Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Audouin's Night-stalking Tiger Beetle (*Omus audouini*) in Canada

Audouin's Night-stalking Tiger Beetle

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For copies of the recovery strategy, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry[1].

Cover illustration: Audouin's Night-stalking Tiger Beetle (*Omus audouini* Reiche 1838) observed on August 6, 2020 at Robert's Bank Wildlife Management Area, Boundary Bay, Delta, BC. Photo by Jennifer Heron.

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[1] www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years after the publication of the final document on the Species At Risk (SAR) Public Registry.

The Minister of Environment and Climate Change (ECCC) is the competent minister under SARA for the Audouin's Night-stalking Tiger Beetle and has prepared this recovery strategy, as per section 37 of SARA. To the extent possible, it has been prepared in cooperation with the British Columbia (B.C.) Ministry of Environment and Climate Change Strategy (ENV) as per section 39(1) of SARA.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by ECCC or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Audouin's Night-stalking Tiger Beetle and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by ECCC and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

The recovery strategy sets the strategic direction needed to reverse the decline of the species, including identification of critical habitat to the extent possible. It provides all Canadians with information to help take action on species conservation. When critical habitat is identified, either in a recovery strategy or an action plan, SARA requires that critical habitat then be protected.

In the case of critical habitat identified for terrestrial species, including migratory birds, SARA requires that critical habitat identified in a federally protected area[3] be described in the *Canada Gazette* within 90 days after the recovery strategy or action plan that identified the critical habitat is included in the public registry. A prohibition against destruction of critical habitat under ss. 58(1) will apply 90 days after the description of the critical habitat is published in the *Canada Gazette*.

[2] www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html#2

[3] These federally protected areas are: a national park of Canada named and described in Schedule 1 to the *Canada National Parks Act*, The Rouge National Park established by the *Rouge National Urban Park Act*, a marine protected area under the *Oceans Act*, a migratory bird sanctuary under the *Migratory Birds Convention Act, 1994* or a national wildlife area under the *Canada Wildlife Act* see ss. 58(2) of SARA.

For critical habitat located on other federal lands, the competent minister must either make a statement on existing legal protection or make an order so that the prohibition against destruction of critical habitat applies.

If the critical habitat for a migratory bird is not within a federal protected area and is not on federal land, within the exclusive economic zone or on the continental shelf of Canada, the prohibition against destruction can only apply to those portions of the critical habitat that are habitat to which the *Migratory Birds Convention Act, 1994* applies as per SARA ss. 58(5.1) and ss. 58(5.2).

For any part of critical habitat located on non-federal lands, if the competent minister forms the opinion that any portion of critical habitat is not protected by provisions in or measures under SARA or other Acts of Parliament, or the laws of the province or territory, SARA requires that the Minister recommend that the Governor in Council make an order to prohibit destruction of critical habitat. The discretion to protect critical habitat on non-federal lands that is not otherwise protected rests with the Governor in Council.

Acknowledgments

This recovery plan was written by Jennifer Heron (British Columbia [B.C.] Ministry of Environment and Climate Change Strategy [ENV]), Dawn Marks (ENV) and Ross Vennesland (Environment and Climate Change Canada – Canadian Wildlife Service – Pacific Region [ECCC-CWS-PAC]). Scientific input and advice was provided from Lea Gelling (B.C. Conservation Data Centre [CDC]) and Robert McGregor (Douglas College). Lea Gelling and Katrina Stipec (CDC) provided mapping support and beetle occurrence information. Brenda Costanzo (ENV), Lea Gelling (CDC), Nick Page (Raincoast Applied Biology), Claudia Copley and Darren Copley (Royal B.C. Museum), Eric Balke (B.C. Ministry of Forests, Lands, Natural Resource Operations and Rural Development [FLNRORD]), Jasmin Carlin (B.C. Conservation Foundation), Markus Merkens (Metro Vancouver), Emily Cameron (CDC), Suzie Lavallee (University of B.C.) and Rob McGregor contributed information on ecological communities, habitats, and search effort, and advised on the updated threats assessment. The maps included in this report were produced by Leon McCartney (ECCC-CWS-PAC). Scientific and technical review was provided by Eric Gross, Kella Sadler, Megan Harrison, Greg Rickbeil and Kimberly Dohms (ECCC-CWS-PAC), Angela Barakat (ECCC-CWS-NCR), Alanah Nasadyk (ENV), Andrea Shaw (B.C. Ministry of Agriculture [AGRI]), Emily Carmichael (AGRI), Nadia Mori (AGRI), Doug Pepper (AGRI) and Grant Bracher (FLNRORD).

Executive Summary

Audouin's Night-stalking Tiger Beetle (*Omus audouini*) is a medium sized (14–18 mm), dull black, flightless beetle. The species ranges in western North America from the southwestern corner of British Columbia (B.C.) south through western Washington and Oregon to northwestern California. Within Canada, the species is restricted to low elevation (< 20 m above sea level) coastal areas of greater Victoria and the lower mainland, although in other parts of its global range in the United States, it resides at higher elevations. In southwestern B.C., it is restricted to a small area in the Georgia Basin within a narrow strip of coastal lowland around Boundary Bay and greater Victoria, where it is known historically from fewer than ten sites. At present, five subpopulations are extant. The detection of a significant number of additional subpopulations is unlikely.

Audouin's Night-stalking Tiger Beetle was designated as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2013, and was listed on Schedule 1 of the *Species at Risk Act* (SARA) in 2018. In B.C, Audouin's Night-stalking Tiger Beetle is ranked S1 (critically imperiled) by the Conservation Data Centre (CDC) and is on the provincial Red list. Recovery is considered to be biologically and technically feasible.

There is little habitat information for Audouin's Night-stalking Tiger Beetle in B.C. It has been recorded from two ecosystem types in the province: 1) sparsely vegetated coastal sand ecosystems (two extant subpopulations) and 2) Garry Oak and associated ecosystems (three extant subpopulations). The beetle's association with these habitat types may be a result of habitat fragmentation, though more research is needed. In general, the beetle's habitat in B.C. includes open grassy areas, sparsely vegetated habitats, coastal bluff meadows, open forests, older agricultural fields (no crops present for a number of years), and similar meadow habitats.

Audouin's Night-stalking Tiger Beetle lives 1–3 years, has four life stages (egg, larva [three larval instars], pupa and adult) and grows through complete metamorphosis. Eggs hatch into larvae, which dwell underground within established and resident burrows above the water table, and comprise the longest part of the species' life history. Burrows have not been found in B.C., but in other areas of the species range they are often found within sloped areas including road cuts, stream banks or adjacent to hiking trails. Pupation takes place within a chamber at the bottom of the larval burrow after the third larval instar. Adults live for only 8-10 weeks. Both adults and larvae are predators of surface active invertebrates.

Major threats to the Audouin's Night-stalking Tiger Beetle include habitat loss from urban, rural, agricultural and other forms of land conversion; habitat changes as a result of the growth of invasive non-native plants that limit larval burrow and adult foraging habitats; recreational activities that compact soil and erode habitat quality; native plant succession (due to fire suppression) and an increase in severity and frequency of storms and flooding within its lowland shoreline habitats as a result of climate change.

The population and distribution objective is to recover Audouin's Night-stalking Tiger Beetle in Canada by increasing redundancy for all extant subpopulations, and any additional subpopulations that may be identified in the future, through ceasing or mitigating human-caused threats and conducting habitat restoration where feasible.

Short-term statements towards meeting the population and distribution objective are:

1. Cease human-caused threats that would cause further loss in the quantity or quality of the habitat needed for recovery.
2. Initiate abatement or mitigation measures for non-habitat human-caused threats for all extant subpopulations by 2027.
3. Restore habitat as required and feasible to achieve recovery by 2027.

Broad strategies to address threats to the survival and recovery of the Audouin's Night-stalking Tiger Beetle are outlined in this document. Critical habitat is identified for four of the five known extant subpopulations. A schedule of studies is included to identify critical habitat for the other known extant subpopulation, and potentially other previously-known subpopulations whose extant status has not been confirmed.

One or more action plans for the Audouin's Night-stalking Tiger Beetle will be posted on the Species at Risk Public Registry within 10 years of the publication of this document.

Recovery Feasibility Summary

Based on the following four criteria that Environment and Climate Change Canada uses to establish recovery feasibility, recovery of Audouin's Night-stalking Tiger Beetle has been deemed technically and biologically feasible.

1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.

Yes. Audouin's Night-stalking Tiger Beetle is known from five extant subpopulations within British Columbia (B.C.). At least two extant populations (#1: Finlayson Point, Victoria and #2: Boundary Bay, Delta) have records that span multiple years and thus provide evidence of breeding and sustaining a long-term presence within the area.

2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.

Yes. Sufficient suitable habitat is available to support at least three of the extant subpopulations. The habitat available to sustain extant subpopulations is assumed to contain the microsites and habitat features needed for all life stages and functions (e.g., foraging, resting, larval tunnel sites, overwintering and mating). For subpopulations where the amount and/or quality of supporting habitat is not sufficient to support the species, habitat management and restoration actions are possible and include removal of non-native plants and encroaching native vegetation, and restricting recreational access to important habitats through fencing or designated trails for dogs and hikers.

3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.

