert 2011). Since island marble is represented by a single small population, mortality and habitat loss resulting from storm surges may have population-level detrimental impacts. Stochastic climate events are expected to increase over time. While disturbance is a necessary element for maintaining early successional host plant availability for the island marble, climate driven stochastic patterns are predicted to be more extreme and frequent and will likely impact the persistence of this species based on regional climate predictions (Adelsman et al. 2012, Littell et al. 2009 and Mote and Salathé 2009).

Illegal Harvest

The illegal collection and trade of rare and endangered butterflies occurs among some unscrupulous private collectors. In the year following the butterfly's rediscovery, WDFW staff were unsuccessfully

solicited by private individuals for butterfly location information for collection purposes. We have no evidence indicating that the illegal collection or trade of island marbles has occurred, however, given the illicit nature of the activities, it is plausible that it has just gone undetected.

Factors Related to Small Population Size

Small populations are exceptionally vulnerable to extinction due to the lack of ability to adapt and rebound from stressors related to demographic, environmental, and genetic changes. It is assumed that island marble has very low genetic diversity because of it being limited to a single small population that occupies a narrow geographic range. Inbreeding depression and random changes in allele frequency due to genetic drift are major concerns that may influence the viability of island marble. Genetic mutations via inbreeding depression will accumulate more rapidly in small populations and limit a species' ability to adapt to changing environmental conditions. Viable populations must be large enough to maintain sufficient genetic variation for adaptation to such changes (see examples in Allendorf et al. 2022). A recent study by Jones et al. 2024 indicates that the population of American Camp, San Juan Island National Historical Park island marble experiences low heterozygosity, a small effective population size (Ne), and low allelic diversity and that high levels of inbreeding were found in some individuals, but inbreeding was uneven across the population (husgs.gov/centers/eesc/science/conservation-genetics-and-genomics-narrowly-endemic-island-marble-butterfly).

Small population size of the island marble butterfly constitutes a significant threat to the continued existence of this species. Any further loss of abundance and/or occupied habitat will further undermine the subspecies continued viability and will move the island marble perilously closer to extinction. Stochastic environmental events such as storm surges have been documented to cause local extinction at one site for several years (Lambert 2011). Additional stochastic events that could potentially be devastating include an early-spring weather abnormality (e.g., extended hard freeze) and/or late-spring, summer droughts that can lead to lack of host plant availability, a year in which predator populations are unusually high, pathogen outbreaks, or a catastrophic event at the single captive rearing facility.

Conservation Actions and Management

Captive Rearing

The island marble captive-rearing program was developed to prevent the extinction of the island marble after alarming declines in 2009 and again in 2013-2014 (Figure 5). Small-scale captive-rearing trials began in 2009 and continued for several years with 16–47 individuals reared annually (Vernon 2015b). In 2014, the NPS converted an outbuilding into a rearing facility, and 88 eggs and larvae were brought in for captive-rearing. At times, environmental conditions in the NPS rearing facility were inconsistent with wild conditions, leading to poorly timed releases. For example, many of the individuals released in 2015 eclosed late and were subsequently released after wild adults and host plants where not suitable for egg-laying (Potter 2016). A captive-rearing technical group outlined a protocol for managing the internal conditions of the captive rearing facility to avoid future late eclosures (Potter 2016). The island marble captive rearing work group (USFWS, NPS, WDFW) meets annually to discuss challenges of the following season and collection, rearing and release strategies for the next season. Since the spring of 2015, a

total of 1,308 island marble butterflies have been released (74-215 annually) and are currently sustaining the last remaining population. In 2024, On Sacred Ground, a local non-profit partner experienced with island marble captive rearing activities staffed the NPS rearing facility. Also as of 2024, USFWS, WDFW, and Woodland Park Zoo (WPZ) are working together on the next steps for a sustainable captive rearing program. WPZ compiled a comprehensive manual with the best available and most pertinent information for the husbandry of island marble in captive care (Uyeda and Sullivan 2024) in coordination with the USFWS. WPZ will be responsible for staffing the rearing lab in future seasons.

