COSEWIC
Assessment and Status Report

on the

Edwards' Beach Moth
Anarta edwardsii

in Canada

ENDANGERED
2009

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Edwards' Beach Moth — Photo by Gary G. Anweiler.

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COSEWIC
Assessment Summary

Assessment Summary – April 2009

Common name
Edwards' Beach Moth

Scientific name
Anarta edwardsii

Status
Endangered

Reason for designation
In Canada, this species of noctuid moth has only been found in sparsely vegetated sandy beach and dune habitats on the coast of Vancouver Island and two small adjacent Gulf Islands. Together, these constitute only two locations. The habitats are at risk from succession, invasive species, recreational activities and changing patterns of sand deposition resulting from increasing frequency and intensity of winter storms. It is currently known from James and Sydney Islands and Pacific Rim National Park. The chance of genetic exchange is minimal between Pacific Rim and other areas and low between the Gulf Islands. One population has not been detected in recent times, and the species could not be found at 38 other locations where there appeared to be suitable habitat.

Occurrence
British Columbia

Status history
Designated Endangered in April 2009. Assessment based on a new status report.

COSEWIC
Executive Summary

Edwards' Beach Moth
Anarta edwardsii

Species information

Edwards' Beach Moth is a robust medium-sized (3.2 - 3.8 cm wingspan) species. The forewings are plain grey-brown with a line of black dots along the outer edge; and the hindwings are white with a broad dull black band on the outer half. Canadian populations belong to the nominate subspecies, which occurs throughout most of the species' range. Inland populations in southern California and Arizona have been described as a separate subspecies.

Distribution

Edwards' Beach Moth occurs along coastal areas of southern Vancouver Island and the adjacent Gulf Islands of British Columbia south along the coast to southern California. It has a disjunct distribution and is apparently absent from most of coastal Washington and Oregon. It is presently known from only 2 locations in Canada. It was previously reported from two additional historic locations: Thetis Island (single specimens in 1966 and 1971) and Mill Bay on the Saanich Peninsula (one specimen in 1935).

Habitat

This species has been captured in sparsely-vegetated sandy beach and beach dunes, including sandy beaches adjacent to saltmarshes. Substrates are generally medium-grained sand with vegetation cover ranging from 5–35%. Its larval host plant (or plants) in Canada is not known with confidence. Throughout its range, coastal populations tend to be concentrated in island complexes and inlets rather than on exposed, high-energy outer beaches.

Biology

Adults in Canadian populations fly from mid-May through July, in a single brood. There are no observations of mating, egg-laying, larval development, or pupation in Canada. Its dispersal abilities are unknown.

Population sizes and trends

There is no quantitative information on population sizes and trends for Edwards' Beach Moth. Recent sampling indicates it can be locally abundant in suitable habitat. Various threats are resulting in habitat loss and have likely resulted in population declines; the species was not found at one historic locality in the most recent survey. It is known from two localities and three populations. Historically, it was known from an additional two localities and an additional three populations.

Limiting factors and threats

The limiting factors and threats to Edwards' Beach Moth in Canada are: (1) habitat specialization confines its distribution to regionally rare and spatially isolated sandy coastal habitats; (2) loss of habitat is occurring as a result of sea level rise and increased frequency and intensity of storms that impact the sandy habitat; (3) exotic Scotch Broom and Fallow Deer have invaded its remaining sites in the Gulf Islands and both are causing a reduction in abundance of native vegetation.

Special significance of the species

Anarta edwardsii is part of a growing list of species restricted to sparsely vegetated sandy coastal ecosystems. These systems are exceptionally vulnerable to loss or degradation. The moth occurs in Canada in only two widely separated locations.

There is no information that suggests *A. edwardsii* has, or had, a significant social or economic role for First Nations.

Existing protection or other status designations

Anarta edwardsii is not specifically protected in any jurisdiction in Canada or the United States. Moths in two areas are protected under the general protection afforded wildlife in National Parks; a third site is partially protected by a Regional Park and another by a Conservation Covenant.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS (2009)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

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SPECIES INFORMATION

Name and classification

Scientific Name*: Anarta edwardsii* (Smith, 1888)

Classification: Order: Lepidoptera
Superfamily: Noctuoidea
Family: Noctuidae
Subfamily: Hadeninae
Tribe: Hadenini
Genus: *Anarta*
Species: *edwardsii*
Subspecies: *edwardsii*

Synonyms: *Trichoclea edwardsii edwardsii* (Smith).

Moths of North America (MONA) Number: 10255

Bibliographic Citation: Smith, J. B. 1888. New genera and species of North American Noctuidae. Proceedings of the United States National Museum Vol. X, pp. 460-479).

Type Specimens: Type locality: Indio, Riverside County, California. Holotype in US National Museum.

English Names: Edwards' Beach Moth

French Name: Noctuelle d'Edwards

Taxonomic Background and Similarities

Until recently *A. edwardsii* was placed in the genus *Trichoclea*, which was synonomized with the genus *Anarta* (Fibiger & Hacker, 2005). The North American species of *Trichoclea*, including *A. edwardsii*, were transferred to *Anarta* by Mustelin (2006). Twenty-three additional species of *Anarta* occur in North America. *Anarta edwardsii* is distinct and is recognized as a valid species. Canadian populations belong to the nominate subspecies, which occupies most of the range of *A. edwardsii*. Inland populations in southern California and Arizona have been described as a separate subspecies, *A. edwardsii deserticola* (Hill).