Yes. The primary threats to the Audouin's Night-stalking Tiger Beetle include habitat loss from urban, rural, and agricultural development, and other forms of land conversion; habitat changes as a result of the growth of invasive non-native species into larval burrows and adult foraging habitats; recreational activities that decrease the habitat quality of larval burrow and adult foraging habitats (e.g., soil compaction and trampling of habitat plants from dog walking and hiking, excess urination from dogs); native plant succession (partially the result of ongoing fire suppression in urban areas) and an increase in severity and frequency of storms and prolonged flooding within its lowland shoreline habitats, as a result of climate change. With the exception of the storms and flooding threat, all of these threats can be avoided or mitigated through habitat protection and restoration, small park infrastructure changes (e.g., changing trails), stewardship and public outreach. At the Boundary Bay subpopulation (#2), a long-term living dyke project to mitigate the impacts of storms and flooding from climate change is proposed. This project is a potential threat to this subpopulation.

4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.

Yes. Existing techniques to achieve population and distribution objectives include habitat protection and restoration and threat mitigation measures. Captive breeding to supplement the wild populations is not currently considered necessary for the recovery of Audouin’s Night-stalking Tiger Beetle, nor is it considered an appropriate mitigation measure where land development may occur or for increasing the abundance in a given habitat. Additional recovery techniques to achieve the population and distribution objectives are expected to be developed within a reasonable time frame.

Table of Contents

Preface i
Acknowledgments iii
Executive Summary iv
Recovery Feasibility Summary vi
1. COSEWIC Species Assessment Information 1
2. Species Status Information 1
3. Species Information 1
3.1 Species Description 1
3.2 Species Population and Distribution 4
3.3 Needs of Audouin's Night-stalking Tiger Beetle 9
3.4 Limiting Factors 12
4. Threats 13
4.1 Threat Assessment 13
4.2 Description of Threats 17
5. Population and Distribution Objective 21
6. Broad Strategies and General Approaches to Meet Objectives 23
6.1 Actions Already Completed or Currently Underway 23
6.2 Strategic Direction for Recovery 24
6.3 Narrative to Support the Recovery Planning Table 27
7. Critical Habitat 27
7.1 Identification of the Species' Critical Habitat 28
7.2 Schedule of Studies to Identify Critical Habitat 35
7.3 Activities Likely to Result in the Destruction of Critical Habitat 35
8. Measuring Progress 38
9. Statement on Action Plans 38
10. References 38
Appendix A: Effects on the Environment and Other Species 45
Appendix B: Photographs of Similar Species 46

1. COSEWIC* Species Assessment Information

Date of Assessment: November 2013

Common Name (population): Audouin's Night-stalking Tiger Beetle

Scientific Name: *Omus audouini*

COSEWIC Status: Threatened

Reason for Designation: This beetle is restricted to a small area in the Georgia Basin of southwestern British Columbia, within a narrow strip of coastal lowland around Boundary Bay and Greater Victoria. Major threats include habitat loss through agricultural and urban development, vegetation succession in open habitats, disturbance from recreational activities, and, in the longer term, sea level rise. There are fewer than ten known sites, and the discovery of more populations is unlikely. The species is flightless and thus dispersal is limited.

Canadian Occurrence: British Columbia

COSEWIC Status History: Designated Threatened in November 2013.

* COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

2. Species Status Information

The legal designation for Audouin's Night-stalking Tiger Beetle on SARA Schedule 1 is Threatened (2018). The species is not listed under the British Columbia (B.C.) *Forest and Range Practices Act*, *Oil and Gas Activities Act* nor the *Wildlife Act*. Less than 10% of the species' global range is in Canada (Figure 2).

Table 1. Conservation status of Audouin's Night-stalking Tiger Beetle (B.C. Conservation Data Centre 2020; NatureServe 2020).

Global (G) Rank*	National (N) Rank*	Sub-national (S) Rank*	COSEWIC Status	B.C. List
G5 (2008)	Canada (N2)	British Columbia (S1)(2017)	Threatened (2013)	Red-list

*Rank 1– critically imperiled; 2– imperiled; 3– vulnerable to extirpation or extinction; 4– apparently secure; 5– secure; H– possibly extirpated; NR – status not ranked.

3. Species Information

3.1 Species Description

Audouin's Night-stalking Tiger Beetle (*Omus audouini* Reiche 1838) grows through complete metamorphosis and has four distinct life stages: egg, larvae, pupae and adult

(COSEWIC 2013). The life cycle spans approximately 2–3 years, with the majority of this time spent in the larval stage. Adult beetles live for 8–10 weeks. While first described as nocturnal, the species is now known to be active during the day, with at least one daytime observation of a beetle in Canada (Subpopulation #5; Table 2). Both adults and larvae are opportunistic predators and feed on a diverse array of epigeal (or surface dwelling) arthropods. Adults are flightless (their elytra, or wing covers, are fused, making them unable to fly), fast crawlers, and each larva is primarily restricted to the confines of its own burrow.

Adults: The adults (14–18 mm long) (Figure 1) are dull black, flightless and non-gregarious (COSEWIC 2013). Adults actively hunt along the ground and take cover under substrates such as coarse woody debris and leaf litter. The genus *Omus* have morphologically distinct hind legs and unmodified, 11-segmented and filiform (threadlike) antennae (antennal segments longer than wide) and punctate (dimpled) elytra. They also have large, toothed and sickle-shaped mandibles that distinguish this genus from other ground beetles in the family Carabidae. Sexes are distinguished by the number of abdominal segments: seven in males and five in females (Comstock 1920).

Figure 1. Audouin's Night-stalking Tiger Beetle (*Omus audouini* Reiche 1838) observed at the portion of subpopulation in #2, Robert's Bank Wildlife Management Area on August 6, 2020, Boundary Bay, Delta, B.C. Photo by Ross Vennesland.

There is one additional beetle within genus *Omus* in B.C., the Greater Night-stalking Tiger Beetle (*Omus dejeani* Reiche 1838), which overlaps in geographic range and some of the same habitat in the province. Greater Night-stalking Tiger Beetle adults are larger (18–21 mm), without dimpled elytra and with a thinner thorax and abdomen (Maser 1977b; Pearson *et al.* 2006). Other ground dwelling and flightless carabids lack the sickle-shaped mandibles present in the genus *Omus*.

Audouin's Night-stalking Tiger Beetle adults are active from May - September, although this is likely reflective of overlapping generations because adults are emerging at different times throughout the summer months. Adults mate sometime in the spring. Mating has not been observed in B.C., although during a study in Oregon mating pairs were observed under cover (usually wood) from April 10 to June 28 (7 different pairs over 7 dates) (Maser 1977a). The species is not parthenogenic. The earliest record of an adult beetle in B.C. is in early spring (May 1–7, captured within a pitfall trap); while the latest record was September 29.

Eggs: The eggs of Audouin's Night-stalking Tiger Beetle have not been described (COSEWIC 2013). In general, the chorion (outer shell of an insect egg) of tiger beetle eggs is translucent and tiger beetle eggs are laid singly in suitable soil (see Section 3.3, Needs of Audouin's Night-stalking Tiger Beetle). In general, captive tiger beetle adults lay 10–20 eggs through early spring. Studies on large-bodied carabids (such as *Scaphanotus angusticollis,* which is similar in size to Audouin's Night-stalking Tiger Beetle), have low fecundity, producing as few as eight eggs per year (Thiele 1977). Eggs hatch 9–38 days after oviposition, depending on the local temperature conditions and the species (Pearson and Vogler 2001; Pearson *et al.* 2006).

Larvae: Audouin's Night-stalking Tiger Beetle larvae reside in burrows and use a sit-and-wait strategy, with heads extending slightly from their burrow entrance waiting for epigeal prey (COSEWIC 2013). When prey is captured, it is dragged to the bottom of the burrow for consumption. The burrow is built such that the solitary larvae can use their head and mandibles to close the entrance.

Larvae have a shiny black head with greenish-brassy and violet metallic reflections; the pronotum (portion of body closest to the head) is brownish-black, gradually becoming yellowish-brown towards the back of the body (Hamilton 1925; Leffler 1979, 1985). The legs, setae (hardened thick hairs) and other sclerotized (hardened) areas of the larva's body are dark brown (Hamilton 1925; Leffler 1979, 1985). In general *Omus* larvae are 15–22mm long, S-shaped and grub-like with stout bristles above their eyes (Dimmock and Mann 1879). *Omus* species grow through three larval instars and are difficult to distinguish without following a taxonomic key (see Leffler 1979). *Omus* larvae are distinguished from other tiger beetle larvae by having three pairs of curved-hook spines on the 5th abdominal segment hump, whereas other tiger beetle larvae have two pairs of spines on the 5th abdominal segment hump (Hamilton 1925; Pearson *et al.* 2005). These spines help improve their success in capturing and subduing large prey.

There is little information on larval development in Audouin's Night-stalking Tiger Beetle. In general, tiger beetles spend from 1–3 years in the larval stage, during which time they develop through three instars. There have been no studies to determine the maximum larval period. First instar larvae hatch from eggs in the soil and begin to develop and excavate long, deep (15–30 cm) and narrow cylindrical tunnels within which they grow and develop. The larvae flip soil pellets from the mouth of their burrow and can chew a hole through any leaf obstructing the tunnel entrance.