Habitat Management at San Juan Island National Historical Park—American Camp

San Juan Island National Historical Park implements conservation measures focused on restoration of native ecosystems. Past and present actions include but are not limited to prescribed fire, seeding and planting plugs of native grasses and forbs (Lambert 2006, NPS 2013) and the support of research and management actions designed to control invasive species, protect and enhance island marble habitat and other rare species (e.g., Rochefort 2012, Lambert 2014, 2015, 2017, NPS 2013, 2022, 2023).

Restoration research showed that fire in combination with herbicide treatments reduced introduced perennial grasses and increased native prairie forb and bunchgrass cover (Lambert 2006). From 2007 through 2011, the NPS managed encroaching plants to open areas where island marble larval host plants could naturally germinate from the seed bank, and planted more than 100,000 native grass plugs (NPS 2013). The native grass plugs improved the native composition of the prairie grassland features but did not result in increased coverage of island marble larval host plants.

From 2014-2017 the NPS supported experimental research designed to 1) establish suitable island marble habitat including reducing introduced grasses in order to increase island marble host plants as well as native prairie composition, 2) protect habitat enhancement areas from deer herbivory, and 3) measure host plant traits and track egg-laying and survivorship to develop recommendations to further protect and conserve the island marble butterfly (Lambert 2014, 2015, 2017). Key results from these studies showed host plant habitat can be successfully created on an annual basis and that island marble readily uses habitat patches for egg laying and larval development. Furthermore, survival of immature stages is highest when host plant phenology and larval stages are synchronized, and it is well documented that protecting host plant habitat from deer browsing is critical to the survivorship of eggs and larvae of island marble (Lambert 2017). Deer exclusion fencing remains an important tool for protecting island marble host plant habitat, especially early in the flight season when survivorship is expected to be the highest (Lambert 2015).

The NPS has implemented management actions including but not limited to invasive plant removal, seeding host plants into mammal disturbance opening, and planting plugs of host plants, but these actions are limited in scale (NPS 2022, 2023). Additionally, NPS has installed temporary fencing in target areas to protect island marble habitat at American Camp to exclude deer, increase host plant availability and reduce indirect consumption of eggs and larvae since 2017. For example, in 2023 approximately nine acres of host plant habitat was protected within fenced areas at three sites across American Camp (Upper and Lower Redoubt and Old Road Bed). In 2023, WDFW surveyed host plants and eggs and

larvae within fenced areas and estimated that fenced areas protected 1,055 *Brassica* and *Sisymbrium* plants and 335 eggs and larvae from deer herbivory (unpub. data).

The NPS continues to manage invasive and encroaching species, including the removal of small stature Douglas-fir trees and Himalayan blackberry (*Rubus armeniacus*), cutleaf blackberry (*R. laciniatus*), snowberry (*Symphoricarpos albus*), one-seeded hawthorn (*Crataegus monogyna*) and Canada thistle (*Cirsium arvense*) and others through manual, mechanical, and herbicide treatment throughout American Camp. These actions have slowed the invasion of native and nonnative species and encroachment by woody plants and have created early-successional conditions. Unfortunately, few larval host plants germinate from the seed bank in the cleared areas (USFWS 2020).

In December 2018, a conservation agreement was renewed between the USFWS and the NPS to manage habitat for the island marble into the future. In the renewed agreement, the NPS committed to 1) restore, where needed, habitat for island marble butterfly, as jointly agreed; and (2) avoid impacts to island marble butterflies, eggs, larvae, and host plants during the implementation of all NPS management actions (USFWS 2023a).

In 2021, the NPS initiated a planning and compliance process to develop, in consultation with a broad group of stakeholders, a reasonable range of alternatives that implement park-specific island marble recovery actions within lands of San Juan Island National Historical Park. Through this process, the NPS has identified landscape-level habitat protection, potentially including evaluation of permanent habitat protection and creation of habitat patches on a landscape scale in some areas of the park (USFWS 2023a) as well as management actions that support other imperiled species such as the sand verbena moth, sharp-tailed snake, and Propertius duskywing butterfly. The NPS plans to implement restoration treatments on a broader scale in the next few years.

