U.S. Fish & Wildlife Service

Recovery Plan for Island Marble Butterfly (*Euchloe ausonides insulanus*)

Photo credit: Trent Leiber, National Park Service

Recovery Plan
for
Island Marble Butterfly
(*Euchloe ausonides insulanus*)

U.S. Fish and Wildlife Service
Portland, Oregon

Approved: HUGH MORRISON Digitally signed by HUGH MORRISON Date: 2023.08.23 16:46:57 -07'00'

Regional Director,
Pacific Region 1

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Recovery plans delineate reasonable actions needed to recover and/or protect listed species. We, the U.S. Fish and Wildlife Service (Service), publish recovery plans, sometimes preparing them with the assistance of recovery teams, contractors, State agencies, and others. Objectives of the recovery plan are accomplished, and funds made available, subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities with the same funds.

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The first uses of technical terms are underlined and are defined in the glossary starting on page 24.

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RECOVERY PLANNING PROCESS

The Service is now using a three-part framework for recovery planning (see https://www.fws.gov/sites/default/files/documents/recovery-planning-and-implementation-fact-sheet.pdf). This approach is intended to reduce the time needed for recovery planning, increase the relevancy of recovery plans over a longer timeframe, and increase the flexibility of recovery planning documents by making them easier to modify as new information or circumstances arise. Under this process, a recovery plan includes the statutorily-required elements under section 4(f) of the Endangered Species Act (Act) (objective and measurable recovery criteria, site-specific management actions, and estimates of time and costs), along with a concise introduction and our strategy for how we plan to achieve species recovery. The recovery plan is supported by two supplementary documents: a species status assessment or species biological report, which describes the best available scientific information related to the biological needs of the species and assessment of threats; and the recovery implementation strategy, which details the particular near-term activities needed to implement the recovery actions identified in the recovery plan. Under this approach, new information on species biology or details of recovery implementation may be incorporated by updating these supplementary documents without concurrent revision of the entire recovery plan, unless changes to statutorily-required elements are necessary.

Thus, this recovery plan document is one piece of a three-part framework:

1. The **Species Status Assessment** (SSA) or **Species Biological Report** (SBR) informs the recovery plan: it describes the biology and life history needs of the species (includes distinct population segments, subspecies, species groups), includes analysis of each species' historical and current conditions, and includes discussion of threats and conservation needs of each species. The SSA or SBR's format is structured around the conservation biology principles of resiliency, redundancy, and representation (Shaffer and Stein 2000, pp. 307-310; Wolf et al. 2015, entire; Smith et al. 2018, entire). This document may be updated as needed based on new information. The SBR for the island marble butterfly contains a more detailed population assessment, including the geographic and environmental context of its range in Washington (USFWS 2023a), which supplements the overview of its biology and threat status in this recovery plan.

2. The **Recovery Plan** contains a concise overview of the recovery strategy for the species (indicating how its recovered state will achieve redundancy, resiliency, and representation), as well as the statutorily-required elements of recovery criteria, recovery actions, and estimates of the time and costs to achieve the plan's goals.

3. The **Recovery Implementation Strategy** (RIS) outlines how the recovery plan will be implemented. The RIS is a short-term, flexible operational document focused on how, when, and by whom the recovery actions from the recovery plan will be implemented. This document may be updated as needed based on new information, allowing it to be adapted to changing circumstances with greater flexibility and efficiency. The RIS is developed and maintained in cooperation with our conservation partners and focuses on the period of time and activities that work best for our partners to achieve recovery goals. The island marble butterfly RIS, prepared in coordination with our conservation partners in Washington, identifies the high-priority actions for recovery (USFWS 2023b).

EXECUTIVE SUMMARY

Species Status

The island marble butterfly (*Euchloe ausonides insulanus*), a subspecies of the large marble butterfly (*E. ausonides*), is an early spring-flying butterfly in the family Pieridae. It was historically known from the southeastern coast of Vancouver Island north to Nanaimo, Canada, but the last known specimen in Canada was collected in 1908. After 90 years without a documented occurrence, the island marble butterfly was rediscovered in 1998 on San Juan Island, Washington, United States. In 2006, five areas of occupied habitat were documented across San Juan and Lopez Islands (Miskelly and Fleckenstein 2007, p. 4; USFWS 2023a). By 2012, the species distribution contracted to a single population at American Camp of San Juan Island National Historical Park, with a few larvae detected on Lopez Island (83 FR 15900, April 12, 2018; 85 FR 26786, May 5, 2020). On April 12, 2018, the Service published a proposed rule in the Federal Register (FR; 83 FR 15900) to list the island marble butterfly as an endangered species and to designate critical habitat. For a detailed description of listing history, see the SBR (USFWS 2023a). The island marble butterfly was listed as endangered and critical habitat for the island marble butterfly was designated under the Act on May 5, 2020 (85 FR 26786). The subspecies has a recovery priority number of 3, indicating that it has a high recovery potential but faces threats that are imminent and of high magnitude (USFWS 2020). In this document, we refer to the island marble butterfly as a species for ease of reference and because subspecies are treated as listable entities, just as are species, under the Act (85 FR 26786, May 5, 2020). In total, 812 acres (329 hectares) on the south end of San Juan Island are designated as critical habitat (Figure 1; 85 FR 26786, May 5, 2020).

Recovery Vision

Recovery of the island marble butterfly will be signified by the conservation and protection of multiple resilient and self-sustaining core occurrence complexes (core OCs) well distributed across the diversity of habitats the species utilizes with the capacity to adapt to environmental and demographic changes over time.

Recovery Strategy

A major cause of the species' decline is the loss and degradation of suitable habitat throughout its range due to vegetational succession, invasive nonnative plants, and herbivory. The island marble butterfly also faces threats of predation from spiders and wasps, incidental predation by black-tailed deer (*Odocoileus hemionus columbianus*), and vulnerabilities associated with occupancy being limited to a single area. The recovery strategy seeks to improve: (1) resiliency, by increasing occupied suitable habitat and ameliorating threats such that core OCs can withstand stochastic events; (2) redundancy, by establishing enough core OCs well distributed across the species range to provide a safety margin to withstand catastrophic events; and (3) representation, by expanding the ecological diversity and preserving the genetic diversity of the species. Activities to ameliorate these threats are included in the RIS.

We note that new or emerging threats may arise over time. If any such issues are so significant as to result in a need to change the recovery strategy or the statutorily-required elements of the recovery plan under section 4(f)(1) of the Act, we will amend or revise the plan as appropriate.

Recovery Criteria

Downlisting Criterion 1

At least four core OCs have been established or identified within the range of the island marble butterfly. These must include a minimum of two core OCs on San Juan Island, a minimum of one core OC on Lopez Island, and one additional core OC that may be on either of those islands or elsewhere within the species' range.

Downlisting Criterion 2

Within the four core OCs in Downlisting Criterion 1, population resiliency is demonstrated by the amount of suitable habitat occupied by the island marble butterfly remaining stable or increasing in at least 9 years over a monitoring period of 9 to 12 years.

Downlisting Criterion 3

Sufficient suitable habitat is conserved and managed with long-term management commitments to achieve Downlisting Criteria 1 and 2. This includes conservation of large, open treeless areas with diverse topographic features, suitable habitat representing the diversity of habitat types used by this species (coastal lagoons/shoreline, grassland/prairie and sand dune), and stepping-stone habitat connecting them.

Delisting Criterion 1

At least six core OCs have been established or identified within the range of the island marble butterfly, with a minimum of three core OCs on San Juan Island, a minimum of two core OCs on Lopez Island, and one additional core OC that may be on either of those islands or elsewhere within the species' range.

Delisting Criterion 2

Within the six core OCs in Delisting Criterion 1, continuing population resiliency after meeting downlisting criteria is indicated by the total amount of suitable habitat occupied by the island marble butterfly remaining stable or increasing in at least 9 years over a monitoring period of 9 to 12 years without population augmentation.

Delisting Criterion 3

Sufficient suitable habitat is conserved and managed with long-term management commitments to achieve Delisting Criteria 1 and 2. This includes conservation of large, open treeless areas with diverse topographic features, suitable habitat representing the diversity of habitats used by this species (coastal lagoons/shoreline, grassland/prairie and sand dune), and stepping-stone habitat connecting them.

<u>Recovery actions and their estimated cost (in fiscal year 2023 dollars). See also RIS (USFWS 2023b).</u>

Recovery Action	Estimated Cost
1. Protect the island marble butterfly and its habitat at American Camp by reducing herbivory on host plants and incidental predation on butterflies, enhancing suitable habitat, and controlling invasive plants	$4,750,000
2. Establish and expand suitable habitat for the island marble butterfly across its range representing the diversity of habitat types used by this species (coastal lagoons/shoreline, grassland/prairie and sand dune).	$2,075,000
3. On sites with long-term conservation commitments, conserve and manage suitable habitat for the island marble butterfly by maintaining disturbance regimes and reducing herbivory on host plants and incidental predation on butterflies.	$10,370,000
4. In areas of suitable habitat within the species range, identify or establish (through captive rearing, augmentation, reintroduction, and/or dispersal) three to five additional core OCs to increase the species' resiliency, representation, and redundancy.	$4,365,000
5. Actively and adaptively manage dispersal corridors and stepping-stone habitat to improve connectivity among core OCs.	$370,000
6. Conduct research on life history, management techniques, and the effects of climate change on the species and habitat to guide conservation efforts for the island marble butterfly.	$1,320,000
7. Monitor the species range-wide, track trends over time, and assess threats.	$1,710,000
8. Coordinate and collaborate with partners to conserve the island marble butterfly throughout its range.	$560,000
Total Estimated Cost	**$25,520,000**

<u>Date of Recovery</u>: Recovery criteria could be met by 2050, based on the conservative assumption that all recovery plan actions are fully funded and implemented as currently outlined, including cooperative efforts by all partners needed to achieve recovery.