Pupae: After the third larval instar, beetles form a pupal case within a chamber at the bottom of the larval burrow (COSEWIC 2013). Pupation lasts 18–30 days but sometimes longer if the onset of pupation is over winter months. Adults emerge from the underground pupal chambers sometime in the spring.

3.2 Species Population and Distribution

Globally, Audouin's Night-stalking Tiger Beetle ranges in western North America, from southwestern B.C. south through western Washington and Oregon to northwestern California (Figure 2; Leffler and Pearson 1976; Pearson *et al.* 2005; COSEWIC 2013). In Canada, the beetle occurs within a thin strip of coastal lowland habitat in southwestern B.C., including the Boundary Bay area of the Lower Mainland and the Greater Victoria area on Vancouver Island. There are no records north of the Victoria area, on the Gulf Islands or east of Boundary Bay in the Lower Fraser Valley (Figure 3). The documentation of a significant number of additional subpopulations is considered unlikely (COSEWIC 2013), though additional surveys may identify a limited number of new subpopulations. The approximate Canadian extent of occurrence is 1600 km^2 (about 10% of the global range), but this includes unsuitable marine habitat in the Strait of Georgia (COSEWIC 2013). The area of occupancy is likely to be considerably less than 10% of the global range (Figure 2).

A subpopulation of Audouin's Night-stalking Tiger Beetle is defined as a geographically distinct group of individuals in the population (population referring to the entire Canadian population) between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less; IUCN 2001). The separation distance[4] between subpopulations for *Omus* ground beetles is 1 km across unsuitable habitat or 10 km across suitable habitat (Schweitzer 2001). For example, a subpopulation can have multiple sites within the 10 km separation distance, if the intervening habitat between sites is suitable. Barriers that limit beetle movements include waterways (e.g., rivers), highways, extensive anthropogenic development or inappropriate habitat. Mapping of Audouin's Night-stalking Tiger Beetle subpopulations has been done by the B.C. Conservation Data Centre (B.C. CDC) (B.C. CDC 2020).

[4] Separation distances are guidelines provided by NatureServe to help delineate element occurrences (NatureServe 2002). For Audouin's Night-stalking Tiger Beetle, NatureServe and B.C. CDC element occurrences correspond to subpopulations.

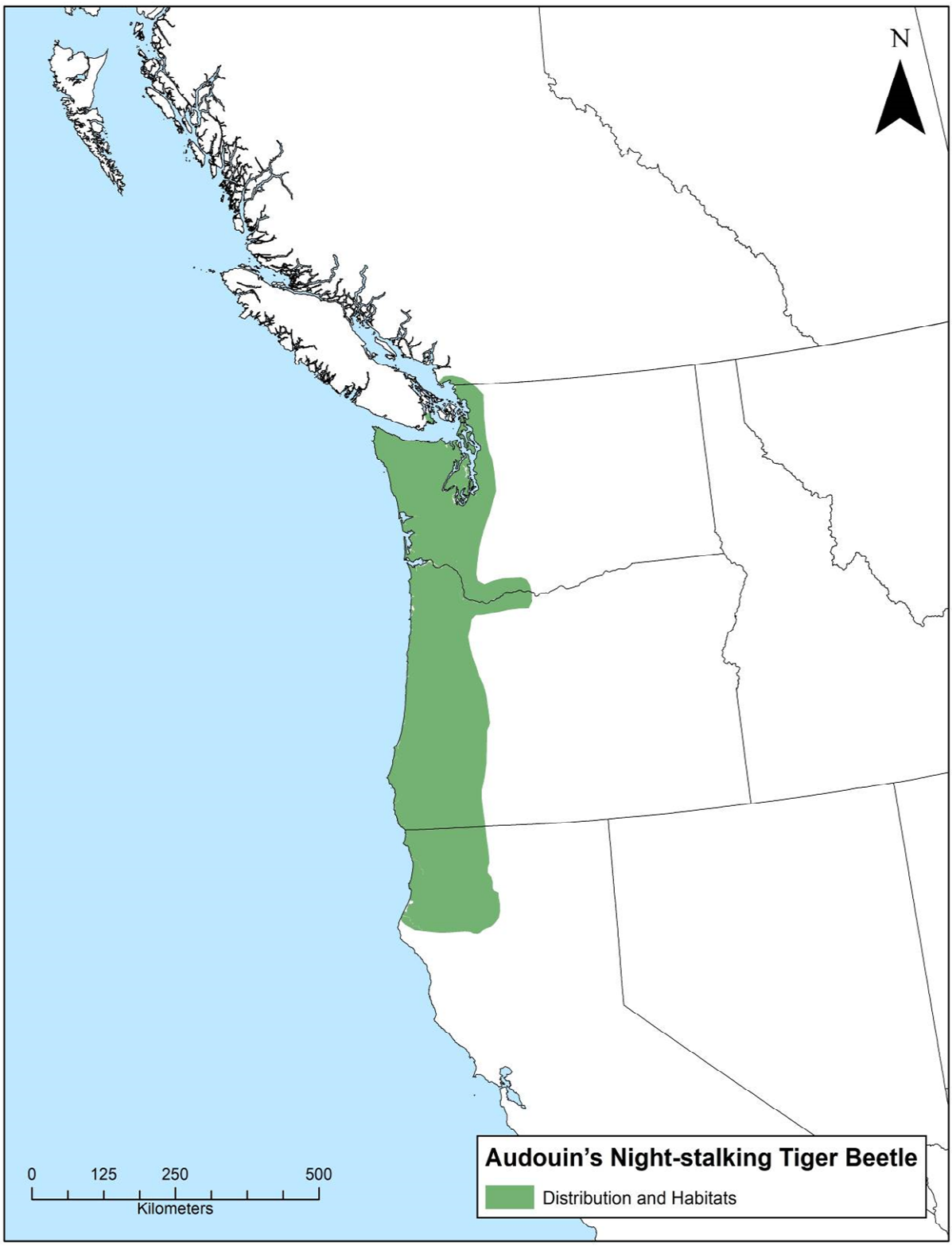

Figure 2. Global range of the Audouin's Night-stalking Tiger Beetle (*Omus audouini*) (based on information in Leffler and Pearson 1976 and Pearson *et al.* 2005).

The dispersal ability or home range size of this beetle is unknown, although it is assumed that if habitat exists for adult territories (including foraging, resting, mating and cover habitat) and larval burrows, the species is likely to maintain occupation of an area within a ten-generation[5] (30-year) timeframe, unless survey data and/or other data confirms the habitat unsuitable (e.g., habitat conversion, lethal or ongoing pesticide spray or other factors could completely decimate a subpopulation). There is some information on the dispersal behaviour of the carabid beetle, *Scaphinotus angusticollis* Mannerheim, a widespread forest-dwelling species present in west-coast forests. This species is capable of traveling up to 75 m within one day, within its natural habitat (Lavallee 1999). A study of an endangered ground beetle, *Carabus hungaricus* Fabricius, using mark-release-recapture recorded an average (47–132 m) and maximum (207–1104 m) distance moved by individuals of both sexes (there was no statistical difference between sexes)(Elek *et al.* 2014). Short distance movements were more common than longer ones (Elek *et al.* 2014). The study spanned over 200 days of monitoring, which is much longer than the lifespan of an adult Audouin's Night-stalking Tiger Beetle. Mobility estimates from mark-release-recapture studies on other studied species suggest long-distance dispersal events are underestimated using this method (e.g. Smout *et al.* 2010; Drag *et al.*, 2011; Pe'Er *et al.* 2013 as read in Elek *et al.* 2014). It is thus expected that beetles are likely able to disperse to unoccupied habitat patches kilometers away as long as no migration barriers exist (e.g. highways, water courses) (Eluk *et al.* 2014).

There are numerous records of Audouin's Night-stalking Tiger Beetle where the spatial uncertainty is high (COSEWIC 2013; B.C. CDC 2020). These records have not been assigned to a subpopulation. Should additional information become available (e.g., historical field notes associated with the specimen are found; literature records are found; additional surveys completed), then the record will be assigned a subpopulation status.

Currently, there are five extant[6] and three historical[7] subpopulations of Audouin's Night-stalking Tiger Beetle in Canada (Table 2; Figure 3). There are an additional six unconfirmed[8] records that are not assigned to a subpopulation. These unconfirmed records are labeled 'Victoria' (1924 and no date), 'Victoria – Highlands Distr.' (1925), 'Saanich' (1924) and 'B.C.' (no date, no specific collection locality). The subpopulations

[5] Audouin's Night-stalking Tiger Beetle has a 2 to 3 year generation time; the species is assessed over a ten year or ten generation timeframe, whichever is the longest and taking the longest generation time (3 years). The assessment timeframe is therefore 30 years.
[6] An extant subpopulation of Audouin's Night-stalking Tiger Beetle is a subpopulation with observation or collections less than 30 years old (ten generations of beetles with a three-year generation time), and evidence that suitable habitat is still present.
[7] A historical subpopulation of Audouin's Night-stalking Tiger Beetle is a subpopulation with records greater than 30 years old (i.e. ten generations of beetles), and evidence that suitable habitat is still present.
[8] An unconfirmed record is one where there is vague information on the collection site, there is no information to accurately georeference the record, or there is no associated date and/or habitat linked to the specimen.

listed below are numbered following the B.C. CDC's element occurrence numbers, except for #7 which has not been mapped by the B.C. CDC (as of December 2020). These occurrences were determined using the separation distances described above.