Morphological description

Adults

Anarta edwardsii is a stocky medium-sized moth with a wingspan of 32–38 mm, (Figure 1). The head, thorax, abdomen, and antennae are uniform brown-grey. The forewing is relatively unmarked except for a prominent terminal line formed by a series of small black spots or wedges. The subterminal line is faint and rudimentary, comprised of a few black scales where the “line” crosses the veins. In most specimens the reniform spot is indicated by a few dark scales. The hindwings are bright white, crossed by a wide dark grey or dull black terminal band. Fringes are brown-grey on the forewings and white on the hindwings. Females tend to have darker forewings than do males.

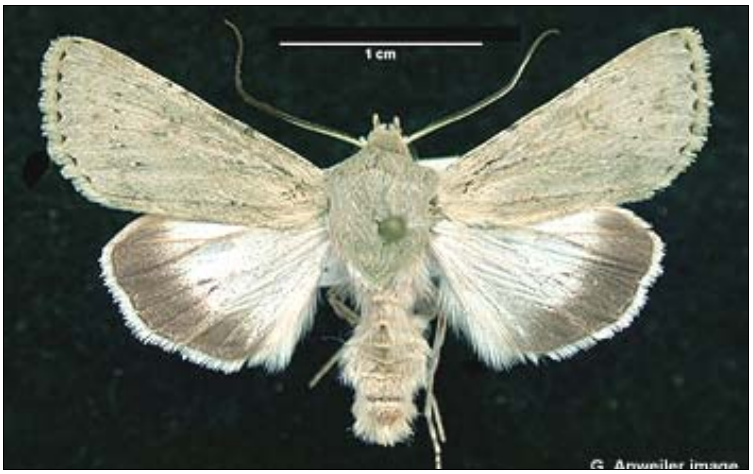

Figure 1. Adult male *Anarta edwardsii* – Sidney Spit BC.

Eggs

The eggs of *A. edwardsii* have not been described.

Larvae

The following larval and pupal descriptions are excerpted from Comstock and Henne (1941). Mature larvae are marked with faint whitish green “etching” over a pale green ground colour. The skin is faintly translucent, with the circulatory tube of the mid-dorsal area showing through as a darker green line. Subdorsal and dorsolateral whitish stripes bordered with dark green run longitudinally, beginning on the first thoracic segment and terminating close to the caudal area. The uppermost stripe is the most conspicuous. True legs and prolegs are somewhat paler than the body background colour. The spiracles are dark brown and the mandibles nearly black.

Pupae

Pupae are approximately 19 mm long, 6 mm wide and tapered at the ends. Immediately following transformation from the larvae they are light tan with a dark mid-dorsal strip on the abdominal segments. The spiracles are dark brownish black. The wing cases extend approximately two-thirds the distance to the caudal extremity. The eye cases are large and slightly protruding. The cremaster is composed of a small, slightly raised, laterally ridged plate located on the ventral surface of the caudal extremity, with two spines approximately 1 mm in length and sometimes bifurcate at the tips. Just prior to adult emergence the pupa takes on a dark reddish brown colour (Comstock and Henne 1941).

Genetic description

Limited genetic information is available for *Anarta edwardsii.* Partial barcode data (approximately 350 base pairs of the COI gene) for a single Canadian specimen of *A. edwardsii* is available on the All Leps Barcode of Life project (Biodiversity Institute of Ontario, 2007).

DISTRIBUTION

Global range

Anarta edwardsii has occurred on beaches along the coast of both the east and west side of southern Vancouver Island and the adjacent Gulf Islands, south along the coast to San Diego, California. The known distribution of subspecies *edwardsii* is disjunct, with an apparent gap between the north coast of Washington and the southern coast of Oregon (Figure 2).

The desert subspecies *deserticola* occurs in inland desert in the Palm Springs area of southern California east to Arizona (California Moth Specimen Database, 2007; Walsh, no date) (Figure 2). The global extent of occurrence is approximately 350,000 km^2 based upon the convex polygon.

Canadian range

Anarta edwardsii has been collected on beaches along both the eastern and western coasts of southern Vancouver Island, as well as on several of the adjacent Gulf islands (Figure 3). It has been recorded in southern BC in only seven places over the past 15 years, and these represent only two localities as per COSEWIC definitions because all sample sites but one are clustered in a single small area. Recent searches at two of the previous collecting sites failed to find the moth. In addition to these, there are two historic specimen records from Thetis Island (1966 and 1971) and one from Mill Bay in Saanich Inlet (1935). The estimated extent of occurrence in Canada is 2050 km^2.

Using the 2X2 grid method, the estimated maximum current area of occupancy is 20 km^2 in Canada (28 km^2 if the two historic localities are included). Suitable habitat within this area (sparsely vegetated sandy habitat) is considerably less, as only about 10% of the calculated area is comprised of such habitat. Habitat area was mapped with 2002 orthophotos in Arcview GIS.

Population structure

In Canada, *A. edwardsii* is associated with regionally rare and discontinuous sparsely vegetated sand beach or sand beach bordering saltmarsh habitats. This habitat specificity influences population structure. These habitats occur where coastal erosion and transport of glacially derived sand deposits have created large depositional coastal features and sustained them over the long term. Sand-dominated coastal areas are generally rare in BC and are typically clustered spatially because of shared physiographic conditions and coastal processes.

Sand-dominated coastal habitats in British Columbia have been rapidly and extensively modified throughout the known range of *A. edwardsii* over the past 100 years. Detrimental effects vary in intensity and include recreational disturbance, construction of roads and buildings, modification of disturbance regimes (e.g., shoreline armoring), vegetation stabilization and impacts from invasive plants and herbivores. At least one area known for the species had agricultural activity prior to its becoming a park. Dunes, spits and other sparsely vegetated communities were the most poorly represented of seven sensitive ecosystem types that were inventoried on southeastern Vancouver Island between 1993 and 1997; only 39.5 ha of dune and 111.3 ha of spit were identified by air photo analysis and field assessment (Ward *et al.*, 1998).