TABLE OF CONTENTS

ACKNOWLEDGMENTS ii
RECOVERY PLANNING PROCESS iii
EXECUTIVE SUMMARY iv
I. INTRODUCTION 1
Background 4
Basic Species Information 4
Threats 5
Viability 6
II. RECOVERY 7
Recovery Vision and Strategy 7
Recovery Vision 7
Recovery Strategy 7
Recovery Criteria 10
Objective 10
Downlisting Criteria 11
Delisting Criteria 13
III. RECOVERY ACTIONS 14
Priority 2 15
Priority 3 15
IV. TIME AND COST ESTIMATES 17
Date of Recovery 19
V. REFERENCES 20
Literature Cited 20
In Litt. References 23
Appendix – Glossary 24
Literature Cited in Glossary 28
Summary of the Comments Received on the Draft Recovery Plan for the Island Marble Butterfly: 29

LIST OF FIGURES

Figure 1. Location of island marble butterfly designated critical habitat (85 FR 26786). 3
Figure 2. Schematic of island marble butterfly observation records, OCs and core OCs. 9

LIST OF TABLES

Table 1. Crosswalk relating threats, recovery criteria, and recovery actions for island marble butterfly. 16
Table 2. Priority and estimated cost of recovery actions for the island marble butterfly. 18

I. INTRODUCTION

The Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act) protects species of wildlife and plants that are federally-listed as endangered or threatened. Recovery is defined as “the process by which listed species and their ecosystems are restored and their future is safeguarded to the point that protections under the [Act] are no longer needed,” according to the 2018 updated National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (Service or USFWS) Interim Recovery Planning Guidelines, Version 1.4 (NMFS and USFWS 2018).

Recovery plans are guidance documents developed to provide recommendations to reduce or alleviate threats to listed species (includes distinct population segments, subspecies, and species groups) and ensure self-sustaining populations in the wild. The Act (section 4(f)(1)) stipulates that recovery plans include: (1) a description of site-specific management actions necessary to conserve the species; (2) objective, measurable criteria that, when met, will allow the species to be removed from the Federal Lists of Endangered and Threatened Wildlife and Plants (Lists); and (3) estimates of the time and cost required to achieve the plan’s goals and intermediate steps.

The island marble butterfly (*Euchloe ausonides insulanus*), a subspecies of the large marble butterfly (*E. ausonides*), was first described by Guppy and Shepard (2001, p. 160). Specimens of the taxon were collected from sites on or near Vancouver Island, Canada, between 1859 and 1908. After 90 years without a documented occurrence, the island marble butterfly was rediscovered in 1998 on San Juan Island in Washington, United States, and was described based on the new occurrence and past collections. Historically, the species’ distribution extended from as far north as Gabriola Island in British Columbia and the southeast portion of Vancouver Island south to San Juan and Lopez Islands in the United States. In 2006, five areas of habitat occupied by the species, then identified as populations, were known across San Juan and Lopez Islands (Miskelly and Fleckenstein 2007, p. 5; USFWS 2023a). By 2012, the species’ range had contracted to a single occupied area at American Camp in San Juan Island National Historical Park (National Park Service), as well as a few larvae detected on Lopez Island (83 FR 15900, April 12, 2018; 85 FR 26786, May 5, 2020). The species is now considered extirpated from Lopez Island. A captive propagation program for the species was established in 2009 and has been used to augment the American Camp population since then (USFWS 2023a).

On May 5, 2020, the island marble butterfly was listed as an endangered species under the Act and critical habitat was designated for the species (Figure 1; 85 FR 26786). The island marble butterfly has a recovery priority number of 3, indicating that it is a subspecies (as opposed to a full species), faces threats that are imminent and of high magnitude, and has a high potential for recovery. In this document, we refer to the island marble butterfly as a species for ease of reference and because subspecies are treated as listable entities, just as are species, under the Act (85 FR 26786, May 5, 2020). In total, 812 acres (329 hectares) on the south end of San Juan Island are designated as critical habitat (Figure 1). On May 22, 2020, the recovery outline for the island marble butterfly was finalized (USFWS 2020); the draft recovery plan was published on June 7, 2022 (USFWS 2022).

This is the first recovery plan for the species. It is based on the recovery outline and species biological report (SBR) which describe the species' biology and life history, threats, conservation actions to date, and potential future actions to aid recovery (USFWS 2020, entire; USFWS 2023a, entire). These and other Service documents about the species are available online within the island marble butterfly species profile page at https://ecos.fws.gov/ecp/species/3285.

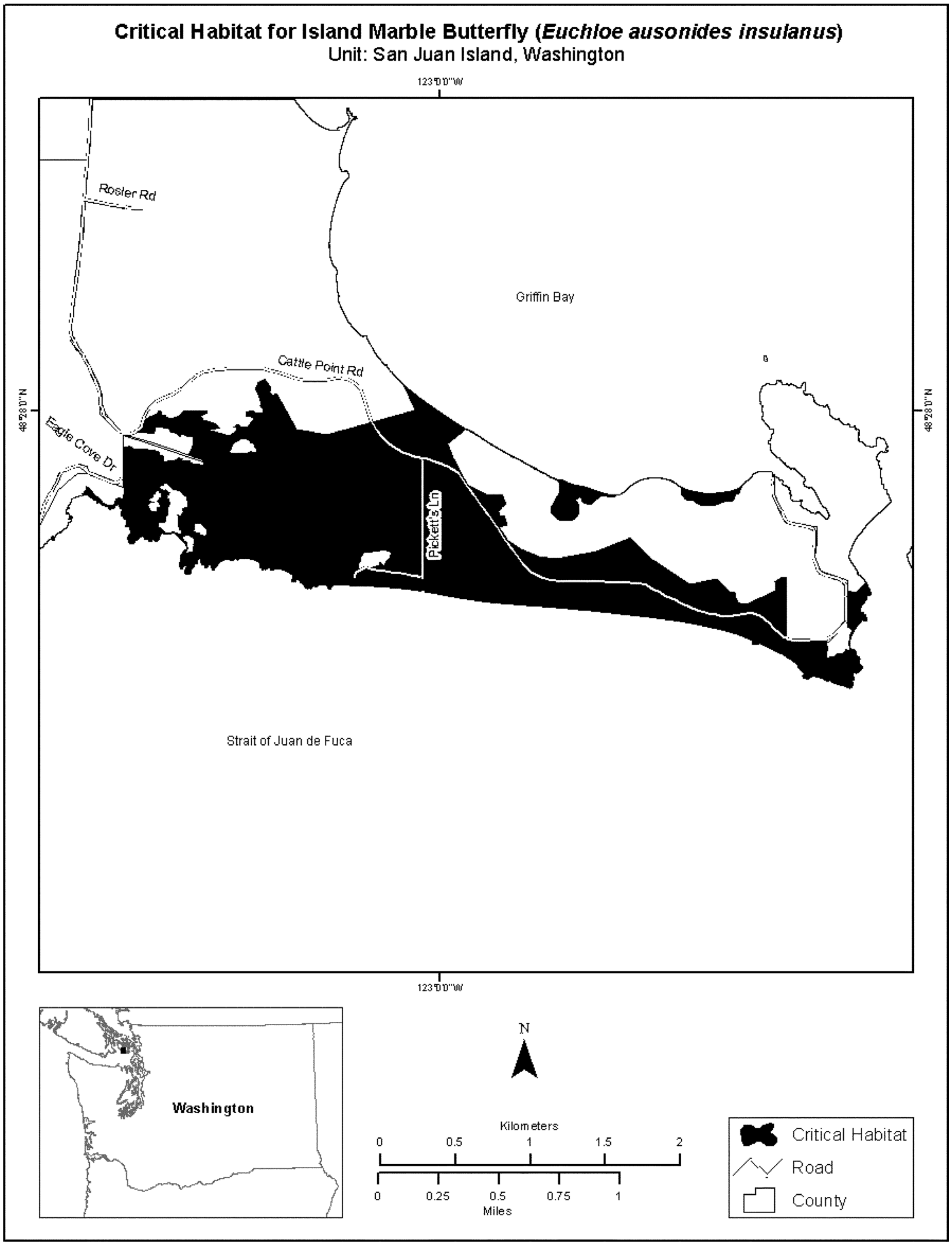

Figure 1. Location of island marble butterfly designated critical habitat (85 FR 26786).

BACKGROUND

Basic Species Information

For a more detailed literature review and full description of the biology, habitat, and distribution of island marble butterfly, please refer to the final listing rule (85 FR 26786, May 5, 2020) and the SBR (USFWS 2023a). The following is a brief overview of the species' natural history and conservation status, as summarized from the SBR (USFWS 2023a).