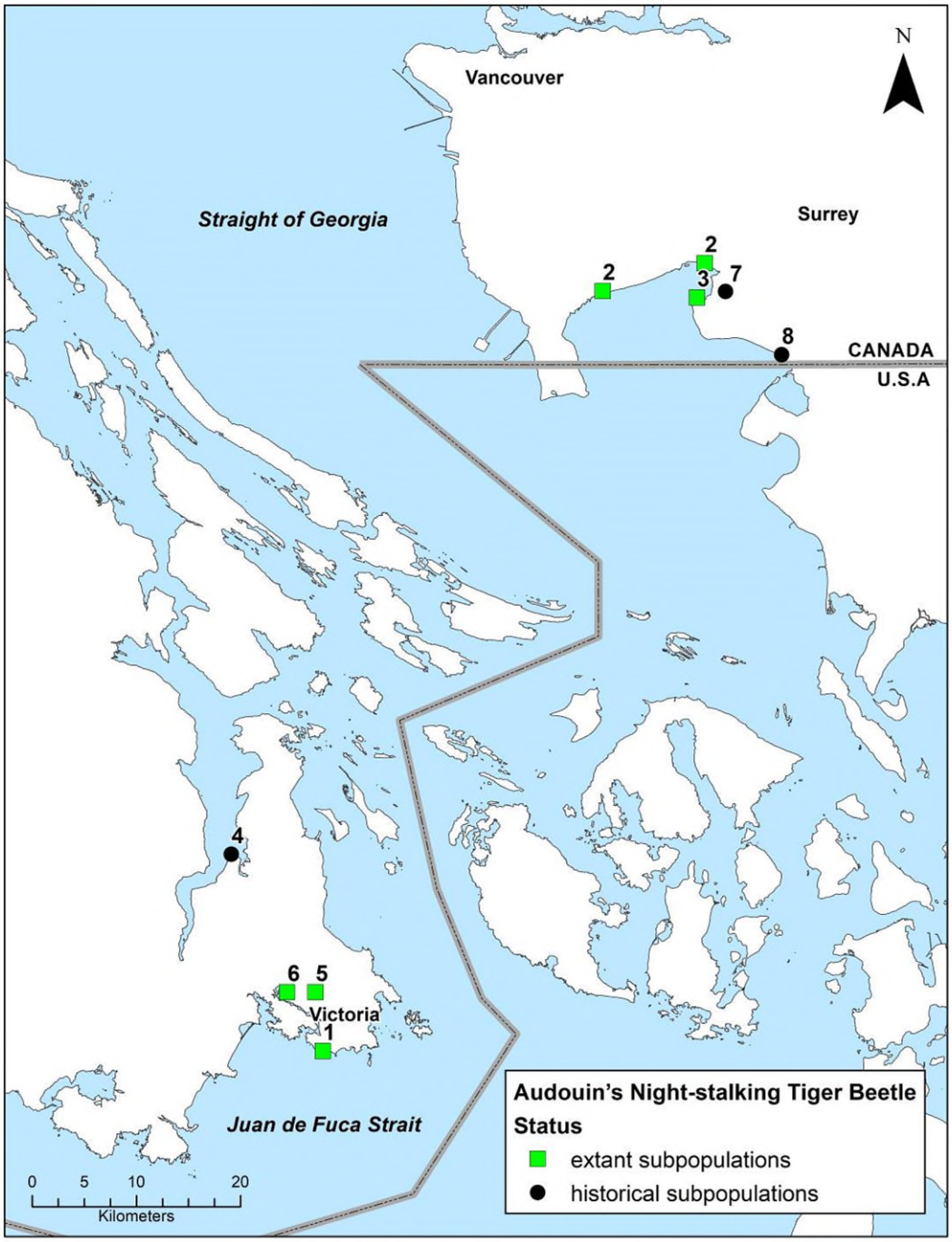

Figure 3. Canadian range and subpopulations of Audouin's Night-stalking Tiger Beetle (*Omus audouini*) (B.C. CDC 2020).

Table 2. Status and description of Audouin's Night-stalking Tiger Beetle subpopulations in British Columbia.

Sub-population Number[b]	Sub-population Name	Status[a] (date of most recent observation)	Habitat Description
1	Finlayson Point, Victoria	Extant (2020)	Observed along coastal bluff meadow habitat south of Dallas Road through Beacon Hill Victoria Municipal Park.
2	Boundary Bay, Delta	Extant (2020)	Observed from 72nd Street access, near the Boundary Bay airport and further east by the Serpentine River outlet. Observations are likely connected via a strip of habitat along the shoreline and fields/ meadows of Boundary Bay area.
3	Blackie Spit (Mud Bay), Surrey	Extant (2010)	Observed at north tip of Blackie Spit.
4	Tod Inlet	Historical (1930)	The precise location is unknown however potentially suitable habitat remains in Tod Inlet.
5	Swan Lake, Victoria	Extant (2012)	Observed during daytime along the Galloping Goose Trail. Swan Lake Nature Sanctuary is nearby connected habitat and there may be some habitat in the trailside verges.
6	Colquitz River, Victoria	Extant (2000)	Observed within a residential yard, surrounded by urban housing and remnant areas of Garry Oak and associated ecosystems habitat.
7	Elgin, South Surrey	Historical (1985)	The precise location is unknown, however potential suitable habitat remains in the area.
8	White Rock	Historical (1962)	The precise location is unknown, however potential suitable habitat remains in the area.

[a] Extant: occurrence has been recently verified as still existing. Historical: used when there is a lack of recent field information verifying the continued existence of the occurrence. The subpopulation is considered historical if there are no verified records after 30 years, which is 10 beetle generations (3 years for a generation).

[b] This number corresponds to the element occurrence (EO) number assigned by the B.C. Conservation Data Centre (2020) except for subpopulations #7 and #8, both of which do not have an EO number.

3.3 Needs of Audouin's Night-stalking Tiger Beetle

3.3.1 General Habitat

Habitat requirements for most tiger beetles are driven by adult activity (e.g., mating, foraging) and larval development (Pearson and Vogler 2001). Overall activity patterns of tiger beetles, including their presence in a specific habitat patch, are influenced by factors such as temperature, water availability, day length and microhabitat features including but not necessarily limited to soil content and understory/ground vegetation (Pearson and Vogler 2001; Pearson *et al.* 2005).

The habitats for all subpopulations in B.C. are within low elevation coastal terrain, less than 3 km from the marine shore and less than 50 m above sea level (B.C. CDC 2020). Some of these sites are in areas potentially flooded by seawater (subpopulations #2, #3) or occasional freshwater floods driven by rain runoff (subpopulations #2, #3); however, the species is not thought to be dependent on such environmental factors nor is it considered a shoreline habitat specialist. The species seems able to tolerate some anthropogenic disturbance, with adults found in residential yards (subpopulation #6) and along trails (subpopulation #5), as well as in habitats with high recreation use and invasive species. In the United States, larvae have been found along hiking trails and within road cuts (COSEWIC 2013).

Audouin's Night-stalking Tiger Beetles are found in two ecosystem types in B.C.: sparsely vegetated coastal sand ecosystems and Garry Oak (*Quercus garryana*) and associated ecosystems.

Two extant (#2, #3) and two historical (#7, #8) Audouin's Night-stalking Tiger Beetle subpopulations are found in sparsely-vegetated coastal sand ecosystems that include sand dunes and sand and gravel spits where vegetation establishes slowly due to harsh environmental conditions (Ward *et al.* 1998; Page *et al.* 2011). These habitats are composed of large amounts of bare soil, dry exposed areas, short turf grasses and significant patches of herbaceous vegetation but low amounts of tree (< 10%) and shrub growth. Three plant communities are present in the areas these subpopulations occupy:

1) The American Searocket (*Cakile edentula*) ecological community. This community forms a narrow band along the shore between the driftwood and upper beach area. Dune Wildrye (*Leymus mollis ssp. mollis*) and Red Fescue (*Festuca rubra*) form the dominant vegetation. Puget Sound Gumweed (*Grindelia stricta*), Yarrow (*Achillea millefolium*), Dune Beach Pea (*Lathyrus japonicus*), and Cascara (*Rhamnus purshiana*) are associated species. This ecological community is unranked in B.C. (B.C. CDC 2020), but is widespread and common within the Georgia Basin.

2) The Large-headed Sedge (*Carex macrocephala*) ecological community. This community is typically on upper to mid-elevation sand flats, on rapidly drained sites with poor nutrient availability. Introduced grasses are common in this community. Dominant species include Large-headed Sedge, Red Fescue, and Puget Sound

Gumweed. Beach Bindweed (*Convolvulus soldanella*), Yellow Sand-verbena (*Abronia latifolia*), Black Knotweed (*Polygonum paronychia*), Sea Thrift (*Armeria maritima*), and Dune Wildrye are other associated species. This plant community is Red-listed (B.C. CDC 2020).

3) The Northern Wormwood - Red Fescue / Grey Rock-moss (*Artemisia campestris-Festuca rubra / Racomitrium canescens*) ecological community. Species composition is variable but most of the plants are similar to the Large-headed Sedge community and include Large-headed Sedge, Red Fescue and Puget Sound Gumweed, while associated species include Beach Bindweed, Yellow Sand-verbena, Black Knotweed, Sea Thrift, and Dune Wildrye. This ecological community is also Red-listed (B.C. CDC 2020).