Sandy coastal and saltmarsh habitats were common during the early post-glacial period (Mosher and Thomson 2000) and the current isolation of Canadian *A. edwardsii* populations may be a product of long-term habitat change; existing populations may be remnants of a larger and better connected series of populations.

Estimating the number of populations and understanding population structure based on the potential dispersal between known localities is difficult because of the lack of information on dispersal ability of *A. edwardsii*.

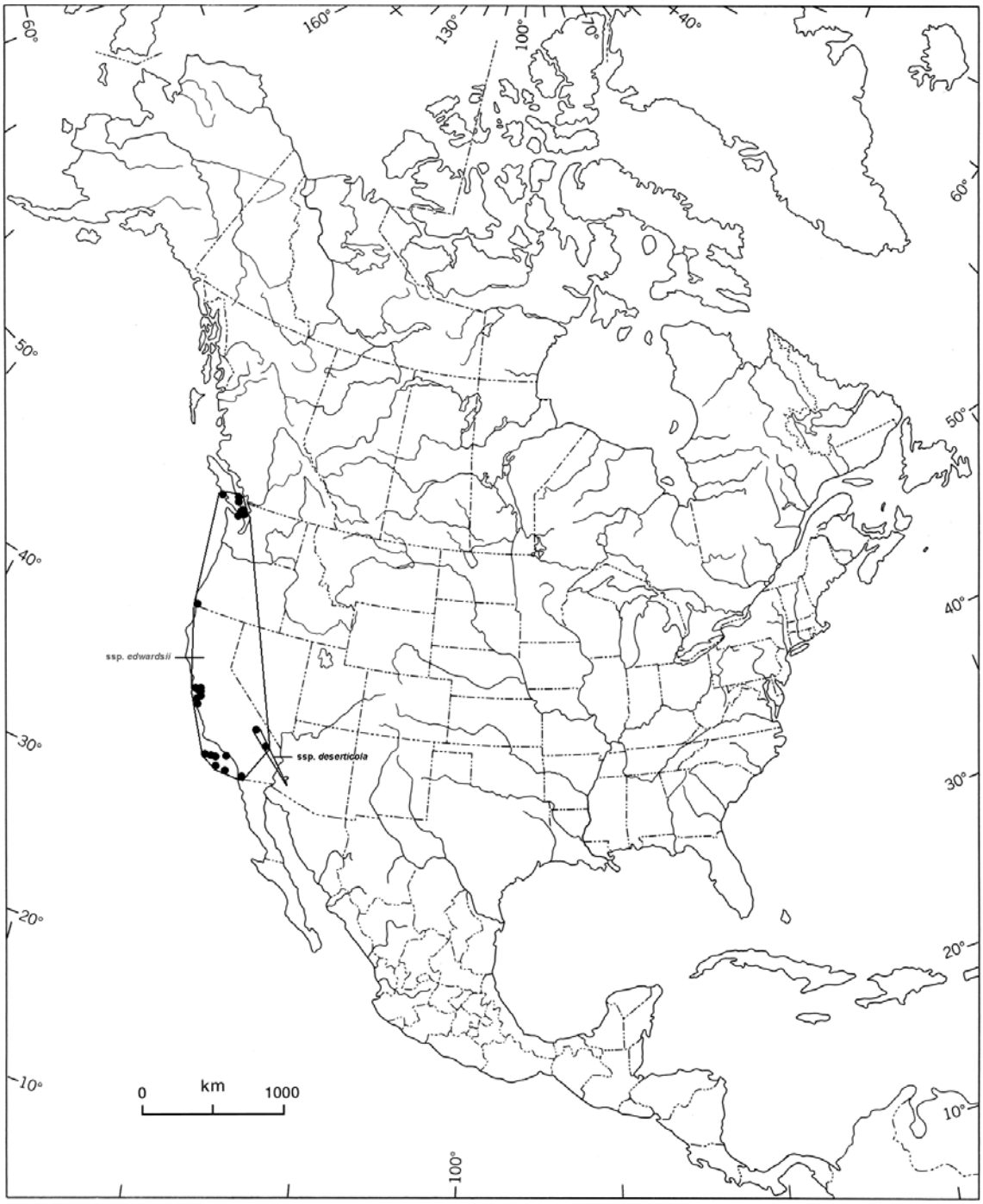

Figure 2. Distribution of *Anarta edwardsii* in North America. The inland records from California and Arizona are spp. *deserticola*. The records off the coast of California are from the Channel Islands. The polygons show the EO for each subspecies.

Figure 3. Distribution of *Anarta edwardsii* in Canada and adjacent USA. Black dots denote recent (post-1990) specimen records; open circles denote older records (pre-1975), and dots with shaded centres are recent localities in adjacent WA. Grey triangles show coastal localities that were sampled by N.A. Page from 2001–2007 without capturing *A. edwardsii*.

Individuals of *A. edwardsii* from James Island (three trap sites) and Sidney Island (one trap site), which are less than 2 km apart across open water, are likely exchanged infrequently. However, dispersal among the three trap sites on James Island is more likely. Historically, limited dispersal between mainland Vancouver Island and the Gulf Islands likely occurred. It is less likely that there was any significant movement of individuals between Thetis Island or Mill Bay and any of the remaining populations, and movement of moths between the two remaining locations (West Vancouver Island and two Gulf Islands) is likely impossible (Figure 3).