The island marble butterfly is an early-spring flying, univoltine butterfly in the family Pieridae, known as "white" butterflies. Adults emerge from diapause between April and June, mate, and lay eggs on three known species of host plants: the native Menzies' pepperweed (*Lepidium virginicum* var. *menziesii*), non-native field mustard (*Brassica rapa*), and non-native tumble mustard (*Sisymbrium altissimum*) (Miskelly 2004, pp. 33, 38; Lambert 2011, p. 2). While all three larval host plants occur in open grass- and forb-dominated systems, each species is most robust in one of three specific habitat types: Menzies' pepperweed at the edge of low-lying coastal lagoon habitat; field mustard in upland prairie habitat, disturbed fields, and disturbed soils; and tumble mustard in sand dune habitat (Miskelly 2004, p. 33; Lambert 2011, pp. 24, 121–123). Female island marble butterflies select specific host plants in one of the three above habitat types, potentially based on the abundance of host plants in each habitat type during the flight season (Miskelly 2004, p. 33; Lambert 2011, pp. 24, 41, 50, 54-57, 121-123). Adult island marble butterflies need open, treeless habitat with diverse topographic features to support movement and dispersal and promote landscape connectivity (Lambert 2011, p. 48).

Development from egg to chrysalis occurs in a little over a month, and island marble butterfly individuals spend up to 334 days in diapause as a chrysalis in the wild (Lambert 2011, pp. 6-22). Island marble butterfly larvae usually form a chrysalis on standing vegetation within about 13 feet (ft) (4 meters [m]) of the individual plant upon which the larva hatched. The chrysalis mimics dead grass and is very difficult to see. The butterfly will remain in this stage for nearly a year until it emerges as an adult the following spring. Adult butterflies are not believed to commonly disperse across distances greater than 1.2 miles (mi) (2 kilometers [km]) (Peterson 2010, p. 3).

The island marble butterfly was historically known from 2 areas along the southeastern coast of Vancouver Island, British Columbia, Canada, based on 14 museum records. The last known specimen of the island marble butterfly from Canada was collected in 1908 on Gabriola Island, and the species is now considered extirpated from British Columbia (COSEWIC 2010, p. 6). Reasons for its disappearance from Canada are unknown. After 90 years without a documented occurrence, the island marble butterfly was rediscovered in 1998 on San Juan Island, Washington, United States. Subsequently, surveys were conducted in suitable habitat in southeastern Vancouver Island and the Gulf Islands in Canada (COSEWIC 2010, p. 5), as well as the San Juan Islands and six adjacent counties (Whatcom, Skagit, Snohomish, Jefferson, Clallam, and Island Counties) in the United States (Miskelly and Potter 2005, p. 3). These surveys located occupied areas on San Juan Island and Lopez Island, which are separated at their closest point by 0.6 mi (1 km). Within the two islands, five areas occupied by island marble butterflies were identified (Miskelly and Fleckenstein 2007, pp. 4-5; 71 FR 66292, November 14, 2006). These areas of occupied habitat included: American Camp and vicinity, San Juan

Valley, northwest San Juan Island, central Lopez Island, and west central Lopez Island. Since 2012, however, butterflies have only been detected at American Camp.

Island marble butterflies generally exhibit low to intermediate dispersal capacity. Historically, the island marble butterfly existed as metapopulations on a landscape scale (Miskelly and Potter 2009, p. 14; Lambert 2011, p. 147). Recent evidence suggests that island marble butterflies exhibit behaviors that are associated with "patchy" population dynamics (A. Lambert *in litt.* 2022), including movement of individuals among suitable habitat patches, using avoidance to prevent the over-abundance of eggs on single host plants, and the occurrence of a disproportionate number of eggs on the edges of host plant patches (Lambert 2011, pp. 147-148; Shapiro 1984, p. 243). Host plant density affects the number of eggs laid, with moderately dense patches supporting the greatest density of eggs (Lambert 2011, pp. 68-69). On a local scale, conservation strategies should incorporate establishing or maintaining patches of moderately dense host plants in close proximity to one another (i.e., a patchy population design), to facilitate movement between patches and provide adequate sites for oviposition (Lambert 2011, pp. 28-69, 147). While we use the term "population" in discussion of population dynamics of the species and reference to the one remaining occupied area at American Camp, there is currently no definition of "population" for the species.

Island marble butterfly individuals tend to occupy multiple suitable habitat patches within a larger, heterogeneous area, with infrequent movements between suitable habitat patches. In a study by Peterson (2010), individual butterflies were rarely observed to move greater than 0.4 mi (600 m) from their origin site; just one marked individual was recaptured 1.2 mi (1.9 km) from its site of origin (Peterson 2010, p. 3). When small, occupied patches become extirpated, recolonization has followed when suitable habitat patches are located in close proximity to nearby populations within the larger contiguous area (Lambert 2011, p. 155).

The abundance of island marble butterflies was estimated to be "probably less than 500 butterflies, and possibly as low as 300 individuals" (71 FR 66292, November 14, 2006). Since then, several efforts have been made to either directly estimate island marble butterfly population size or evaluate changes in relative abundance through time through site occupancy (Lambert 2016, entire; Griesemer 2019, entire), transect counts (Peterson 2009, entire; Lambert 2011, entire), and mark-release-recapture (Peterson 2009, entire). These methods generate trend data, but do not estimate the total abundance for the species due to the limitations of the surveys (e.g., changes in habitat location over time can affect the number of individuals using an area with a fixed transect) and limitations for models to estimate abundance due to variable data collection methodology. Therefore, to date there are no accurate estimates of the number of island marble butterfly individuals, nor of their population size.

Threats

The most significant threats to the island marble butterfly are loss and degradation of habitat, storm surges, direct and incidental predation, late emergence of adult butterflies (phenological asynchrony), and vulnerabilities associated with small population size. Habitat loss and degradation occur through vegetation succession and encroachment by invasive plant species, which inhibits the germination and growth of the species' annual, early-successional larval host plants. Herbivory by black-tailed deer, European rabbits (*Oryctolagus cuniculus*), and brown garden snails (*Cornu aspersum*) destroys suitable egg-laying habitat and negatively affects recruitment and establishment of host plants for the island marble butterfly (USFWS 2023a). Increased sea level resulting from climate change may enhance the impacts of storm surges and flooding on low-lying coastal habitat where the only native larval host plant for the species occurs (Lambert 2011, p. 145; WDFW 2015, p. 5-6). Low-lying habitat has high encounter rates during species surveys and comprises an estimated 15 to 20 percent of habitat for the species at American Camp. Due to the small size of the remaining known island marble butterfly population and the importance of this low-lying habitat, loss or degradation of this habitat will lead to a further decline of the species (USFWS 2023a).

Predation by spiders and wasps is considered the greatest source of mortality for the island marble butterfly, with the majority of predation found at the egg and early instar stages (Lambert 2011, p. 93-97, 99; 117; Lambert 2015, pp. 14-18; Lambert 2017, p. 11). Incidental predation by browsing black-tailed deer is also a considerable source of egg and larva mortality (Lambert 2011, p. 102). Over time, negative impacts from late-season emergence will affect the population dynamics of the single, small population of island marble butterflies. Given that the very small population at American Camp is likely the only remaining population of the species, we conclude that small population size makes it particularly vulnerable to a variety of likely stochastic events, constituting a threat to the island marble butterfly at the individual, population, and species levels. The combined effects of environmental and demographic stochasticity, especially on a small population, can lead to a decline that is unrecoverable and results in extinction (Brook et al. 2008, pp. 457-458). The impacts of stressors that might be sustained by a larger, more resilient population have the potential to synergistically affect the size, growth rate, and genetic integrity of a species that persists as a small, isolated population.

Viability

Our assessment of species viability, defined as the likelihood of persistence over the long term, is based on the concepts of resiliency, redundancy, and representation (Smith et al. 2018, p. 8; USFWS 2016, p. 21; Wolf et al. 2015, pp. 204-205). The island marble butterfly has low resiliency because it consists of a single core OC that is highly susceptible to stochastic events. There is only one core OC, so redundancy is non-existent. We presume the genetic diversity is low and the ecological diversity is limited to three habitat types, resulting in low representation. Thus, the species’ viability is low and extinction risk is high because of the species’ inability to withstand stochastic and catastrophic events.

II. RECOVERY

RECOVERY VISION AND STRATEGY

A recovery vision is an explicit expression of recovery in terms of resiliency, redundancy, and representation. It builds on the description of viability for the species and defines what recovery looks like for the species. The recovery strategy provides a recommended approach for achieving the recovery vision, and ultimately, the down- and/or delisting criteria.

Recovery Vision

Recovery of the island marble butterfly will be signified by the conservation and protection of multiple resilient and self-sustaining core occurrence complexes (OCs) well distributed across the diversity of habitats the species utilizes, with the capacity to adapt to environmental and demographic changes over time.

Recovery Strategy

The main cause of the species' decline is the loss and degradation of suitable habitat throughout its range. The island marble butterfly also faces threats from predation from spiders and wasps and incidental predation by black-tailed deer, herbivory of host plants by European rabbits and brown garden snails, and vulnerabilities associated with small population size. Activities to ameliorate these threats are included in the recovery implementation strategy (RIS) (USFWS 2023b).

The recovery strategy seeks to improve: (1) resiliency, by increasing occupied suitable habitat and habitat productivity, and ameliorating threats such that populations can withstand stochastic events; (2) redundancy, by establishing a sufficient number of core OCs that are well distributed across the species' range to provide a safety margin to withstand catastrophic events; and (3) representation, by expanding the ecological diversity and preserving the genetic diversity of the species to ensure its adaptive potential.