Three extant (#1, #5, #6) and one historical (#4) Audouin's Night-stalking Tiger Beetle subpopulations in the greater Victoria area are recorded from Garry Oak and associated ecosystems, which are sparsely-treed open meadow habitats. Understory vegetation includes both native and introduced grasses and a variety of forbs and shrubs. Garry Oak, Arbutus (*Arbutus menziesii*), Douglas-fir (*Pseudotsuga menziesii*), and other trees are also present. See Erickson (1993; 1995) and Fuchs (2000) for further descriptions of this ecosystem.

Audouin's Night-stalking Tiger Beetle is found in small pockets or remnant patches of natural habitat, with well-drained soil, within larger urban or agricultural developed areas. Hedgerows surrounding agricultural fields, residential areas, riparian areas where some natural vegetation remains, steeper portions of habitat or naturalized areas are all places where beetles have been observed here or in other parts of its geographic range. The habitats described above are typical natural habitats, but it appears that beetles can survive, establish larval burrow sites, and use these areas, even if for one or two generations. Further research is needed as to whether these areas are population sinks and/or the result of rescue effect from adjacent or nearby subpopulations residing in more natural habitats. Audouin's Night-stalking Tiger Beetle is also large and relatively mobile, and has the potential to disperse and crawl to other areas in search of epigeal prey items, new oviposition (egg laying) sites or mating opportunities.

3.3.2 Specific Habitat Functions

Oviposition and Egg Development habitat

Adult females oviposit (or lay) eggs singly in habitat suitable for constructing larval burrows; often in banks with fine clay soil, fine sand, and rarely, coarse-grained sand (i.e., the larval burrow must remain intact for the duration of this life stage). Oviposition sites are above the water table.

Larval and pupal habitat

Audouin's Night-stalking Tiger Beetle larvae live in underground burrows. Larvae and their burrows have not yet been observed in B.C., so no local information is available, but there is information on *Omus* from other areas. Elsewhere in the species global range, larval tunnels have been found constructed on sloping ground (up to 50% slope), with most being found on banks and coastal bluffs, stream banks, adjacent to hiking trails and road cuts. However at most habitats in B.C., steep slopes are not evident in the surrounding habitat (e.g., #2, #3, #5 and #6). Soil composition must be loose enough for burrow construction, but cohesive enough to prevent collapse (e.g., banks with fine clay soil, fine sand, and rarely, coarse-grained sand). Larval tunnels can reach 15-30 cm in depth, so suitable soils must be at least 15 cm deep and above the water table.

Soil microsite characteristics such as pH and temperature requirements are unknown. However, larval burrows in other regions tend to be on south-facing slopes, presumably to take advantage of warmer temperatures. During the winter, larvae close their burrows.

Adult foraging, cover, resting and mating habitat

Adults are fast crawlers, and spend their time on the surface of the ground and/or under leaf litter. Adults hunt in open habitats with suitable line-of-sight for seeking epigeal prey. They are heliophilic (heat loving), and prefer open, sunny sites such as meadows, open forest, forest margins, coastal bluffs, inactive agricultural fields and open grassy areas (COSEWIC 2013; B.C. CDC 2020; R. McGregor pers. comm. 2020).

When seeking cover, beetles use a variety of objects including wood, logs, stones, and dead leaves as well as anthropogenic items such as black plastic, tar paper and old automobile tires (COSEWIC 2013). While mating has not been observed in B.C., mating pairs in Oregon were all found under cover, usually wood (Maser 1977a).

Audouin's Night-stalking Tiger Beetle adults likely maintain a home range which includes habitat suitable for hunting so they can forage, find mates and reproduce. Home range size and the ecological components are unknown. Travel throughout and beyond home ranges are limited to movements based on adults walking or running because the species is flightless and does not jump.

Table 3. Summary of essential functions and features of Audouin's Night-stalking Tiger Beetle (*Omus audouini*) habitat in Canada.

Life stage	Function[a]	Feature(s)[b]	Attribute
Egg, larva, pupae, adult (mating)	Incubation, larval refuge, pupation, oviposition (egg laying)	Accessible (i.e., sloped) substrates loose enough for burrow construction but cohesive enough to prevent collapse and deep enough to accommodate typical burrowing depths	*Slope:* sloped substrates with up to 50% slope; not typically on completely flat terrain *Soil composition:* clay, fine clay, or sand *Soil depth:* >15 cm *Soil moisture*: balanced moisture to ensure larvae do not desiccate or drown, and to ensure that soil has appropriate substrate cohesion to ensure tunnels can be effectively constructed and will not collapse before the end of larval development
Adult	Hunting	Habitats with vegetation that is low/sparse up to moderate height (1 m tall) and density	Meadows, open forest, forest margins, coastal bluffs, open grassy areas, and anthropogenic areas with suitable habitat, such as inactive (i.e., untilled) agricultural fields, agricultural fields with an intact ground substrate (e.g., blueberry fields), urban parks, mature gardens, and other human-maintained grassy habitats such as mowed areas and golf courses.
		Prey availability	A variety of epigeal (surface dwelling) arthropods as prey items (e.g., ants, centipedes)
Adult	Cover, mating	Safe locations for taking cover from weather and predators and for mating	Available cover objects including, but not limited to, wood, logs, stones and vegetative debris.

[a] Function: a life-cycle process of the species (e.g., breeding, resting, pupation, mating, feeding/foraging).

[b] Feature: the essential structural components of the habitat required by the species.

3.4 Limiting Factors

Limiting factors are generally not human induced and include characteristics that make the species less likely to respond to recovery and conservation efforts. It is presumed that Audouin's Night-stalking Tiger Beetle subpopulations are present in high enough numbers for breeding and recruitment and that sufficient habitat is currently available to support existing subpopulations. However, several limiting factors for Audouin's Night-stalking Tiger Beetle make them more vulnerable to future impacts.

- *Limited dispersal ability:* Audouin's Night-stalking Tiger Beetle is a large beetle and is able to run and crawl; however, it is flightless and does not jump. As such, the overall dispersal ability of the species is likely to be relatively poor, being restricted to distances and areas to which it can move on foot.

- *Natural parasites:* The wingless parasitic wasp, *Methocha californica*, is an obligate species on Audouin's Night-stalking Tiger Beetle (Burdick and Wasbauer 1959). This species has not been recorded at any of the Audouin's Night-stalking Tiger Beetle sites, nor is its impact on population abundance known. This species is not considered a threat to subpopulations.

- *Specific site/substrate requirements for egg and larval development (including soil type and mineral composition):* Although the precise requirements are unknown, soil type, mineral content and pH likely play an important role in Audouin's Night-stalking Tiger Beetle habitat selection and their resulting productivity and survivorship, and suitable conditions for eggs and larval development may be restricted to a small number of sites.

- *Habitat availability*: All subpopulations are within close proximity (< 3 km) to the marine shoreline and could potentially be impacted by earthquakes or tsunamis. This region of the country has the highest threat of earthquake and tsunami in Canada.

4. Threats

4.1 Threat Assessment

The Audouin's Night-stalking Tiger Beetle threat assessment is based on the IUCN-CMP (International Union for the Conservation of Nature–Conservation Measures Partnership) unified threats classification system. Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (e.g., species) in the area of interest (i.e., at the national scale in Canada). Threats were considered over a 10 year time frame (corresponding to three generations). Limiting factors are not considered during this assessment process. For purposes of threat assessment, only present and future threats are considered. Historical threats, indirect or cumulative effects of the threats, or any other relevant information that would help understand the nature of the threats are presented in Section 4.2, Description of Threats.

Table 4. IUCN-CMP threats assessment for extant subpopulations of Audouin's Night-stalking Tiger Beetle (*Omus audouini*) in B.C. Subpopulations are: #1 Finlayson Point, Victoria; #2 Boundary Bay, Delta; #3 Blackie Spit (Mud Bay), Surrey; #5 Swan Lake, Victoria; #6 Colquitz River, Victoria.

Threat No.	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Threats by subpopulation
1	Residential & commercial development	Low	Small (1-10%)	Extreme (71-100%)	High (Continuing)	
1.1	Housing & urban areas	Low	Small (1-10%)	Extreme (71-100%)	High (Continuing)	#1 and #5, and undeveloped / unchecked potential habitat (particularly #2, #3)
1.2	Commercial & industrial areas	Low	Small (1-10%)	Extreme (71-100%)	Low (Possibly in the long term, >10 yrs)	#2; and unchecked potential habitat
1.3	Tourism & recreation areas	Low	Small (1-10%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs)	#2; and unchecked potential habitat
2	Agriculture & aquaculture	Low	Small (1-10%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs)	
2.1	Annual & perennial non-timber crops	Low	Small (1-10%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs)	#2; and unchecked potential habitat
2.3	Livestock farming & ranching	Negligible	Negligible (<1%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs)	#2
5	Biological resource use	Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals	Negligible	Pervasive (71-100%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	All subpopulations.
5.2	Gathering terrestrial plants	Unknown	Small (1-10%)	Unknown	High (Continuing)	#2

Threat No.	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Threats by subpopulation
6	Human intrusions & disturbance	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	
6.1	Recreational activities	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	#1, #2, #3 and #5
7	Natural system modifications	Medium - Low	Restricted (11-30%)	Serious - Slight (1-70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
7.1	Fire & fire suppression	Low	Pervasive (71-100%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	All subpopulations.
7.2	Dams & water management/use	Medium - Low	Restricted (11-30%)	Serious - Slight (1-70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	#2
7.3	Other ecosystem modifications	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	All subpopulations.
8	Invasive & other problematic species & genes	Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
8.1	Invasive non-native/alien species	Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	All subpopulations.
9	Pollution	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	
9.3	Agricultural & forestry effluents	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	Unchecked potential habitat in the Boundary Bay areas (#2).
9.4	Garbage & solid waste	Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	All subpopulations.