Habitat Establishment and Protection on Non-Federal Lands, Outreach and Education

In 2009, WDFW made efforts across islands to communicate and inform the public of the conservation needs of the island marble. WDFW developed and distributed informational factsheets that described the natural history, habitat requirements and biological needs of the butterfly. In addition, outreach by USFWS and WDFW in 2018 aimed to inform non-federal landowners of a Candidate Conservation Agreement with Assurances (CCAA) program. Seven hundred postcards were mailed out to residents, newspaper articles and bulletins served as outreach, and six meetings were open to the public to describe the CCAA opportunity (USFWS 2023a).

In 2019, WDFW and USFWS developed a Programmatic Candidate Conservation Agreement with Assurances (CCAA) to promote island marble conservation and recovery on non-federal lands through habitat creation and protection (WDFW and USFWS 2019). A CCAA is a voluntary agreement whereby landowners (including state, tribal, non-federal, publicly owned, or privately owned lands) agree to manage their lands, or portion thereof, to both remove or reduce threats to affected covered species that may become listed under the Endangered Species Act of 1973, as amended (ESA)(87 Stat. 884; 16 U.S.C. 1531 et seq.) and, per USFWS regulations, are expected to provide a net conservation benefit to affected covered species (50 C.F.R. 17.22). In return for managing their lands to provide a net conservation benefit to covered species, enrolled landowners receive assurances that they can

implement covered activities identified in the agreement with no risk of violating the ESA by inadvertently taking (i.e., killing, injuring, etc.) the covered species if it becomes listed as threatened or endangered under the ESA so long as the CCAA remains in place and is being fully implemented. The CCAA is designed to create suitable habitat in locations that are not currently occupied by the island marble butterfly, to protect existing island marble butterfly habitat, and to ameliorate potential threats (WDFW and USFWS 2019).

Interest in the CCAA was considerable and final enrollment included 18 independent private parcels, one homeowner's association, two governmental agencies, and one nonprofit organization. Current enrollment provides CCAA coverage for 1,180 acres with a commitment to establish .74 acres of island marble host plant habitat. Since 2019, with funding from the USFWS and WDFW, county-level and non-profit partners have led a habitat expansion project at target sites to create suitable habitat patches for the last five years (e.g., Foley 2020, 2024) to support habitat development and monitoring of island marble and host plant resources at CCAA sites. Additionally, since 2020, with funding from state resources and two consecutive USFWS Wildlife and Sport Fish Recreation Program Competitive State Wildlife Grants, DNR has developed suitable host plant habitat (*Sisymbrium*) and restored native prairie at Cattle Point NRCA (Natural Resources Conservation Area). Cattle Point NRCA is a CCAA site and is directly adjacent to American Camp and serves to expand immediate habitat outside of American Camp.

Habitat expansion efforts described above show successful gains that meet the CCAA's primary objective to create suitable habitat aimed at expanding the subspecies range to areas outside the core population area at American Camp SAJH. For example, in 2024, WDFW reported that CCAA enrollees cultivated, maintained, and protected a total 0.64 acres of suitable host plant habitat which supported a total of 128 island marble butterflies at various live stages (6 adults, 25 larvae and 97 eggs). Finally, USFWS supported the development guidelines (Martin 2024) for landowners regarding how to create suitable island marble habitat focused on *Brassica*. Once the species was listed, no new landowners were eligible to enroll in the CCAA, however, the USFWS's Partners for Fish and Wildlife Program has provided funding, technical assistance, and ESA take coverage for additional landowners to participate in island marble host plant habitat patch creation on San Juan and Lopez Islands.