To be resilient, core OCs must be large enough to withstand stochastic disturbance and have sufficient productivity to be self-sustaining. Sufficient suitable habitat must be created and conserved to provide resources to support the island marble butterfly throughout its life stages and perpetuate resilient core OCs. Monitoring trends in the amount of occupied habitat and status and trend of threats will enable us to assess species viability over time and determine whether populations are self-sustaining.

Viable core OCs must have access to large, treeless, open areas with diverse topographic features containing multiple, discrete suitable habitat patches composed of the species host plants. Connectivity through stepping-stone habitat patches is important to support foraging, dispersal, and reproduction. Because the larval host plants are early-successional species, regular management is needed to maintain patches of suitable habitat occupied by host plants within OCs and may require control of invasive plants or encroaching woody vegetation. Dispersal corridors, or open treeless areas between suitable habitat, may need to be actively managed to promote landscape connectivity and dispersal between suitable habitat patches. Host plants are adversely affected by herbivory from black-tailed deer, European rabbits, and brown garden snails. Predation on island marble butterflies (either incidentally by black-tailed deer or directly by spiders and wasps) is also a significant source of mortality for eggs, larvae, and adults. Thus, long-term conservation commitments by land managers will be necessary to maintain the disturbance regimes needed to perpetuate larval host plants, and to ameliorate herbivory, direct and incidental predation, and habitat loss through management for the species (e.g., deer exclusion fencing, targeted control of herbivores or predators, improving road maintenance practices, and vegetation management).

The historical distribution of the island marble butterfly is not fully understood. In Canada, its range included Vancouver Island as far north as Nanaimo and Gabriola Island. In the United States, occupancy was formerly centered around five areas, located on San Juan and Lopez Islands (Miskelly and Potter 2005, entire; USFWS 2023a); currently it is known from only one site (American Camp on San Juan Island). While not known for certain, the species could also have occupied suitable habitat on other islands within the San Juan archipelago. We define the species' range as encompassing all areas the species was known to occupy, both historically and currently, and intervening suitable habitats. In the United States, this includes all suitable habitat within the boundaries of San Juan County, Washington. Because this species has a limited geographic range and distribution, establishing multiple core OCs over broad ecological conditions and locations is important to improve redundancy and representation and provide protection from catastrophic events.

Redundancy of the island marble butterfly will be improved by conserving the single core OC at American Camp and establishing additional core OCs distributed across the species' range. Multiple well-distributed populations will reduce extinction risk associated with catastrophic events such as storm surges. If additional core OCs are discovered (either within or outside of the historical U.S. range in San Juan County), these core OCs would also count toward the total needed for meeting recovery criteria. The captive propagation program that has been in place since 2009 provides some redundancy for protection against catastrophic events and has been used to reinforce the American Camp core OC (USFWS 2023a). Increasing captive rearing capacity and reintroduction may be necessary to establish core OCs in suitable habitat where natural dispersal or recolonization cannot occur. Stepping-stone habitat patches will be established to promote movement between and dispersal into more distant suitable habitat patches, expanding the species' distribution.

Occurrence complexes are mapped based on observation record(s) (i.e., occurrences) with a buffer of 0.4 mi (600 m), which encompasses observed movement distances that have been most commonly documented for the species (Peterson 2010, p. 3; Lambert 2011, pp. 48-49, 146). A core OC is two or more connected OCs with a total area equal to or greater than 0.89 mi^2 (2.3 km^2), which is equivalent to the area of two OCs with adjoining buffers (i.e., centers separated by 0.8 mi [1.2 km]) (Figure 2; USFWS 2023a, pp. 10-12). Occurrence complexes represent short-term local occupancy and capture single or spatially clustered island marble butterfly observation records, while core OCs represent long-term occupancy through a network of spatially clustered, local patchy OCs of island marble butterfly linked by suitable habitat (USFWS 2023a, pp. 10-12). In years when habitat quality is low in one OC, suitable habitat in a connected OC can be reached by an adult moving from patch to patch with moderate-distance dispersal (greater than 0.6 mi [1 km]).

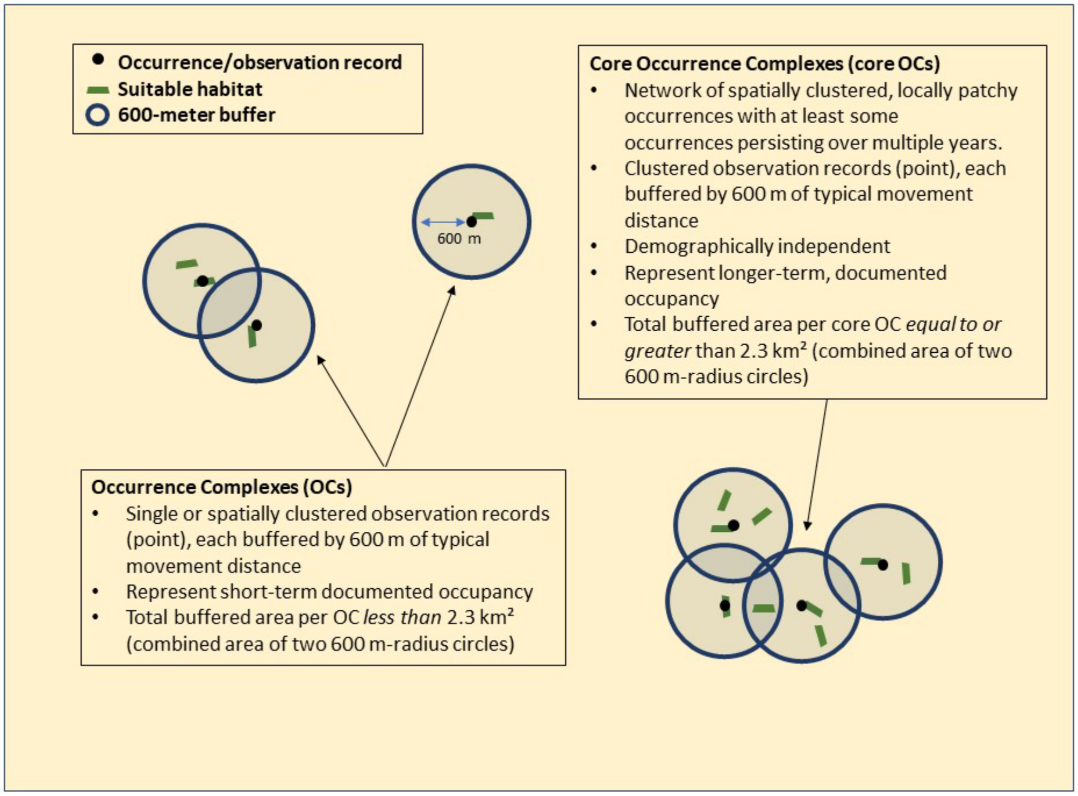

Figure 2. Schematic of island marble butterfly observation records, OCs and core OCs.

Representation will be improved by establishing multiple core OCs on San Juan and Lopez Islands, with an additional core OC either on those islands or elsewhere within the species' historical range, across the variety of habitat types the species utilizes. This will expand the species' ecological diversity as well as conserve its genetic diversity. Core OCs contribute to species viability by ensuring the species is present over a large geographic area with multiple, suitable habitat patches. Ecological and genetic representation should be improved by enhancing occupancy and gene flow across core OCs' coastal lagoons/shoreline, grassland/prairie and sand dune habitats that support the species' host plants. Establishment of habitat patches across the variety of ecological conditions that support the species will increase the genetic and ecological diversity and ameliorate the threat of phenological asynchrony with host plants.

We envision that when the island marble butterfly is recovered, there will be multiple resilient core OCs on San Juan Island, Lopez Island, and potentially at least one additional location elsewhere within the species' range if suitable habitat is available. Collectively, core OCs should be able to withstand stochastic and catastrophic disturbances as well as maintain sufficient ecological and genetic diversity and the connectivity needed to maintain gene flow to allow the species to adapt to changing environmental conditions. Threats must be sufficiently understood and ameliorated to ensure the species' long-term conservation. To ensure sufficient resiliency, redundancy, and representation and to address unforeseen events/threats, core OCs will need to be monitored and adaptively managed through long-term management commitments.

Recovery Criteria

Section 4(f)(1)(B)(ii) of the Act states that each recovery plan shall incorporate, to the maximum extent practicable, "objective, measurable criteria which, when met, would result in a determination... that the species be removed from the List." Legal challenges to recovery plans (see Fund for Animals v. Babbitt, 903 F. Supp. 996 (D.D.C. 1995)) and a Government Accountability Audit (GAO 2006) also have affirmed the need to frame recovery criteria in terms of threats assessed under the five listing factors.

Recovery criteria serve as objective, measurable guidelines to assist in determining when an endangered species has recovered to the point that it may be downlisted to threatened, or that the protections afforded by the Act are no longer necessary and the species may be delisted. Delisting is the removal of a species from the List. Downlisting is the reclassification of a species from endangered to threatened. The term "endangered species" means any species that is in danger of extinction throughout all or a significant portion of its range. The term "threatened species" means any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Recovery criteria represent our best assessment, at the time the recovery plan is completed, of the conditions that would likely result in a determination that listing under the Act as threatened or endangered is no longer required. However, revisions to the List, including delisting or downlisting a species, must reflect determinations made in accordance with sections 4(a)(1) and 4(b) of the Act. Section 4(a)(1) requires that the Secretary determine whether a species is an endangered species or threatened species because of threats to the species, based on an analysis of the five listing factors in section 4(a)(1). Section 4(b) requires that the determination be made "solely on the basis of the best scientific and commercial data available." Recovery plans provide important guidance to the Service, states, and other partners on methods of minimizing threats to federally-listed species and measurable criteria against which to measure progress towards recovery. However, they are guidance and not regulatory documents.