Threat No.	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Threats by subpopulation
11	Climate change & severe weather	Low	Pervasive (71-100%)	Slight (1-10%)	Moderate (over the short term, < 10 yrs/3 gen	
11.1	Habitat shifting & alteration	Unknown	Pervasive (71-100%)	Unknown	Moderate (over the short term, < 10 yrs/3 gen)	#2 and #3
11.2	Droughts	Low	Pervasive (71-100%)	Slight (1-10%)	Moderate (over the short term, < 10 yrs/3 gen)	All subpopulations.
11.3	Temperature extremes	Low	Pervasive (71-100%)	Slight (1-10%)	Moderate (over the short term, < 10 yrs/3 gen)	All subpopulations.
11.4	Storms & flooding	Low	Pervasive (71-100%)	Slight (1-10%)	Moderate (over the short term, < 10 yrs/3 gen)	All subpopulations.

[a] **Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment timeframe (e.g., timing is insignificant/negligible or low as threat is only considered to be in the past); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.

[b] **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%; Negligible < 1%).

[c] **Severity** – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%; Negligible < 1%; Neutral or Potential Benefit ≥ 0%).

[d] **Timing** – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.

4.2 Description of Threats

Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of Audouin's Night-stalking Tiger Beetle in B.C. (adapted from Salafsky *et al.* 2008). For purposes of the threat assessment, only present and future threats are considered.[9] Threats presented here do not include limiting factors,[10] which are presented in Section 3.4.

For the most part, threats are related to human activities, but they can also be natural. The impact of human activity may be direct (e.g., destruction of habitat) or indirect (e.g., habitat changes as a result of the spread of invasive plant species, climate change). Effects of natural phenomena (e.g., fire, flooding) may be especially important when the species is concentrated in one locality or has few occurrences, which may be a result of human activity (Master *et al.* 2012). As such, natural phenomena are included in the definition of a threat, though they should be considered cautiously. These stochastic events should only be considered a threat if a species or habitat is damaged from other threats and has lost its ability to recover. In such cases, the effect on the Canadian population would be disproportionately large compared to the effect experienced historically (Salafsky *et al.* 2008).

The overall province-wide threat impact for Audouin's Night-stalking Tiger Beetle is High[11]. This overall threat considers the cumulative impacts of multiple threats. Primary threats include natural systems modification (7.2 dams and water management), residential and commercial development (1.1 and 1.2), human intrusion and disturbance through recreational activities (6.1); and impacts from climate change (11) (Table 4).

Threat descriptions are provided in decreasing order of Threat Impact levels, as per classification in Table 4.

IUCN-CMP #7.2 Dams and water management/use (Medium-Low impact)

The habitat at Boundary Bay (subpopulation #3) is within the proposed area for a future large-scale infrastructure "Living Dike" project. The habitat at Boundary Bay includes tidal marsh vegetation, which slows down wave energy and reduces the height of waves, thus protecting adjacent communities from coastal flooding. With sea level anticipated to rise by 1 m by the year 2100, these tidal ecosystems cannot migrate landward to areas of higher elevation due to the presence of dikes around the perimeter

[9] Past threats may be recorded but are not used in the calculation of threat impact. Effects of past threats (if not continuing) are taken into consideration when determining long-term and/or short-term trend factors (Master *et al.* 2012).

[10] It is important to distinguish between limiting factors and threats. Limiting factors are generally not human induced and include characteristics that make the species or ecosystem less likely to respond to recovery/conservation efforts (e.g., inbreeding depression, small population size, and genetic isolation).

[11] The overall threat impact was calculated following Master *et al.* (2012) using the number of Level 1 Threats assigned to this species where timing = High or Moderate, which included 0 Very High, 0 High, 1 Medium, and 5 Low (Table 4). The overall threat impact considers the cumulative impacts of multiple threats.

of the bay, and thus it is anticipated that these tidal marshes will be drowned out by the rising water levels. The Living Dike concept proposes adding small amounts of sediment over several years to enable the tidal marsh vegetation to grow at increasingly higher elevations, and thus continue to provide coastal flood protection and ecosystem structure/functions as the sea rises (E. Balke pers. comm. 2020). Small changes and shifts to the sediment will impact and change the larval burrow habitat and adult foraging opportunities and territories at Boundary Bay; however, there may be enough time between dike work that the subpopulation can adjust with the gradual habitat manipulation. More study is needed.

IUCN-CMP #1.1 Housing and urban areas (Low impact)

Audouin's Night-stalking Tiger Beetle Canadian range occurs within some of the most valuable housing and urban areas in Canada. Most of the urban development is historical, although there continues to be small undisturbed areas that are slowly being developed within the immediate range of the beetle and there is immense pressure to convert open private farmland, as well as land currently in the Agricultural Land Reserve, to urban housing. This threat applies to all potential habitats within a 5 km radius around each subpopulation; most of these remaining areas are in private ownership (private individuals, organizations or local government). The threat is highest in the Boundary Bay (subpopulation #2) and south Surrey (subpopulation #3) areas.

In addition to the loss of habitat through direct conversion, activities associated with land development can also impact microhabitat conditions. For example, works that alter hydrologic patterns can reduce the amount of suitable habitat available (e.g., by creating soil conditions that are either too dry or too wet for inappropriate lengths of time).

IUCN-CMP #1.2 Commercial and industrial areas (Low impact)

The same factors that apply to 1.1 also apply to this threat. In particular, There are potential expansion plans for the Boundary Bay Airport (subpopulation #2).

IUCN-CMP #1.3 Tourism and recreational areas (Low impact)

The demand for tourism and recreational areas within the lower Fraser Valley and the greater Victoria areas has increased substantially within the past decade. Natural areas continue to be developed into golf courses, campgrounds, parks, and recreation facilities. This threat applies to small areas of habitat within recreational areas and surrounding habitat areas at subpopulation #2. Within existing parks, as well as regional and municipal properties, habitat conservation and recreational development potentially conflicts with Audouin's Night-stalking Tiger Beetle conservation (subpopulations #2, #3, #4, #5). Potential threats include construction of picnic areas, new trails and rights-of-way within highly used Metro Vancouver parks such as Boundary Bay Regional Park (subpopulation #2).

IUCN-CMP #2.1 Annual and perennial non-timber crops (Low impact)

Potentially-suitable habitats within the Agricultural Land Reserve (e.g., old fields, fallow fields[12], fields with perennial crops[13], re-naturalized areas, meadows and open forest) as well as private farms and larger rural properties, potentially at risk of clearing and conversion. This is a potential threat at many agricultural sites within the lower Fraser Valley with verges of natural habitat surrounding agricultural fields (subpopulations #2 and #3). The threat also applies to remnant areas of unsurveyed habitat (e.g., ditch banks and verges, crop verges and the perimeter of agricultural fields) where Audouin's Night-stalking Tiger Beetles may remain in small habitat patches, throughout its range on both Vancouver Island and the lower mainland. Approximately 90% of the Swan Lake Nature Sanctuary (part of the habitat polygon that includes subpopulation #5) is within the Agricultural Land Reserve; although this property is currently protected from agricultural development.

In the past decade there has been an increase in greenhouse construction on land zoned as Agricultural Land Reserve, which contributes to loss of old field and meadow ecosystem habitat. Approximately 90% of greenhouses in B.C. are in the lower Fraser Valley (B.C. Ministry of Agriculture 2012). This threat is applicable to potential habitats around subpopulation #2.

IUCN-CMP #6.1 Recreational activities (Low impact)

Ongoing recreational activities such as walking, dog-walking (including off-leash dog-walking), picnicking, sunbathing, spontaneous sports (e.g., playing catch) are ongoing at subpopulations #1, #2, #3, #4 and #5. Horseback riding occurs at subpopulations #2 and #3 and trail and mountain biking may occur at all habitats. All the above activities can cause habitat degradation, especially through soil compaction of larval burrowing sites, as well as direct mortality (e.g. accidental strikes along trail edges). Recreational activities also can increase the spread of introduced plant species (see Threat 7.3).

IUCN-CMP #7.1 Fire and fire suppression (Low impact)

The threat of fire is present throughout the entire range of the Audouin's Night-stalking Tiger Beetle, although the risk is greater in Garry Oak habitats (subpopulations #1, #4, #5, #6). Human activities that increase the threat of fire include discarded cigarettes and illegal campfires within recreational areas (highest in subpopulations #2, #3, #5). Audouin's Night-stalking Tiger Beetle habitats remain relatively moist or wet throughout the year, but the threat of fires increases substantially in July through September. Habitat clearing for fire suppression may also impact the species, particularly the resting (i.e., cover), mating and foraging sites.

[12] Agricultural areas that have not grown crops for a number of years.
[13] Crops such as blueberries, which do not require surface tilling.