Canadian *A. edwardsii* are therefore considered to comprise three extant populations; one on each of two Gulf Islands and one on the west coast of Vancouver Island. A population on the SE coast of Vancouver Island seems no longer extant. The historic sites from Thetis Island and Mill Bay may no longer be extant.

HABITAT

Habitat requirements

There is little information about the specific habitat requirements of *A. edwardsii*. In Canada, it has been captured in both sparsely vegetated sandy beach and dune habitats, as well as on sandy beaches adjacent to saltmarshes. Throughout its range, coastal populations tend to be concentrated in island complexes and inlets rather than on exposed high-energy outer beaches. It is unknown how important, if at all, the saltmarsh vegetation component is for *A. edwardsii* populations. Substrates are generally medium-grained sand, and vegetation cover ranges from 5–35%. Common plants in sandy beach habitats are *Leymus mollis* (Trin.) Pilger, *Ambrosia chamissonis* (Less.) Greene, *Carex macrocephala* Willd. ex Spreng, *Lathyrus japonicus* Willd., and *Cakile edentula* (Bigelow) Hook. Common saltmarsh plants include *Distichlis spicata* (L.) Greene, *Salicornia virginica* L. and *Atriplex patula* L.

The identification of habitat requirements for *A. edwardsii* is complicated by the limited knowledge about its larval host plant or plants in Canada. In the Channel Islands of southern California larvae were collected from and reared on a saltbush, *Atriplex leucophylla* (Moq.) D. Dieter (Comstock and Henne 1941). *Atriplex canescens* is listed as the larval host for the closely related *Anarta antica* in California, and the genus *Atriplex* is also listed as the larval host for European populations of *Anarta trifoli* and Indian *Anarta arenaria* (Natural History Museum 2007). *Atriplex patula* L. is common in saltmarshes and coastal beaches in the Georgia Basin, but was uncommon or absent at some places where *A. edwardsii* was captured.

Although *Atriplex* species are known to be a host plant for several species of *Anarta*, and a species of *Atriplex* is the only recorded host for *A. edwardsii* (in California) it should also be noted that *Atriplex patula*, which is not uncommon on some beaches and in saltmarsh habitats in southern BC, is apparently an introduced Old World species, and if so cannot have been the host for *A. edwardsii* prior to its introduction and establishment in this area. It is more likely that one or more species of native Chenopodeaceae is the host, or perhaps it uses one or more unrelated species, such as *Abronia* (Nyctaginaceae).

An analysis of vegetation at capture localities was undertaken by N. A. Page to better assess the association of specific plants with *A. edwardsii*. The following plants were most common and abundant within 15 m of traps in which *A. edwardsii* was captured: *Abronia latifolia*, *Ambrosia chamissonis*, *Carex macrocephala*, and *Leymus mollis.* However, these are common in many sandy beach areas in which *A. edwardsii* is apparently absent, and are not always present in areas where *A. edwardsii* occurs. *Abronia latifolia* is considered a rich resource for many noctuid moths, including Sand-verbena Moth (*Copablepharon fuscum*); however, it is not abundant in one area which supports a population of *A. edwardsii*, nor is it known to occur at Thetis Island or Mill Bay, localities where *A. edwardsii* was found historically.

Larval hosts of non-pest species of Noctuidae are not well studied, and whether or not most species of *Anarta* are restricted to one genus or even a single species of host plant or conversely use a wider range of hosts is not known. Larval hosts for only a very few of the more than two dozen North American members of the genus have been reported. At least one member of the genus *Anarta* (*A. trifoli*) which commonly uses *Atripex* as a host also feeds on a large range of other plants, including a variety of garden vegetables, and sometimes reaches pest status (Natural History Museum, 2007). Thus it is possible that *A. edwardsii* uses more than a single host plant.

The importance, if any, of saltmarsh vegetation to *A. edwardsii* populations is poorly understood. *Anarta edwardsii* is often abundant in sandy beaches adjacent to saltmarshes (see Figure 4), but has also been found (in lower abundance) >1 km from saltmarsh vegetation. Additionally, *A. edwardsii* was not captured at several sampling localities (e.g. Boundary Bay, Tsawwassen causeway, Iona Beach, Lionsgate saltmarsh, portions of Goose Spit, and Witty's Lagoon) which were specifically searched for noctuid moths of saltmarsh or saltmarsh/sand beach habitats.

The *deserticola* subspecies of *A. edwardsii* occurs in dry grasslands and sandy washes in the interior of California and Arizona. Another moth within the same genus, *A. antica*, feeds on *Atriplex canescens* (Pursh) Nutt. in the deserts of California, Arizona and Nevada.

a

b

c

d

e

f

Figure 4. Habitat characteristics at sampling areas where *A. edwardsii* was captured between 2001–2007: a) Sidney Island, BC; b) James Island, BC; c) dune with *Abronia latifolia* on James Island, BC; d) James Island, BC; e) dense patch of *A. latifolia* on Sidney Island, BC; and f) dune margin and saltmarsh (Dungeness Spit, WA). All photos by N.A. Page.

Habitat trends

Without a better understanding of habitat requirements, it is difficult to infer habitat trends for *A*. *edwardsii.* However, based on the general information that it occurs in sparsely vegetated sandy coastal habitats, perhaps particularly those adjacent to saltmarshes, suitable habitat has declined.