An agency decision to delist or downlist a species is informed by the recovery criteria but is ultimately based on an analysis of threats using the best scientific and commercial data then available. When changing the listing status of a species under the Act, we first propose the action in the Federal Register to seek public comment and peer review, after which we announce a final decision in the Federal Register.

The island marble butterfly should be considered for downlisting and/or delisting when the following objective and criteria have been met. Downlisting and delisting criteria are subject to change as additional information becomes available about species biology and threats.

Objective

Establish multiple core OCs of the island marble butterfly across its range that are resilient and will conserve or expand genetic and ecological representation. Suitable habitat should be established on conserved sites where habitat loss and degradation, incidental predation, and small population size will be adequately managed.

Downlisting Criteria

Downlisting Criterion 1

> At least four core OCs have been established or identified within the range of the island marble butterfly. These must include a minimum of two core OCs on San Juan Island, a minimum of one core OC on Lopez Island, and one additional core OC that may be on either of those islands or elsewhere within the species range.

Downlisting Criterion 2

> Within the four core OCs in Downlisting Criterion 1, continuing population resiliency is demonstrated by the total amount of suitable habitat occupied by the island marble butterfly remaining stable or increasing in at least 9 years over a monitoring period of 9 to 12 years.

Downlisting Criterion 3

> Sufficient suitable habitat is conserved and managed with long-term management commitments to achieve Downlisting Criteria 1 and 2. This includes conservation of large, open treeless areas with diverse topographic features, suitable habitat representing the diversity of habitat types used by this species (coastal lagoons/shoreline, grassland/prairie and sand dune), and stepping-stone habitat connecting them.

Rationale

The conservation and management of suitable habitat is essential for the persistence of the island marble butterfly. Suitable habitat should be managed to support the needs of the species and the host plants upon which it relies on at sites conserved under long-term management commitments. Conserving and managing suitable habitat representing a diversity of habitats within the species' range improves ecological representation and the species' capacity to withstand stochastic events, changing environmental conditions, and catastrophic events.

Conserving and managing large, open treeless areas among habitat patches creates landscape connectivity (Lambert 2011, p. 48) and increases population resiliency through facilitation of movement and dispersal. Having multiple discrete, occupied patches within a larger contiguous area supports connectivity and allows for patchy population dynamics to maintain gene flow and adapt to changing environmental conditions. Stepping-stone habitat patches promote movement between and dispersal into more distant suitable habitat patches, expanding the species distribution promoting resiliency and redundancy.

The downlisting criterion requiring at least four resilient core OCs distributed throughout the island marble butterfly's range (see above) is intended to increase the species' chance of surviving catastrophic events. The five populations identified prior to the species' decline were loosely defined based on NatureServe guidelines (Miskelly and Fleckenstein 2007, p. 4). We applied our definition of core OCs to the same data in order to clarify the past distribution of island marble butterfly. Four core OCs would exceed by one the number of core OCs identified from data collected in 2005 to 2008 (USFWS 2023a, Figure 1, p. 12). Captive propagation and reintroduction/translocation strategies may be used to support the establishment of additional core OCs across the species' range.

Core OCs support resiliency by providing opportunities for movement of individuals and facilitate recolonization of extirpated patches. If multiple core OCs exhibit stable or increasing trends in occupied habitat, this likely indicates improved resiliency (i.e., core OCs are more able to withstand stochastic events and threats that cannot be completely removed, such as storm surges, phenological asynchrony, and direct predation from native spiders and wasps). Increasing the distribution of the core OCs within the species' range will improve the butterfly's representation.

Population trends cannot be used to assess species viability at this time because there are currently no reliable methods to estimate island marble butterfly populations. Thus, we use the total amount of occupied habitat from occupancy survey data to assess viability of core OCs. Occupancy surveys are useful when butterfly species are present at low densities or are difficult to detect (Taron and Ries 2015, p. 37), and they have been used to assess population trends in other listed butterflies including the Karner blue butterfly (Monfils and Cuthrell 2018, p. ii). This baseline occupancy data will enable us to document future demographic responses (i.e., survival, reproduction) and population changes by assessing occupied suitable habitat. Occupancy models have revealed a positive relationship between average occupancy and mean abundance in local populations of the Glanville fritillary butterfly (*Melitea cinxia*) (Schultz et al. 2020, p. 306). Monitoring occupancy of suitable habitat will inform our knowledge of the island marble butterfly distribution and enable us to assess the number and resiliency of core OCs over time as well as their response to management.

The timeframe required to improve and monitor the viability of the island marble butterfly is based on the species' response to habitat management cycles: 3-year cycles of management to maintain habitat quality and larval host plant density (Lambert 2014, p. 6; USFWS 2019b, p. 13). We expect to have a better understanding of the demographic response to management such as habitat disturbance and population augmentation implemented in core OCs after three to four habitat management cycles (USFWS 2019b, p. 13). The life cycle of one generation for the island marble butterfly is 1 year. Given normal annual variability, we expect that a monitoring period of 9 to 12 years should be sufficient to detect a demographic response to habitat management that will allow us to assess whether occupied suitable habitat is stable, declining, or increasing. Because of natural interannual variability in butterfly populations, as well as the potential for temporary declines in habitat suitability at the end of each habitat management cycle with successional change in vegetation, we anticipate that occupied habitat area will vary dynamically and may occasionally show transient decreases from one year to the next even if management successfully results in long-term positive trends. Thus, the recovery criteria recommend that the area of occupied suitable habitat should be stable or increasing in at least 9 years over a monitoring period of 9 to 12 years. This timeframe is comparable to those in other butterfly recovery plans (e.g., USFWS 2015 (at least 10 years); USFWS 2019a (4 years); USFWS 2019c (10 to 20 years); USFWS 2019d (15 years); USFWS 2019e (minimum of 8 years)). We anticipate that occupancy of suitable habitat will remain stable or increase as core OCs are managed, protected, and conserved.

Delisting Criteria

Delisting Criterion 1

> At least six core OCs have been established or identified within the range of the island marble butterfly, with a minimum of three core OCs on San Juan Island, a minimum of two core OCs on Lopez Island, and one additional core OC that may be on either of those islands or elsewhere within the species range.

Delisting Criterion 2

> Within the six core OCs in Delisting Criterion 1, continuing population resiliency after meeting downlisting criteria is indicated by the total amount of suitable habitat occupied by the island marble butterfly remaining stable or increasing in at least 9 years over a monitoring period of 9 to 12 years without population augmentation.

Delisting Criterion 3

> Sufficient suitable habitat is conserved and managed with long-term management commitments to achieve Delisting Criteria 1 and 2. This includes conservation of large, open treeless areas with diverse topographic features, suitable habitat representing the diversity of habitats used by this species (coastal lagoons/shoreline, grassland/prairie and sand dune), and stepping-stone habitat connecting them.

Rationale

Six core OCs within the species' recovery distribution will improve resiliency, redundancy, and representation by ensuring multiple OCs of sufficient size which will facilitate patchy population dynamics (i.e., patches that become extirpated will be recolonized naturally). Six core OCs would exceed by three the number of OCs documented in 2005 to 2008, prior to the species' decline to a single core OC (USFWS 2023a). While there were three core OCs in the period from 2005 to 2008, at least three other OCs were distributed across San Juan and Lopez Islands during that time, indicating the potential to support the species in other locations (USFWS 2023a). Increasing the number and distribution of core OCs for the island marble butterfly contributes to redundancy of the species.

As discussed above under Downlisting Criteria, trends in the extent of occupied habitat should continue to be stable to increasing for the species to be delisted. Natural variability in butterfly populations and temporary declines in habitat suitability from successional changes at the end of a habitat management cycle is expected to result in occasional year-to-year reductions in occupied habitat extent, but these should occur in no more than 3 out of 12 years.

In general, viability of a species requires that wild populations are self-sustaining over time, based on timeframes that are biologically meaningful given the life history of the species (USFWS 2016, p. 9). Stable or increasing trends in occupied suitable habitat of island marble butterfly, without reintroduction or reinforcement by release of captive individuals, will indicate that population resiliency has been achieved and that recolonization of patches after local extirpations can be achieved without human intervention.

III. RECOVERY ACTIONS

This recovery plan identifies recovery actions needed to implement the recovery strategy and attain the recovery criteria. The timing of recovery actions and ability to implement them will depend on their priority, availability of funds and resources, coordination with partners, and complexity and logistical constraints. A broad action may have multiple components developed as needed to best coordinate recovery implementation. Specific project-level implementation of these actions will be accomplished through shorter-term activities (collectively referred to as the Recovery Implementation Strategy or RIS) in coordination with all partners interested and willing to work on implementing the activities. Activities are intended to be adaptable and guide all partners to coordinate recovery implementation and further identify those responsible for each action described in the recovery plan. Because these activities are described in the RIS (USFWS 2023b), they can be modified as needed without requiring future revision of this recovery plan, so long as they remain consistent with the recovery actions described here.