IUCN-CMP #7.3 Other ecosystem modifications (Low impact)

The threat of invasive plant species is present at all sites; however, there is some uncertainty as to the level of impact of this threat. Since the growth of invasive non native plants is considered a proximate threat (e.g., the plant growth changes the habitat, which then impacts the beetle indirectly) this threat is scored under this category, rather than 8.1 (invasive non-native/alien species). The growth of invasive non-native plants changes the open sandy habitat available for oviposition sites and larval tunnel site development. The habitats at all subpopulations have introduced Himalayan Blackberry (*Rubus armeniacus*) and other non-native plants, although the scope of introduction and suite of species present is not fully known. Sparsely-vegetated plant communities are susceptible to colonization by invasive plants such as Scotch broom (*Cytisus scoparius)* and grasses such as Cheatgrass (*Bromus tectorum*), European Beachgrass (*Ammophila arenaria*), Orchardgrass (*Dactylis glomerata*), Common Velvetgrass (*Holcus lanatus*), Soft Brome (*Bromus hordeaceus*), and Rat-tail Fescue (*Vulpia myuros*). Annual Vernalgrass (*Anthoxanthum odoratum*) may be accelerating vegetation stabilization. English Ivy (*Hedera helix*) is known to spread and displace the native vegetation on forest floors. Scotch broom is known to fix nitrogen in low fertility sand soils and rapidly take over sand-dominated areas (Parker 2002).

In addition, activities such as mowing and cutting of vegetation within sites (for rights-of-way maintenance) can impact adult foraging and larval tunnel habitat.

IUCN-CMP #9.3 Agricultural and forestry effluents (Low impact)

The use of pesticides, especially those used to control road and trail-side vegetation, has potential to harm Audouin's Night-stalking Tiger Beetle subpopulations directly, through killing individual eggs and larvae, and indirectly, through killing the species' prey. In general, the use of pesticides within parks and protected areas is not practiced, and this is not considered a threat to the portion of subpopulations within these jurisdictions. However, subpopulations span habitats outside of these protected areas and the threat could still apply to these unprotected habitats. Provincial initiatives that consider the ban on home use of pesticides for cosmetic purposes throughout the province are ongoing (Nagel 2011). This threat is potentially applicable to unsurveyed potential habitats surrounding subpopulations #1, #2, #3 and #5. There is a community garden across from subpopulation #5, however there is a low risk from agricultural pesticide run-off from this site (D. Pepper pers. comm. 2020). Overall the impact of this threat is unknown and requires study.

IUCN-CMP #11.2 Droughts and #11.3 Temperature extremes (Low impact)

Increased summer droughts and higher summer temperatures may decrease microhabitat moisture for prey species, larval burrow sites and larval development. Combined with other threats, such as water diversion and infilling, drought within natural habitat may increase in the next decade.

IUCN-CMP #11.4 Storms and flooding (Low impact)

All subpopulations are within 3 km of the shoreline and subpopulations #2, #3 and # 4 may be flooded by seawater during storm surges. Temporary flooding is usually during winter when the larval burrows are sealed. Sea level rise is considered a threat to the Lower Mainland (Forseth 2012; Thomson *et al.* 2008; Kangasniemi 2009). If frequency and severity of storms and flooding increases, impacts may cause an overall Canadian population decline.

IUCN-CMP #2.3 Livestock farming and ranching (Negligible impact)

Livestock grazing, including horse, sheep, cattle, chickens, goats and llamas, may apply to habitats surrounding subpopulations #2 and #3. Livestock grazing can be detrimental to tiger beetle populations (Knisley 2011). Trampling of sensitive forest and meadow areas is often a result of livestock congregating adjacent to watercourses or near preferential vegetation, and there would be direct mortality caused by trampling of larval development sites and habitat as well as consumption of herbaceous vegetation otherwise used as cover by Audouin's Night-stalking Tiger Beetle adults. It is possible that the beetle may be able to tolerate moderate livestock grazing, as long as larval sites are not heavily compacted. In Washington State, two recorded Audouin's Night-stalking Tiger Beetle sites are known to have historical grazing. Mima Mounds Prairie was heavily grazed from 1905 – 1967 and Glacial Heritage has been partially grazed (Maynard 2007). It is not clear if the tiger beetles survived the grazing or re-colonized the area after the grazing ceased, so more study is required.

IUCN-CMP #5.2 Gathering terrestrial plants (Unknown impact)

There is yearly harvest of *Salicornia virginica* (Sea Asparagus) within the Boundary Bay area (subpopulation #2). Impacts of the harvest activities on the beetle, including boat access or shoreline activities associated with this harvest, or its habitat are unknown.

IUCN-CMP #8.1 Invasive non-native/alien species (Unknown impact)

Introduced gastropods, earthworms, rabbits, squirrels, mice and various introduced carabid beetles are present throughout the habitats of all subpopulations. These species are known to consume both adult and larval beetles, although the impacts to Audouin's Night-stalking Tiger Beetle subpopulations are unknown.

5. Population and Distribution Objective

The population and distribution objective is to recover Audouin's Night-stalking Tiger Beetle in Canada by increasing redundancy for all extant subpopulations, and any additional subpopulations that may be identified in the future, through ceasing or mitigating human-caused threats and conducting habitat restoration where feasible.

Short-term statements towards meeting the population and distribution objective

1. Cease human-caused threats that would cause further loss in the quantity or quality of the habitat needed for recovery.
2. Initiate abatement or mitigation measures for non-habitat human-caused threats for all extant subpopulations by 2027.
3. Restore habitat as required and feasible to achieve recovery by 2027.

Rationale for Population and Distribution Objective

The Audouin's Night-stalking Tiger Beetle was assessed by COSEWIC (2013) as Threatened based on its small distribution, small range and continuing declines in the area, extent and quality of habitat, compromising the key survival characteristic of redundancy[14].

There is currently no information or evidence from historical sampling to suggest the beetle was abundant throughout its range in Canada, so the primary approaches to improving the species' redundancy are to stop the decline in habitat for known occurrences, by addressing threats caused by humans (primarily residential, commercial, agricultural and recreational land use, fire and water management, invasive species, pollution and climate change) and those caused by other factors (primarily limiting environmental factors such as their dispersal ability, parasites and substrate needs, and threats from tsunamis and severe weather events), and to restore habitat as feasible. However, because survey effort has been limited and several historical locations have not been recently surveyed, it is possible that new surveys may confirm additional subpopulations, so searching for additional subpopulations is included as a secondary approach to improving the species' redundancy in Canada. Given the lack of information about the historical number of subpopulations, active intervention to increase the number of subpopulations (e.g., through translocation) is not considered appropriate at this time. In addition, it should be noted that captive breeding to supplement wild populations is not currently considered necessary for the recovery of Audouin's Night-stalking Tiger Beetle. Additional recovery techniques to achieve the population and distribution objectives are expected to be developed within a reasonable time frame.

Quantitative targets for the number of individuals at subpopulations cannot be set at this time because subpopulation information for of Audouin's Night-stalking Tiger Beetle is limited, incomplete and/or outdated. Consequently, there is little information with which to measure abundance trends or to complete a minimum subpopulation viability analysis.

[14] Redundancy refers to the number of subpopulations and/or the degree to which the species is widespread. A species that has multiple subpopulations or locations, or a distribution that is very widespread, is more likely to persist over the long term because of reduced risk of catastrophic loss or extirpation from a single, local event. If one subpopulation becomes destroyed, others may be able to act as a source population.

6. Broad Strategies and General Approaches to Meet Objectives

6.1 Actions Already Completed or Currently Underway

Habitat Management, Restoration, and Conservation (in progress)

- Portions of the habitat at Boundary Bay (#2) fall within the Robert's Bank Wildlife Management Area (provincial protected area).
- Local government bylaws that conserve environmental values on private lands differ between local governments. Currently, no bylaws specifically conserve Audouin's Night-stalking Tiger Beetle; however, numerous local governments recognize the importance of rare ecosystems and use Sensitive Ecosystem Inventory information (Ward *et al.* 1998) to guide and limit the type of development within certain areas. Depending on the jurisdiction, development permit applications may require environmental assessments that include wildlife values and consider impacts to natural habitats as part of the approval process. For example, the District of Central Saanich Official Community Plan includes provisions to conserve sensitive environmental areas within several development permit areas, including coastal sand spits and inland bluff habitats (Page 2010).

Research, Inventory, and Monitoring (in progress)

- Inventory to 2012 is summarized in the COSEWIC (2013) status report. Areas targeted for searches in 2012 included: Cordova Spit (including Island View Beach Regional Park); Central Saanich Park and some First Nation lands (Parkinson and Heron 2010; J. Heron pers. data).
- Habitat and inventory studies by McGregor (2016 - 2020) occurred at the Boundary Bay Wildlife Management Area and other habitats in the Boundary Bay area (R. McGregor pers. comm. 2020).

6.2 Strategic Direction for Recovery

Recovery planning for Audouin's Night-stalking Tiger Beetle is similar to approaches for other species under the Garry Oak Ecosystems Recovery Team and the South Coast Conservation Program (www.sccp.ca). Because of the extensive knowledge gaps for Audouin's Night-stalking Tiger Beetle, most of the recovery planning activities listed in Table 5 centre on monitoring, information gathering, and threat clarification. These activities will help direct future surveys and inform habitat protection efforts. A combined approach to recovery includes engaging private landowners, the agricultural sector, including the B.C. Ministry of Agriculture and stewardship groups within this sector, the B.C. Ministry of Transportation and Highways, municipal governments, the academic, naturalist, and stewardship communities in recovery projects for the species.