Many sand-dominated coastal areas in the Georgia Basin have been modified throughout the known range of *A. edwardsii* over the past 100 years. These modifications have been due to construction of roads, buildings, and golf courses, alteration of disturbance regimes (e.g., shoreline armoring), recreational disturbance such as trail formation and use, and vegetation stabilization due to the effects of invasive plants. Invasive Scotch Broom and Fallow Deer are reducing the abundance of native vegetation in at least some of the sites where *A. edwardsii* has been collected. Natural habitat loss, such as spit erosion has also reduced the amount of sparsely vegetated sandy habitat in some areas, and increased storm frequency and intensity is increasing the rate of change in these areas. Dunes, spits, and other sparsely vegetated coastal plant communities were the most poorly represented of seven sensitive ecosystem types that were inventoried on southeastern Vancouver Island between 1993 and 1997; only 39.5 ha of dune and 111.3 ha of spit were identified by air photo analysis and field assessment (Ward *et al.*, 1998).

Progressive loss of open sand habitats from vegetation stabilization is the primary cause of habitat decline for species requiring open coastal habits in Canada, e.g. *Copablepharon fuscum* (COSEWIC, 2003). Sand-dominated coastal sites develop from sand accretion which is controlled by sediment transport processes (Thomson, 1981). Vegetation stabilization rates show similar temporal variability, and the recent stabilization trend in many dunes and spits in the Strait of Georgia may reflect a period of reduced sediment transport. It is more likely, however, that much of the recent vegetation stabilization is caused by anthropogenic impacts. In particular, the introduction of invasive exotic plant species such as *Cytisus scoparius* (Scotch broom) and a variety of exotic grasses (e.g., *Bromus tectorum, Ammophila arenaria, Dactylis glomerata, Holcus lanatus, Bromus hordeaceus, Vulpia myuros, Anthoxanthum odoratum*) has accelerated stabilization. Native mosses (*Tortula ruralis, Racomitrium canescens, Ceratodon purpureus* and *Bryum capillare*) function in concert with vascular plants rapidly colonizing the sand surface. *Cytisus scoparius* is the most important of the exotic species in sand-dominated coastal sites because of its rapid growth and ability to fix nitrogen in low fertility sand soils (Parker, 2002). *Ammophila arenaria*, a widespread invasive grass species of outer west coast beaches from B.C. to California (Wiedemann and Pickart, 1996), is also present in some dune sites in the southern Strait of Georgia. Increased log debris in some coastal sites may also contribute to stabilization.

Direct habitat loss from land development (e.g., roads, buildings, etc.) or recreational use has also resulted in habitat decline. Recreational uses may have contributed to localized damage to some plant communities, e.g. *A. latifolia*, although in other areas limited disturbance has maintained open sand areas.

Shoreline modifications, including erosion protection, may reduce sand supply and change transport and deposition patterns. This may contribute to stabilization of dunes.

Historic air photos were used to evaluate land cover change in the three Canadian areas also located on coastal southeastern Vancouver Island where *C. fuscum*, a related noctuid moth with similar sandy habitat requirements, occurs. Photos were scanned, adjusted to a common scale, and land cover types (urban, tree and shrub, grass and bryophyte, and open dune) were measured. For the two northern areas, photos from 1957 were compared to 1995 or 1997 photos. For the southern area, photos from 1932 were compared to 1995.

Table 1. Changes in total area and land cover in *C. fuscum* localities.

Site	Date	Total Area	Urban	Forest/Shrub	Grass/ Bryophyte	Open Dune
Place 1	1957	27.5	2.6	3.5	17.0	4.4
(Comox area, B.C.)	1997	28.2	9.2	8.2	8.8	2.2
Change (ha.)		+0.7	+6.6	+4.7	-8.8	-2.2
Place 2	1957	5.4	0.0	1.3	3.3	0.8
(Comox area, B.C.)	1996	5.4	0.0	1.9	3.1	0.4
Change (ha.)		0.0	0.0	+0.6	-0.2	-0.4
Place 3	1932	6.8	0.0	0.5	4.0	2.3
(near Sidney, B.C.)	1995	6.9	0.0	1.6	3.5	1.8
Change (ha.)		+0.1	0.0	+1.1	-0.5	-0.5

In general, all three regions show relatively little overall change in total area and similar but variable loss of open dune habitat (Table 1). Two places enlarged slightly (0.7 ha and 0.1 ha increases) because of sand accretion, while the other remained stable. Open dune areas declined in all places; two places lost 50% of their open dune area (loss of 2.2 and 0.4 ha), while the other lost 21% (loss of 0.5 ha). Grass and bryophyte areas also declined in all places; one place lost over 52%, while the others lost 6% and 13%. Forest and shrub cover increased substantially in all places: 134% in one place, 46% in another and 220% in the third (gain of 4.7, 0.6 and 1.1 ha). Only one area had urban land use and increased from 2.6 ha to 9.2 ha (254% increase) since 1957.

Recent increased intensity and frequency of winter storms has resulted in an increased rate of sand transportation in areas that are not stabilized (Fig. 5).

Protection and ownership

One place where the species has been found on Sidney Island is protected as part of Southern Gulf Islands National Park Preserve. James Island is entirely privately owned, but much of the habitat suitable for *A. edwardsii* is becoming protected through a Conservation Covenant. The sites of two Canadian historic records of A*. edwardsii* (Thetis Island and Mill Bay) are most likely privately owned, but the exact positions where the specimens were collected are not known. Areas on southeastern Vancouver Island are primarily on First Nations land, with smaller areas in a Regional (0.9 ha.) and Municipal Park (1.8 ha.). One population is protected as part of Pacific Rim National Park. However, the protection afforded the moth by these “protected” areas is not effective against some of the threats faced by the species.

BIOLOGY

Current knowledge of the biology of *A*. *edwardsii* is based on limited field sampling supplemented with minor information for California populations (Comstock and Henne, 1941; Hill, 1924), and observations by Lars Crabo in Washington (pers. comm.).