As discussed in the Introduction, this recovery plan is a guidance document rather than being regulatory in nature. As such, implementation of recovery actions is voluntary and depends on the cooperation and commitment of partners in this conservation effort. All Federal agencies, however, have an obligation under section 7(a)(1) of the Act to carry out programs for the conservation of federally-listed species.

The following is a list of prioritized actions, including site-specific management actions, that when fully implemented are expected to result in recovery of the island marble butterfly. Priority 1 actions are defined as those actions that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future. Priority 2 actions are those that must be taken to prevent a significant decline in population size or habitat quality or some other significant negative impact. Priority 3 actions are all other actions necessary to provide for full recovery of the species. The assignment of priorities does not imply that some recovery actions are of low importance, but instead implies that lower priority items may be deferred while higher priority items are being implemented. Please refer to Table 1 for a clear association among recovery actions and the threats addressed by these actions. Specific tasks required to implement these recovery actions are detailed in the RIS (USFWS 2023b).

Priority 1:

1. Protect the island marble butterfly and its habitat at American Camp by reducing herbivory on host plants and incidental predation on butterflies, enhancing suitable habitat, and controlling invasive plants.
2. Establish and expand suitable habitat for the island marble butterfly across its range representing the diversity of habitat types used by this species (coastal lagoons/shoreline, grassland/prairie, and sand dune).
3. On sites with long-term conservation commitments, conserve and manage suitable habitat for the island marble butterfly by maintaining disturbance regimes and reducing herbivory of host plants and incidental predation on butterflies.
4. In areas of suitable habitat within the species' range, identify or establish (through captive rearing, augmentation, reintroduction and/or dispersal) three to five additional core OCs to increase the species' resiliency, representation, and redundancy.

5. Actively and adaptively manage dispersal corridors and stepping-stone habitat to improve connectivity between core OCs.

Priority 2:

6. Conduct research on life history, management techniques, and the effects of climate change on the species and habitat to guide conservation efforts for the island marble butterfly.
7. Monitor the species throughout its range, track trends over time, and assess threats.

Priority 3:

8. Coordinate and collaborate with partners to conserve the island marble butterfly throughout its range.

Table 1. Crosswalk relating threats, recovery criteria, and recovery actions for the island marble butterfly.

Listing Factor	Threat	Downlisting Criteria	Delisting Criteria	Recovery Actions
A **Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range**	Habitat loss from plant succession.	2, 3	2, 3	1, 2, 3, 5, 6, 7, 8
	Herbivory by black-tailed deer, European rabbits, and brown garden snails	3	3	1, 2, 3, 5, 6, 7, 8
	Invasion by plants that displace larval host plants.	2, 3	2, 3	1, 2, 3, 5, 6, 7, 8
	Habitat loss from storm surges.	1, 3	1, 3	2, 3, 6, 7, 8
C **Disease or Predation**	Predation by native spiders and non-native wasps.	1	1	4, 6, 7, 8
	Incidental predation by black-tailed deer.	3	3	1, 3, 4, 6, 7, 8
E **Other Natural or Manmade Factors**	Vulnerabilities associated with small population size.	1, 2	1, 2	1, 2, 3, 4, 6, 7, 8
	Environmental and demographic stochasticity.	1, 2, 3	1, 2, 3	1, 2, 3, 4, 5, 6, 7, 8

IV. TIME AND COST ESTIMATES

Achieving the recovery criteria for the island marble butterfly and delisting the species is expected to require approximately 28 years, although our confidence in this estimate is limited by the information available. This estimate assumes full funding will be available over time and the coordinated, effective implementation of all the recovery actions in this plan will be carried out by necessary partners. The expected minimum cost to implement all site-specific recovery actions and their estimated implementation costs, projected to the estimated date of recovery, is $25,520,000 (Table 2). The RIS (USFWS 2023b) also provides a more detailed breakdown of implementation costs for recovery activities that contribute to these cost totals[a]. Estimated costs include planning, design, implementation, and research, monitoring, and evaluation associated with specific actions. These costs only include project-specific contract, staff, or operations costs in excess of base budgets. They do not include budgeted amounts that support ongoing agency staff responsibilities. This recovery plan does not commit the Service or any partners to carry out a particular recovery action or expend the estimated funds.

Recovery actions will be evaluated to ensure that they are appropriately and effectively addressing threats to the species and meeting the plan's objectives. If the actions are not effective, changes in management should be made and additional planning and scientific research may be necessary.

[a] Cost estimates were informed by costs of other projects funded or implemented by the Service and our partners, including land stewardship, animal husbandry, surveys and monitoring, and habitat protection and restoration. Current land values for undeveloped agricultural lands in San Juan were considered in estimating costs for easements and acquisitions.

Table 2. Priority and estimated cost of recovery actions for the island marble butterfly. See also RIS (USFWS 2023b).

Recovery Action	Priority	Estimated Cost
1. Protect the island marble butterfly and its habitat at American Camp by reducing herbivory on host plants and incidental predation on butterflies, enhancing suitable habitat, and controlling invasive plants.	1	$4,750,000
2. Establish and expand suitable habitat for the island marble butterfly across its range representing the diversity of habitats used by this species (coastal lagoons/shoreline, grassland/prairie and sand dune).	1	$2,075,000
3. On sites with long-term conservation commitments, conserve and manage suitable habitat for the island marble butterfly by maintaining disturbance regimes and reducing herbivory on host plants and incidental predation.	1	$10,370,000
4. In areas of suitable habitat within the species' range, identify or establish (through captive rearing, augmentation, reintroduction and/or dispersal) three to five additional core OCs to increase the species' resiliency, representation, and redundancy.	1	$4,365,000
5. Actively and adaptively manage dispersal corridors and stepping-stone habitat to improve connectivity between core OCs.	1	$370,000
6. Conduct research on life history, management techniques, and the effects of climate change on the species and habitat to guide conservation efforts for the island marble butterfly.	2	$1,320,000
7. Monitor the species range-wide, track trends over time, and assess threats.	2	$1,710,000
8. Coordinate and collaborate with partners to conserve the island marble butterfly throughout its range.	3	$560,000
TOTAL ESTIMATED COST OF RECOVERY		**$25,520,000**

DATE OF RECOVERY

If all actions are fully funded and implemented as outlined, including cooperative efforts by all partners needed to achieve recovery, we estimate the earliest that the delisting criteria could be met would be 2050. We estimate that it will take at minimum 28 years to reach recovery of the island marble butterfly. This assumes that the first 19 years would include establishing adequate suitable habitat to support six core OCs for the island marble butterfly, establishing core OCs via natural colonization and/or reintroduction, and assessment of suitable occupied habitat over at least 9 years to determine whether all core OCs show stable or increasing occupancy of suitable habitat (Downlisting Criterion 2). When six core OCs are established, at least 9 additional years would be needed to assess species' viability and determine whether all core OCs show stable or increasing occupancy of suitable habitat, without population augmentation (Delisting Criterion 2).

V. REFERENCES

LITERATURE CITED

Brook, B.W., N.S. Sodhi, and C.J.A. Bradshaw. 2008. Synergies among extinction drivers under global change. Trends in ecology and Evolution 23(8):453-460.

[COSEWIC] Committee on the Status of Endangered Wildlife in Canada. 2010. COSEWIC status appraisal summary on the Island Marble Butterfly (*Euchloe ausonides insulanus*) in Canada. Committee of the Status of Endangered Wildlife in Canada. Ottaway. viii pp. (www.sararegistry.gc.ca/status/status_e.cfm). 8 pp.

[GAO] Government Accountability Office. 2006. Endangered species: Time and cost to recovery species are largely unknown. GAO-06-463R. 27 pp.

Guppy, C.S. and J.H. Shepard. 2001. Butterflies of British Columbia. University of British Columbia Press, Vancouver. 413 pp.

Griesemer, A. 2019. Island marble butterfly habitat patch occupancy surveys American Camp (2019 field season), San Juan Island National Historic Park, National Park Service Technical Report. 21 pp.

Lambert, A.M. 2011. Natural history and population ecology of a rare pierid butterfly, *Euchloe ausonides insulanus* Guppy and Shepard (Pideridae). Doctoral thesis. School of Forest Resources, University of Washington, Seattle, Washington. 123 pp.

Lambert, A.M. 2014. Island marble habitat restoration at American Camp, San Juan Island. Draft proposal dated September 21, 2014. 22 pp.

Lambert, A.M. 2015. Island marble butterfly (*Euchloe ausonides insulanus*) research, 2015, American Camp, San Juan Island National Historical Park, Final Report. 27 pp.

Lambert, A.M. 2016. Island marble butterfly habitat research, 2016, American Camp, San Juan Island National Historical Park, Draft report. 64 pp.

Lambert, A.M. 2017. Island marble butterfly habitat research, 2017, American Camp, San Juan Island National Historical Park, Draft report. 42 pp.

Miskelly, J.W. 2004. Habitat requirements and conservation of the butterflies *Euchloe ausonides insulanus* (Pieridae) and *Euphydryas editha taylori* (Nymphalidae) in southwestern British Columbia. Master's thesis. Department of Biology, University of Victoria, Victoria, British Columbia, Canada. 115 pp.

Miskelly, J.W. and J. Fleckenstein. 2007. Surveys for Island Marble butterfly (*Euchloe ausonides insulanus*) in San Juan County, Washington, 2006. Washington State Department of Natural Resources report to the United States Fish and Wildlife Service. April 2007. 24 pp.