Conclusion and Recommendation

Washington State defines "Endangered" to mean any wildlife species native to the state that is seriously threatened with extinction throughout all or a significant portion of its range. Local extinction has occurred at all previously occupied sites on San Juan and Lopez Island except for the one remaining population located on the southern end of San Juan Island. It is likely that this sole population remains viable because of population augmentation of annual release of adult butterflies through a captive rearing program. We conclude that the island marble is at a high risk of extinction given that: 1) only one population remains; 2) annual transect monitoring from 2004-2023 at the core population shows a consistent decline in encounter rate; and 3) local extirpation has occurred at all previously occupied sites on San Juan and Lopez Islands except for the remaining population located on the southern end of San Juan Island. In addition, the USFWS has already classified the island marble as endangered under the ESA; WAC 220-610-110 guides WDFW to recommend an endangered or threatened listing for any species listed as endangered or threatened under the federal ESA. Therefore, we also conclude that the

island marble is at a high risk of extinction. It is recommended that the island marble butterfly be classified as a Washington state endangered species.

Literature Cited

The references that are cited in the *Status Report* for the island marble are categorized for its level of peer review pursuant to section 34.05.271 RCW, which is the codification of Substitute House Bill 2661 that passed the Washington Legislature in 2014. A key to the review categories under section 34.05.271 RCW is provided in Table A.

Table A. Key to 34.05.271 RCW Categories:

34.05.271(1)(c) RCW	Category Code
(i) Independent peer review: review is overseen by an independent third party.	i
(ii) Internal peer review: review by staff internal to the department of fish and wildlife.	ii
(iii) External peer review: review by persons that are external to and selected by the department of fish and wildlife.	iii
(iv) Open review: documented open public review process that is not limited to invited organizations or individuals.	iv
(v) Legal and policy document: documents related to the legal framework for the significant agency action including but not limited to: (A) federal and state statutes; (B) court and hearings board decisions; (C) federal and state administrative rules and regulations; and (D) policy and regulatory documents adopted by local governments.	v
(vi) Data from primary research, monitoring activities, or other sources, but that has not been incorporated as part of documents reviewed under the processes described in (c)(i), (ii), (iii), and (iv) of this subsection.	vi
(vii) Records of the best professional judgment of department of fish and wildlife employees or other individuals.	vii
(viii) Other: Sources of information that do not fit into one of the categories identified in this subsection (1)(c).	viii

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Appendix A.

Observed nectar plants for the island marble butterfly (Miskelly 2000, Pyle 2004, Miskelly and Potter 2005, Lambert 2011, Vernon and Weaver 2012).

Plant Family	Common Name	Scientific Name	Native/ Introduced
Apiaceae	common lomatium	*Lomatium utriculatum*	Native
Asparagaceae	Howell's brodiaea	*Triteleia grandiflora*	Native
Asteraceae	hairy cat's ear	*Hypochaeris radicata*	Introduced
Asteraceae	common dandelion	*Taraxacum officinale*	Introduced
Asteraceae	yarrow	*Achillea millefolium*	Native
Boraginaceae	common forget-me-not	*Myosotis discolor*	Introduced
Boraginaceae	fiddleneck	*Amisinckia menziesii*	Native
Brassicaceae	tall peppergrass	*Lepidium virginicum var. menziesii*	Native
Brassicaceae	field mustard	*Brassica rapa*	Introduced
Brassicaceae	tumble mustard	*Sisymbrium altissimum*	Introduced
Brassicaceae	American sea rocket	*Cakile edentula*	Introduced
Caryophyllaceae	field chickweed	*Cerastium arvense*	Native
Fabaceae	seashore lupine	*Lupinus littoralis*	Native
Geraniaceae	dovefoot geranium	*Geranium molle*	Introduced
Geraniaceae	common stork's bill	*Erodium cicutarium*	Introduced
Melanthiaceae	death camas	*Toxicoscordion venenosum*	Native
Nyctaginaceae	yellow sand verbena	*Abronia latifolia*	Native
Ranunculaceae	California buttercup	Ranunculus californicus	Native
Rosaceae	trailing blackberry	Rubus ursinus	Native