Lifecycle and reproduction

The capture dates of adults in Canada indicate a single annual brood, with the flight period extending from mid-May through July. Populations in California appear to be double-brooded, with adults flying from mid-April through July, and again in October and November. Reproduction coincides with the flight season and adult moths likely die shortly after reproducing.

Mating, egg laying, pupation, and larval feeding behaviour in Canada have not been observed. Comstock and Henne (1941) provide morphological observations of larvae and pupae from southern California but do not provide ecological information other than their capture of larvae from *Atriplex leucophylla* plants along the shoreline.

The only reported larval host plant for *A. edwardsii* is the saltbush *Atriplex leucophylla*; larvae were found on this plant, which was growing along the shoreline of the Channel Islands in southern California (Comstock and Henne 1941). Related species of *Anarta*, including *A. decepta* (North America), *A. arenaria* (India), and *A. trifoli* (Holoarctic), also use *Atriplex* species as larval hosts. The first two have been recorded only from *Atriplex* while *A. trifoli* also uses a wide range of plants in other families including garden vegetables and particularly Clover (*Trifolium*) on which it sometimes reaches pest status. *Atriplex patula* is present in saltmarshes and beach edges in *A. edwardsii* habitat in coastal BC, and is a logical suspect as the host plant. However, it appears to be rare or absent from some places where the moth is present. Furthermore, *A. patula* is an introduced exotic plant, and while it may now be used as a host plant, it cannot have been the original host plant in this area, unless *A. edwardsii* arrived here from the south since *A. patula* was introduced, which seems unlikely. It is

more probable that *A. edwardsii* feeds on one or more of the “fleshy” herbs in and adjacent to the sandy beach habitats it frequents, members of the family Chenopodiaceae being the most likely. The fleshy beach plant *Abronia latifolia* is known to be palatable to noctuid moths as it is the only known host of the endangered *Copablepharon fuscum*. which occurs at some of the same places as *A. edwardsii* (COSEWIC 2003).

Predation and parasitism

Annual and longer-term survival rates are unknown. There is no information on predation, intra- or inter-specific competition, disease or other factors that may affect survival of *A*. *edwardsii*.

Physiology

In Canada, *Anarta edwardsii* flies during the onset of warmer weather in early to mid-summer. It is assumed that larval growth occurs during late summer and early fall. Larval overwintering activities are unknown. It is unknown how seasonal temperature changes affect adult flight periods, mating, or larval survival.

Climate may be an important limiting factor for *A*. *edwardsii*’s distribution. It is unknown how seasonal temperature changes affect adult flight periods, mating, or larvae survival.

Dispersal and migration

Dispersal abilities of *A*. *edwardsii* have not been assessed and are difficult to infer from other species. Given that sandy habitats are often patchily distributed across a landscape it is likely that dispersal at this scale is frequent. However, regional dispersal between more isolated habitats (e.g., landscape-level dispersal >10 km) or across the ocean among islands is considered unlikely or very infrequent.

Anarta edwardsii is not known to migrate or otherwise undertake large-scale movements on a regular basis.

Interspecific interactions

Anarta edwardsii larvae were found feeding on *A. leucophylla* in California (Comstock and Henne, 1941). No other interspecific interactions are known.

Adaptability

There is no information on adaptability for *A*. *edwardsii*. It has not been bred in captivity, although Comstock and Henne (1941) apparently used captive-raised individuals for their morphological observations.

POPULATION SIZES AND TRENDS

Search effort

Two sampling strategies were used to search for *A. edwardsii*. First, moths were trapped in sand beaches and adjacent dune or coastal meadow habitats as part of a larger survey for Sand-verbena Moth, *Copablepharon fuscum,* and other beach moths in coastal BC (see Fig. 3). Sampling area selection was general in approach and attempted to sample different plant communities and substrate conditions within coastal habitats. A total of 35 sample localities in coastal BC, including the west coast of Vancouver Island and the Puget Sound area of WA, were sampled between May 2001 and June 2007, with 1 to 3 traps used per locality. Repeat sampling was conducted at several localities and a total of 60 trap nights (1 trap for 1 night = 1 trap night) of sampling was completed. Figure 3 shows where much of the sampling took place. All trapping was undertaken using battery-operated modified Robinson light-traps.

There was also targeted sampling of plant communities with *A. patula* in 12 areas in coastal BC because of the reported association between *A. edwardsii* and *A. leucophylla* in California. These included some sand beach habitats as well as saltmarsh ones with *A. patula.*

During these surveys a total of 266 *A. edwardsii* adults were captured at sample sites on James Island, Sidney Island, the West Coast of Vancouver Island and also in Washington State (Dungeness Spit). One area on Sidney Island was sampled repeatedly (2001, 2004, 2006, and 2007) to better refine habitat characteristics. Lars Crabo also found *A. edwardsii* at the base of Dungeness Spit, WA repeatedly in the early 1990s, and also recently captured large numbers (>50) adjacent to a saltmarsh on Henry Island, WA (immediately east of Roche Harbour on San Juan Island). There is also an unconfirmed record from Roche Harbour, WA (L. Crabo, pers. comm.). Additional records of *A. edwardsii* collected in coastal southern BC by J. Troubridge were obtained from specimens in the Troubridge collection now housed in the University of Alberta Strickland Museum collection (UASM).

Table 2 summarizes the sample localities and number of *A. edwardsii* caught by N.A. Page over the study period; it does not include records provided by L. Crabo for Washington.

The species has not been found where two historic records are known from the work of Troubridge (Cordova Spit and Island View Beach where it had been found in 1994-1995) despite searches for it there in more recent years by N.A. Page.