Miskelly, J. and A. Potter. 2005. 2005 Surveys for island marble butterfly (*Euchloe ausonides insulanus*) in northern coastal Washington. Washington Department of Fish and Wildlife. 26 pp.

Miskelly, J.W. and A. Potter. 2009. Surveys for Island Marble (*Euchloe ausonides insulanus*) in San Juan County, Washington, 2007. Washington Department of Fish and Wildlife Report. 26 pp.

Monfils, M.J. and D.L. Cuthrell. 2018. Evaluation of Karner blue butterfly occupancy and relationships to management on state lands in Michigan. Michigan Natural Features Inventory, Report Number 2018-16. Lansing, Michigan. 10 pp.

[NMFS and USFWS] National Marine Fisheries Service and U.S. Fish and Wildlife Service. 2018. Interim endangered and threatened species recovery planning guidance, version 1.4. National Marine Fisheries Service, Silver Spring, Maryland. 122 pp.

Peterson, M.A. 2009. Population ecology of the island marble butterfly (*Euchloe ausonides insulanus*): quantifying abundance and dispersal. Final report to San Juan Island National Historical Park. Study number: SAJH-00039. 14 pp.

Peterson, M.A. 2010. Monitoring plan for the island marble butterfly (*Euchloe ausonides insulanus*) at American Camp, San Juan Island National Historical Park. 20 pp.

Schultz, T., J. Vanhatalo, and M. Saastamoinen. 2020. Long-term demographic surveys reveal a consistent relationship between average occupancy and abundance within local populations of a butterfly metapopulation. Ecography 43:306-317.

Shaffer, M.L. and Stein, B. 2000. Safeguarding our precious heritage. Pages 301-322 in Stein, B.A., Kutner, L.S., Adams, J.S., eds. Precious Heritage: The Status of Biodiversity in the United States. Oxford University Press.

Smith, D.R., N.L. Allan, C.P. McGowan, J.A. Szymanski, S.R. Oetker, and H.M. Bell. 2018. Development of a species status assessment process for decisions under the US Endangered Species Act. Journal of Fish and Wildlife Management 9(1): 302-320.

Shapiro, A.M. 1984. “Edge effect” in oviposition behavior: A natural experiment with *Euchloe ausonides* (Pieridae). Journal of Lepidopterists’ Society 38:242-245.

Taron, D. and L. Ries. 2015. Butterfly monitoring for conservation. In: Daniels J. (eds) Butterfly Conservation in North America. Springer, Dordrecht. https://doi.org/10.1007/978-94-017-9852-5_3.

[USFWS] U.S. Fish and Wildlife Service. 2015. Recovery plan for the Behren’s silverspot butterfly (*Speyeria zerene behrensii*). U.S. Fish and Wildlife Service, Sacramento, California. 82 pp.

[USFWS] U.S. Fish and Wildlife Service. 2016. U.S. Fish and Wildlife Service Species Status Assessment Framework: an integrated analytical framework for conservation. Version

3.4 dated August 2016. 21 pp. Available online at https://www.fws.gov/sites/default/files/documents/species-status-assesment-framework-2016-08-10.pdf

[USFWS] U.S. Fish and Wildlife Service. 2019a. Recovery plan amendment for the Palos Verdes Blue Butterfly (*Glaucopsyche lygdamus palosverdesensis*). U.S. Fish and Wildlife Service, Carlsbad, California. 9 pp.

[USFWS] U.S. Fish and Wildlife Service. 2019b. Programmatic Candidate Conservation Agreement with Assurances for the Island Marble Butterfly (*Euchloe ausonides insulanus*) in San Juan County, Washington. Between the Washington Department of Fish and Wildlife and the United States Fish and Wildlife Service. 36 pp.

[USFWS] U.S. Fish and Wildlife Service. 2019c. Recovery plan amendment for the Quino checkerspot butterfly (*Euphydryas editha quino*). U.S. Fish and Wildlife Service, Carlsbad, California. 22 pp.

[USFWS] U.S. Fish and Wildlife Service. 2019d. Recovery plan amendment for three endangered species endemic to Antioch Dunes, California: Lange's metalmark butterfly (*Apodemia mormo langei*), Antioch Dunes evening primrose (*Oenothera deltoides* subsp. *howellii*), and Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*). U.S. Fish and Wildlife Service, Carlsbad, California. 64 pp.

[USFWS] U.S. Fish and Wildlife Service. 2019e. Recovery plan amendment for the El Segundo Blue butterfly (*Euphilotes battoides allyni*). U.S. Fish and Wildlife Service, Carlsbad, California. 17 pp.

[USFWS] U.S. Fish and Wildlife Service. 2020. Recovery outline for the island marble butterfly. Portland, Oregon. 9 pp.

[USFWS] U.S. Fish and Wildlife Service. 2022. Draft recovery plan for the island marble butterfly (*Euchloe ausonides insulanus*). Portland, Oregon. viii + 27 pages.

[USFWS] U.S. Fish and Wildlife Service. 2023a. Species Biological Report for Island Marble Butterfly (*Euchloe ausonides insulanus*). Version 1.1. Portland, Oregon. iv + 55 pp.

[USFWS] U.S. Fish and Wildlife Service. 2023b. Recovery Implementation Strategy for Island Marble Butterfly (*Euchloe ausonides insulanus*). Version 1.1. 21 pp.

[WDFW] Washington Department of Fish and Wildlife. 2015. Washington's State Wildlife Action Plan, 2015 update. Washington Department of Fish and Wildlife, Olympia, Washington, USA. 1095 pp.

Wolf, S., B. Hartl, C. Carroll, M.C. Neel, and D.N. Greenwald. 2015. Beyond PVA: Why recovery under the Endangered Species Act is more than population viability. Bioscience 65(2): 200-207.

In Litt. References

Lambert, A. 2022. Email from Amy Lambert, University of Washington, to Julie Combs, Washington Department of Fish and Wildlife. Re: Island Marble consultation and pers. comm. review. January 25, 2022.

APPENDIX – GLOSSARY

Term	Definition
Chrysalis	The inactive stage between the larva (caterpillar) and the adult stage of a butterfly; also known as pupa (singular) or pupae (plural).
Core occurrence complex (core OC)	A core OC is a network of spatially clustered, locally patchy populations of island marble butterflies linked by suitable habitat within both short (less than 0.4 mi [600 m]) (see occurrence complex definition, USFWS 2023a) and moderate adult dispersal distances. Core OCs are demographically independent of other core OCs and contain suitable habitat consistently occupied over a relatively long term. The area of a core OC contains at least two connected OCs and a significant portion of the suitable habitat supporting the populations. On occasion adult dispersals between patches occur over moderate distances of greater than 0.6 mi (1 km), when host plant patches are scant or difficult to locate, or if habitat has been disturbed (which is rare in high quality habitat) (Lambert 2011, pp. 48, 146). In years when habitat quality is low in one OC, suitable habitat in a connected OC can be reached by an adult moving from patch to patch in a moderate-distance dispersal. To account for this dispersal behavior, we determined that a core OC must have an area equal to or greater than 0.89 mi^2 (2.3 km^2): the area of a set with two OCs spatially separated by a distance of 0.8 mi (1.2 km) (i.e., a moderate dispersal distance). For mapping purposes, we set a rule that the GIS buffered edge of an OC must touch/overlap the perimeter of another OC to be included in the same core OC.
Diapause	A period of suspended development in an insect during unfavorable environmental conditions.
Genetic diversity	The variation in the amount of genetic information within and among individuals of a population or a species.

Habitat management cycle	A management cycle for the island marble butterfly is a 3-year cycle to maintain habitat quality and larval host plant density. All three host plants for the island marble butterfly are early successional species, requiring ground disturbance from active management to create space in the plant community for seed establishment and provide opportunities for larval host plants to compete with other weedy plant species (USFWS 2023a, p. 6). Creation of suitable habitat is initiated in year one, with the objective of suitable habitat becoming available in year two. By year three, suitable habitat patches will need to be refreshed to maintain habitat quality and target density of the annual host plants (Lambert 2014, p. 6; USFWS 2019b, p. 13).
Instar	A phase between two periods of molting in the development of an insect larva or other invertebrate animal.
Larval host plant	Plants that possess both flowers and buds from the months of April through June, on which adult butterflies lay their eggs, and which provide larvae with food and shelter as they grow throughout their life stages. The island marble butterfly has been documented to successfully complete its life cycle on host plants in the mustard family (Brassicaceae): *Brassica rapa* (field mustard), *Lepidium virginicum* var. *menziesii* (Menzies' pepperweed), and *Sisymbrium altissimum* (tumble mustard).
Landscape connectivity	The degree to which the landscape facilitates or impedes movement among habitat patches. For the island marbled butterfly, a matrix of open, treeless areas facilitates movement and supports the recolonization of unoccupied patches (i.e., metapopulation dynamics). Fragmentation of open, treeless areas and obstruction of flight paths, for example via the growth of trees, limits landscape connectivity and results in the isolation of populations.
Metapopulations	Groups of spatially separated populations that interact, with individual members moving from one occupied location to another.
Occupancy	A single host plant or patch of host plants that contains eggs and/or larvae (Lambert 2017, p. 3).

Occurrence complex (OC)	An occurrence complex consists of a single or spatially clustered island marble butterfly observation record(s) (i.e., occurrences), representing short-term documented occupancy. The area of an OC contains suitable habitat where an observed butterfly(ies) is likely to occur, in accordance with recorded movement behavior. Female adult island marble butterflies move short distances (mostly) of 0.06 to 0.4 mi (100 to 600 m) between host plant patches (Lambert 2011, p. 49; Peterson 2010, p. 3). We buffered each island marble butterfly observation record by 0.4-mi (600-m) movement radii to delineate the area of each OC and spatially account for anticipated movement behavior. The area of an OC must be less than 0.89 mi^2 (2.3 km^2), the area of a set with two buffered observation records spatially separated by a distance of 0.8 mi (1.2 km) (i.e., a moderate dispersal distance).
Redundancy	The ability of a species to withstand catastrophic events by spreading risk among multiple populations or across a large area. Redundancy protects species against the unpredictable and highly consequential events for which adaptation is unlikely (Smith et al. 2018, p. 3). Redundancy is best achieved by having multiple populations widely distributed across the species' range. Having multiple populations reduces the likelihood that all populations will be affected simultaneously. The more widely distributed populations are, the less likely they are to be similarly affected by a catastrophic event. Given sufficient redundancy, single or multiple catastrophic events are unlikely to cause the extinction of a species. Thus, the greater redundancy a species has, the more viable it will be.
Representation	The ability of a species to adapt to short- and long-term changes in the environment over time; it is the evolutionary capacity or flexibility of a species (Smith et al. 2018, p. 3). Representation is the amount of variation found in a species, and this variation (called adaptive diversity) is the source of species' adaptive capabilities. The greater the adaptive diversity, the more responsive and adaptable the species will be over time, thereby increasing its viability. Maintaining adaptive diversity includes conserving the ecological and genetic diversity of a species. Ecological diversity is the physiological, ecological, and behavioral variation exhibited by a species across its range. A common measure of genetic diversity is the number and frequency of unique alleles (variants of the same gene) within and among populations.

Resiliency	The ability of a species to sustain populations in the face of environmental variation and transient perturbations (Smith et al. 2018, p. 3). Environmental variation includes normal variation in weather, as well as unseasonable weather events. Perturbations are stochastic events such as wildfire, flooding, and storms. To be resilient, a species must have healthy populations that are able to sustain themselves through conditions in favorable and unfavorable years.
Species viability	The species' ability to sustain populations in the wild over a specified time period, assessed in terms of resilience, redundancy, and representation (USFWS 2016).
Species range	The species range for island marble butterfly encompasses its historical range along Vancouver Island, Canada, as far north as Nanaimo and Gabriola Island. In the United States, occupancy was formerly centered around five areas located on San Juan and Lopez Islands (Miskelly and Potter 2005, entire; USFWS 2023a). Currently, the island marble butterfly occupies one site (American Camp) on San Juan Island. We define the species range as encompassing all areas and intervening suitable habitats that the species was known to occupy, both historical and present.
Stepping-stone habitat	Small patches of habitat that may or may not have all the resources found in suitable habitat, but that facilitate the movement of individuals to larger, more distant suitable habitat when resources are lacking and/or at times of catastrophic events, improving connectivity in a fragmented landscape.
Suitable habitat	Discrete patches of larval host plants, nectar plants, short-statured white flowering plants, and adjacent standing vegetation providing adequate resources and sites for egg laying, feeding, larval development, mating, and pupation (diapause).
Univoltine	A species that has one brood of offspring per year.

LITERATURE CITED IN GLOSSARY

Lambert, A.M. 2011. Natural history and population ecology of a rare pierid butterfly, *Euchloe ausonides insulanus* Guppy and Shepard (Pideridae). Doctoral thesis. School of Forest Resources, University of Washington, Seattle, Washington. 123 pp.

Lambert, A.M. 2014. Island marble habitat restoration at American Camp, San Juan Island. Draft proposal dated September 21, 2014. 22 pp.

Miskelly, J. and A. Potter. 2005. 2005 Surveys for island marble butterfly (*Euchloe ausonides insulanus*) in northern coastal Washington. Washington Department of Fish and Wildlife. 26 pp.

Peterson, M.A. 2010. Monitoring plan for the island marble butterfly (*Euchloe ausonides insulanus*) at American Camp, San Juan Island National Historical Park. 20 pp.

Smith, D.R., N.L. Allan, C. P. McGowan, J. A. Szymanski, S. R. Oetker, and H. M. Bell. 2018. Development of a species status assessment process for decisions under the U.S. Endangered Species Act. Journal of Fish and Wildlife Management 9:302-320.

[USFWS] U.S. Fish and Wildlife Service. 2016. USFWS species status assessment framework: an integrated analytical framework for conservation. Version 3.4. August 2016. 21 pp. Available online at https://www.fws.gov/sites/default/files/documents/species-status-assesment-framework-2016-08-10.pdf

[USFWS] U.S. Fish and Wildlife Service. 2019b. Programmatic Candidate Conservation Agreement with Assurances for the Island Marble Butterfly (*Euchloe ausonides insulanus*) in San Juan County, Washington. Between the Washington Department of Fish and Wildlife and the United States Fish and Wildlife Service. 36 pp.

[USFWS] U.S. Fish and Wildlife Service. 2023a. Species Biological Report for Island Marble Butterfly (*Euchloe ausonides insulanus*). Version 1.1. Portland, Oregon. iv + 55 pp.

APPENDIX B

Summary of the Comments Received on the Draft Recovery Plan for the Island Marble Butterfly:

Background

We posted a Document Availability Notice on June 7, 2022, to announce that the Draft Recovery Plan for the Island Marble Butterfly was available for a 60- day comment period for public review, and to solicit comments by the scientific community, State and Federal agencies, Tribal governments, and other interested parties on the general information base, assumptions, and conclusions presented in the draft plan. The public comment period was open until August 9, 2022.

During the public comment period, we received eight responses in total: one from a State agency, three from individuals who work on the island marble butterfly, and four from the general public. Four letters contained substantive comments.

Comments received ranged from providing minor editorial suggestions to specific recommendations on plan content. We considered all substantive comments. We thank the reviewers for these comments and to the extent appropriate, we have incorporated the applicable information or suggested changes into the final recovery plan. Below, we provide a summary of public comments received on the draft recovery plan with our responses; however, some of the comments that we incorporated as changes into the final recovery plan did not warrant an explicit response and, thus, are not presented here.

1. *Comment:* We received one suggestion to add actions that enhance suitable habitat to Recovery Action 1, which focuses on the American Camp population.

   Response: We agree with this suggestion and have edited Recovery Action 1 to add "enhancing suitable habitat", which encompasses the recovery activities outlined under Recovery Action 1 in the RIS (USFWS 2023b).

2. *Comment:* We received multiple suggestions to provide more clarification within the glossary definitions and ensure consistency between the three recovery documents in use of these defined terms.

   Response: Based on the comments received, we have provided updated definitions to the following terms to provide more clarification: occurrence complex, core occurrence complex, larval host plant, occupancy, suitable habitat, and stepping-stone habitat. We have ensured consistent use and definitions of all terms across the three recovery documents. We added a schematic to the Recovery Plan and the SBR (USFWS 2023a) to clarify the differences between occurrence, occurrence complex, and core occurrence complexes.

3. *Comment:* We received multiple suggestions that the use of occupancy in determining progress toward recovery criteria would limit the use of other monitoring methodologies to understand island marble butterfly population dynamics.

   Response: Recovery criteria must provide objective, measurable thresholds to determine if a species is still warranted for listing. We employed an approach that will allow us to utilize past observation records to determine how many complexes would be feasible and defensible to target, and that can be applied to occurrence data in the future so that biologists can clearly evaluate progress toward recovery. The recovery plan does not preclude future discussions between partners to explore and establish suitable methodologies to monitor the island marble butterfly, nor does it eliminate use of any other monitoring methodologies into the future to further our understanding of the species and its needs; it merely provides a framework to evaluate progress toward recovery based on the best, currently available information. We are working with partners to coordinate a multi-method approach for survey and monitoring that will inform various elements of recovery and our understanding of the species.

4. *Comment:* We received two comments suggesting setting a population size "target" for recovery.

   Response: There are no data currently available to inform abundance (or relative abundance) targets on a range-wide scale for recovery criteria. Without reliable methods for population estimates and a lack of consistently collected data to inform targets on a range-wide scale, we focused on using stable or increasing occupied suitable habitat to assess the status of the island marble butterfly. As more information becomes known about the species, abundance data might be ascertained. However, currently there is not enough information to definitively describe a "target" population size. Should other monitoring methods be developed by the Service and State partners in the future to overcome these limitations, measurable targets may be developed to help inform recovery efforts.

5. *Comment:* We received one comment suggesting that the estimated cost of recovery might differ from the actual cost of implementing these actions.

   Response: We made the time and cost estimates based on the conservative assumption that all recovery actions are fully funded and implemented successfully as currently outlined, including cooperative efforts by all partners needed to achieve recovery. Estimates were informed by available information on costs of projects including, but not limited to, land stewardship and acquisition, animal husbandry, and restoration actions that the Service has funded or cooperated on with external partners. Costs of recovery actions have been identified to the maximum extent practicable, but they are estimates only, and we acknowledge that, when implemented, recovery efforts may end up being more or less expensive than cost figures outlined by the recovery plan and the recovery implementation strategy.