Table 2. *Anarta edwardsii* captures in Canada (2001–2007) by N.A. Page.		
Sample Locality	**Date**	**No. Captured per Trap**
Pacific Rim National Park	June 12, 2001	1*
Sidney Island	July 23, 2001	23
Sidney Island	June 11, 2002	11
Dungeness Spit, WA	June 12, 2002	3
Sidney Island	June 11, 2004	1
Sidney Island	June 23, 2006	4
Sidney Island	June 23, 2006	1
James Island	June 27, 2007	177
James Island	June 27, 2007	19
James Island	June 27, 2007	27

*number collected this date not known; 1 specimen deposited in UASM collection

Abundance

A total of 266 *A. edwardsii* specimens were captured, ranging from 1 per trap to 177 per trap (mean of 30 per trap) during recent sampling by Page (Table 2). As an indicator of local abundance, *A. edwardsii* was often the most abundant moth captured where it occurred. The large number of individuals (177) trapped at one of the James Island localities demonstrates that while being regionally rare, *A. edwardsii* can be locally abundant.

Because of uncertainties in measuring capture success, suitable habitat, and other factors, a population estimate cannot be calculated for *A. edwardsii* using the available data.

Fluctuations and trends

There are no data regarding population fluctuations and trends for *A. edwardsii*. The inherent difficulty in assessing population sizes, variability, and trends in rare, nocturnal insects has greatly reduced the potential for detailed population information. Loss or degradation of sandy beach habitat and saltmarsh habitats adjacent to sandy beaches as well as the natural vegetation cover of these habitatas could be expected to have impacts corresponding in magnitude to the extent of habitat loss or degradation. There are no data to indicate measurable population fluctuations. Trends in habitat loss and degradation are expected to be negative overall.

Rescue effect

The closest known population of *A. edwardsii* to those in Canada separates the James and Sidney island areas from Henry Island, WA. The distance is approximately 12 km (across open water). Dungeness Spit, WA moths are approximately 52 km further to the south, 32 km of which is over water. Rescue through dispersal of moths from Henry Island is possible in the long term, but it is unlikely from Dungeness Spit.

LIMITING FACTORS AND THREATS

Habitat

Anarta edwardsii is associated with both sparsely vegetated sandy habitats and sandy beaches adjacent to saltmarshes. While its specific habitat requirements, particularly its larval host plant(s), are unknown, its association with a rare coastal habitat is considered a limiting factor because it confines distribution to regionally rare and spatially isolated coastal habitats.

Habitat loss

The primary threat to *A. edwardsii* is loss or degradation of sparsely vegetated sandy beach habitats from natural or anthropogenic disturbance.

The potential effects of climate change on *A. edwardsii* are complex, but likely mostly negative. Sea-level rise will threaten habitat directly. Sand spits and dunes are particularly prone to loss when sea level rise is accompanied by storms of increased frequency and intensity. Past sea level rise in Victoria has been estimated at 3.1 cm/50 year period using records from 1910-2003 (BC Ministry of Environment, 2008). However, accelerated coastal disturbance and sediment transport associated with increased storm frequency may result in increased development of open sand habitats, which could have a positive effect. Nonetheless, the movement of sand during winter storms will inevitably expose overwintering individuals to increased predation.

The increasing incidence of intensive storms is resulting in increased loss of sandy habitat in the SE portion of the species' range in Canada. Figure 5 shows changes in sandy habitat in the Cordova Spit and Island View Beach area of Vancouver Island, where *A. edwardsii* seems to have become extirpated recently. Considerable change can be seen between 2005 and 2007 as a result of severe winter storms and these have continued.

Figure 5. Orthophotos of Island View Beach and Cordova Spit, Vancouver Island, 2005 (left) and 2007 (right) showing loss of beach due to winter storm activity. More losses occurred in the 2008/2009 winter.

Recreational disturbance and coastal development have reduced the amount and quality of habitat. James Island has recently seen development, but the conservation covenant between the landowner and NCC for the sandy regions on the west, north and northeast parts of the island prohibits development in the important habitat for the species and provides opportunities for active conservation.

Invasive species

Introduced Scotch Broom and Fallow Deer are causing ecological havoc on James and Sidney Islands. Scotch Broom outcompetes the native vegetation, while the Fallow Deer consumes the native vegetation but generally avoids eating the invasive plant.

Conservation concerns in similar species

The Sand-verbena Moth is an endangered species that is restricted to similar sand beach and dune habitats to those occupied by *A. edwardsii* in south coastal BC. Other rarely collected noctuid moths that are more or less restricted in Canada to coastal beaches in southern BC include: *Apamea maxima* (Dyar), *Oligia tusa* (Grote), *Lasionycta wyatti* (Barnes & Benjamin), *Lasionycta arietis* (Grote), *Agrotis gravis* Grote, and *Euxoa wilsoni* (Grote) (Troubridge and Crabo, 1996).

SPECIAL SIGNIFICANCE OF THE SPECIES

Anarta edwardsii is a species with a very restricted range in Canada. It is only found in sandy, sparsely vegetated, coastal ecosystems in BC that are declining because of habitat loss or change.

There is no information that suggests *A. edwardsii* has, or had, any social or economic role for First Nations.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Anarta edwardsii is not protected as such in any jurisdiction in Canada or the United States. Two populations are protected under the general protection afforded wildlife in National Parks, one is partially protected by a Regional Park and another is becoming protected through a conservation covenant. There is insufficient information in the USA about this species to reasonably categorize its status (Natureserve, 2007).

TECHNICAL SUMMARY

Anarta edwardsii
Edwards' Beach Moth Noctuelle d'Edwards
Range of Occurrence in Canada: southwestern British Columbia (southern Vancouver Island and adjacent Gulf Islands)

Demographic Information

Generation time (average age of parents in the population)	1 year or less.
[suspected] percent [reduction] in total number of mature individuals over the last [10 or 5 years, or 3 or 2 generations].	Unknown but some decline likely due to loss of one population since 1994
[suspected] percent [reduction] in total number of mature individuals over the next [10 or 5 years, or 3 or 2 generations].	Unknown; probable decline due to loss of sandy habitats and impacts of invasive species
[suspected] percent [reduction] in total number of mature individuals over any [10 or 5 years, or 3 or 2 generations] period, over a time period including both the past and the future.	Unknown; probable decline due to loss of sandy habitats and impacts of invasive species
Are the causes of the decline clearly reversible?	Removal of Scotch Broom is possible but expensive, removal of Fallow Deer is possible but likely controversial. Climate change-related impacts are likely irreversible.
Are the causes of the decline understood?	Somewhat
Have the causes of the decline ceased?	No
Observed trend in number of populations	One population no longer extant
Are there extreme fluctuations in number of mature individuals?	Unknown
Are there extreme fluctuations in number of populations?	No

Extent and Area Information

Estimated extent of occurrence (based on distribution records and the convex polygon)	2050 km^2 in Canada 350,000 km^2 globally
[Observed] trend in extent of occurrence	Slight decline observed in Canada since 1994
Are there extreme fluctuations in extent of occurrence?	No
Index of area of occupancy (IOA)	16 km² using 2X2 for last 10 years, 20 km^2 for last 15 years, 28 km^2 including historical records
Observed trend in area of occupancy	Decline in Canada observed since 1994
Are there extreme fluctuations in area of occupancy?	No
Is the total population severely fragmented?	Yes, the 2 known locations are widely separated by unsuitable habitat
Number of current locations	It is known to occur at 2 locations in Canada at present
Trend in number of locations	Likely decline (Thetis Island and Mill Bay locations may be no longer occupied).
Are there extreme fluctuations in number of locations?	No
Trend in [area and/or quality] of habitat	Declining

Number of mature individuals in each population

Population	N Mature Individuals
Total	Unknown
Number of populations (locations)	Populations 3 (historically 6), locations 2 (historically 4)

Rescue Effect (immigration from an outside source)

Status of outside population(s)? USA: 2 populations known in WA; likely with similar trends to Canadian populations; numerous populations in California but no trend data available.	
Is immigration known?	None known. None from USA populations with possible exception of those in the San Juan Islands in Washington State.
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes, likely
Is rescue from outside populations likely?	Maybe, but would not be extensive

Current Status

Designated as Endangered in April 2009.

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Endangered	B1ab(i,ii,iii,iv)+2ab(i,ii,iii,iv)

Reasons for designation:

In Canada, this species of noctuid moth has only been found in sparsely vegetated sandy beach and dune habitats on the coast of Vancouver Island and two small adjacent Gulf Islands. Together, these constitute only two locations. The habitats are at risk from succession, invasive species, recreational activities and changing patterns of sand deposition resulting from increasing frequency and intensity of winter storms. It is currently known from James and Sydney Islands and Pacific Rim National Park. The chance of genetic exchange is minimal between Pacific Rim and other areas and low between the Gulf Islands. One population has not been detected in recent times, and the species could not be found at 38 other locations where there appeared to be suitable habitat.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Insufficiently known
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered B1ab(i,ii,iii,iv)+2ab(i,ii,iii,iv) as EO is less than 5000 km², IAO is at most 24 km² in two widely separated areas, one population has been lost since 1994, and there is a continuing reduction in quality of habitat due to increased winter storm frequency and intensity, browsing by invasive deer and competition between larval food plants and invasive Scotch Broom.
Criterion C (Small and Declining Number of Mature Individuals): Insufficiently known
Criterion D (Very Small Population or Restricted Distribution): Meets Threatened D2 as there are less than 5 locations.
Criterion E (Quantitative Analysis): not performed

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BIOGRAPHICAL SUMMARY OF REPORT WRITERS

Nicholas A. Page is a biologist who works on the assessment and management of species and ecosystems. His project work includes watershed planning, plant community ecology, and studies of rare invertebrates. He completed a Master of Science degree in the Institute for Resources, Environment, and Sustainability at the University of British Columbia in 2003. His thesis focused on regional and local effects of exotic plant invasion in beach vegetation of Vancouver Island, BC. He wrote the COSEWIC status report for the Sand-verbena Moth, an endangered *Copablepharon* moth found in sand dunes of the Strait of Georgia, BC. He is also studying three other *Copablepharon* species (*C. grandis, C. viridisparsa, C. absidum*) found in sparsely vegetated sandy habitats in the Canadian prairies, as well as Taylor's Checkerspot, an endangered butterfly in coastal BC.

Gary G. Anweiler is a research associate at the University of Alberta Strickland Entomological Museum. He has extensive experience studying Noctuid moths in western Canada, and has authored and co-authored 5 Draft Status reports on western Canadian noctuid moths for COSEWIC.

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COLLECTIONS EXAMINED

The following collections were contacted or visited:

Canadian National Collection (CNC) of Insects, Acari and Nematodes (contact: Jim Troubridge).

RBCPM Victoria (contact: Rob Cannings).

George J. Spencer Entomological Museum at the University of British Columbia (Contact: Karen Needham).

Jim Troubridge, private collection [now divided between the CNC and UASM collections)

Lars Crabo, Bellingham WA - private collection

UASM Edmonton (contact D. Shpeley)