Table 5. Recovery Planning Table.

Threat or Limitation	Priority[a]	Broad Strategy to Recovery	General Description of Research and Management Approaches
Habitat Management, Restoration and Conservation			
All threats	High	Identify and mitigate threats at subpopulations	1. Gather site specific data and assess the scope, severity and timing of threats applicable for known subpopulations (#1-6). 2. Assess impacts of current land management activities on Audouin's Night-stalking Tiger Beetle habitats for known subpopulations (#1-6). 3. Develop best management practices (BMP) and/or stewardship plans (SP) in consultation with landowners/managers (including sector-specific and Indigenous knowledge holders within and outside government) for known subpopulations (#1-6), and additional subpopulations, as needed.
All threats	High	Ecosystem and habitat conservation	4. Work with landowners and managers (including sector-specific and Indigenous knowledge holders within and outside government) to determine appropriate measures to conserve Audouin's Night-stalking Tiger Beetle habitat at each of the known sites (#1-6). 5. At undesignated provincial Crown sites, establish Section 17 notation of interest under the B.C. *Land Act*, such that future development interests know species-at-risk habitat exists at the site. 6. On private land sites, including private conservation land, work with landowners and managers to develop BMP guidelines to mitigate site-specific threats and restore habitat for the Audouin's Night-stalking Tiger Beetle. 7. Within municipal parks and provincial protected areas, integrate conservation measures into existing management plans and other relevant park planning documents.

Threat or Limitation	Priority[a]	Broad Strategy to Recovery	General Description of Research and Management Approaches
			8. Recommend Audouin's Night-stalking Tiger Beetle be a priority for listing in the category "Species at Risk" under the B.C. *Forest and Range Practices Act* (FRPA) and *Oil and Gas Activities Act*. Draft an Identified Wildlife Species Account under FRPA.
2.3; 6.1; 6.3; 7.1; 7.3;	High	Increase host plant abundance and health	9. Develop a site prescription for restoration of Audouin's Night-stalking Tiger Beetle habitats of subpopulation #1-6 to mitigate site specific threats.
All threats	Low	Increase profile of Audouin's Night-stalking Tiger Beetle and associated habitats	10. Increase public awareness of the existence and conservation value of Audouin's Night-stalking Tiger Beetle and associated habitats. 11. Engage local stewardship and conservation groups through the development and delivery of public education and outreach materials concerning Audouin's Night-stalking Tiger Beetle and associated habitats.
All threats	Low	Restore habitat	12. As feasible and based on results of 6, 8 and 9 above, restore habitat at subpopulations to increase the amount of suitable habitat present and improve redundancy and connectivity.
Research, Inventory and Monitoring			
Knowledge gaps; species range, distribution and abundance	High	Confirm species presence, habitat use and range extent in Canada	13. Develop and implement a 10-year inventory strategy and schedule: complete a habitat model/map that predicts and prioritizes Audouin's Night-stalking Tiger Beetle habitats, determine land ownership and obtain necessary permissions to work with landowners on private lands, provincial conservation areas and other land tenures; and complete yearly inventory. 14. Monitor sites annually, including sites that were mapped as priority habitat but where beetles have yet to be confirmed (e.g., subpopulation #6).
Knowledge gaps; species biology and habitat requirements	High	Determine specific habitat characteristics at extant sites	15. Develop standard protocol for gathering habitat information at known subpopulations (subpopulations #1-6). 16. Clarify egg, larval and pupal habitat requirements: When/if subpopulation(s) are confirmed, initiate research to gain natural history information through observations of oviposition and larval development, pupal development sites and associated soil habitat. 17. Monitoring: when/if subpopulations are confirmed, further develop and refine monitoring of these sites to obtain information on the life history, movements, habitat use, and subpopulation biology of the species. This will enable a better understanding of habitat requirements for each life stage, and the potential dispersal to adjacent habitats.

Threat or Limitation	Priority[a]	Broad Strategy to Recovery	General Description of Research and Management Approaches
			18. Clarify dispersal and life span: when/if subpopulations are found, initiate a mark-recapture-release study that will help determine the dispersal and life span of adult beetles. 19. Clarify factors that may limit Audouin's Night-stalking Tiger Beetle subpopulations: e.g., the temperature thresholds for flight and foraging habits and daily activity patterns, and mating habits; parasitism and predation. 20. Develop a list of additional studies that address how limiting factors may affect beetle subpopulations when cumulative threats are applied. 21. Engage academia and researchers for studies on Audouin's Night-stalking Tiger Beetle.

[a] *"Priority" reflects the degree to which the broad strategy contributes directly to the recovery of the species or is an essential precursor to an approach that contributes to the recovery of the species.*

6.3 Narrative to Support the Recovery Planning Table

Habitat Management, Restoration and Conservation

Habitat management, restoration and conservation actions are necessary to ensure subpopulations are maintained at each of the five extant subpopulations. Concurrent with landowner contact and outreach, there is a need for a subpopulation-specific site prescription, best management practices and/or stewardship plan for each subpopulation to ensure each of these five extant subpopulations are sustained.

Conservation of habitats on provincial crown land will also contribute to both species and habitat conservation of Audouin's Night-stalking Tiger Beetle. This includes listing Audouin's Night-stalking Tiger Beetle as a *Species At Risk* under the B.C. *Forest and Range Practices Act* and *Oil and Gas Activities Act*; and integrating species management into protected areas planning.

Increasing the profile of Audouin's Night-stalking Tiger Beetle and its conservation value will help engage Canadians in stewardship of this species. This work can be implemented through engaging local stewardship and conservation groups and concurrent development and delivery of public education and outreach materials concerning Audouin's Night-stalking Tiger Beetle and associated habitats.

Research, Inventory and Monitoring

In order to confirm that all extant subpopulations have been identified, and monitor the status/recovery of those subpopulations, a 10-year survey and monitoring strategy is needed. The inventory and monitoring strategy will include developing a habitat model to identify potentially-suitable areas that have not been surveyed, a standard and repeatable survey protocol, and methods for clarifying and monitoring threats (i.e., scope, severity and timing) to each subpopulation and associated habitat.

There are few observations and occurrence records from which to ascertain the habitat needed to sustain a subpopulation of Audouin's Night-stalking Tiger Beetle. Unknowns include temperature and degree-day requirements; egg, larval and pupal development, mating and oviposition; daily activity patterns; mating and resting sites; and other natural history information. Further research is needed to clarify factors that may limit Audouin's Night-stalking Tiger Beetle subpopulation persistence. There is a need to develop a list of additional studies that address how limiting factors may affect beetle subpopulations when cumulative threats are applied.

7. Critical Habitat

Section 41 (1)(c) of the SARA requires that recovery strategies include an identification of the species' critical habitat to the extent possible, as well as examples of activities that are likely to result in its destruction. More precise boundaries may be mapped, and additional critical habitat may be added in the future, if additional research supports the

inclusion of areas beyond those currently identified. A primary consideration in the identification of critical habitat is the amount, quality, and locations of habitat needed to achieve the population and distribution objective.

Critical habitat for Audouin's Night-stalking Tiger Beetle is identified in this recovery strategy to the extent possible based on the best available information. It is recognized that the critical habitat identified below is insufficient to achieve the population and distribution objective for the species (Section 6). A schedule of studies (Section 7.2) has been developed to provide the information necessary to complete the identification of critical habitat that will be sufficient to meet the population and distribution objective. The identification of critical habitat will be updated when additional information becomes available.

7.1 Identification of the Species' Critical Habitat

Critical habitat for Audouin's Night-stalking Tiger Beetle is identified at four of the five known extant subpopulations. The geospatial areas containing critical habitat for Audouin's Night-stalking Tiger Beetle (totalling 704.4 ha[15]) are presented in Figures 4-8. Within these geospatial areas, critical habitat is identified wherever the following biophysical attributes occur.

7.1.1 Biophysical attribute description

A description of the known biophysical features and attributes of the habitat that are required to support Audouin's Night-stalking Tiger Beetle life-cycle processes (functions) in Canada is provided in Table 3. The biophysical features and attributes required by Audouin's Night-stalking Tiger Beetle overlap geospatially across life history stages, in that they combine to provide an ecological context for the species at sites where it occurs. Therefore, within the geospatial areas containing critical habitat, only unsuitable areas that do not possess any of the features and attributes required by Audouin's Night-stalking Tiger Beetle at any time are excluded from identification as critical habitat. Examples of these excluded areas include: paved roadways or parking lots, active farmland where the surface is tilled or planted regularly, streams and marine areas below the high tide line, and active aerodrome spaces that are, and will continue to be, actively managed for aviation and public safety purposes.

7.1.2 Information and methods used to identify critical habitat

The geospatial areas containing critical habitat for Audouin's Night-stalking Tiger Beetle were delineated to include all suitable habitat surrounding extant subpopulations in all directions until a distance of 10 km had been travelled over contiguous suitable habitat (the B.C. CDC separation distance for subpopulations across suitable habitat; Natureserve 2020) or until unsuitable habitat was reached. The resulting geospatial areas extended from known subpopulation point locations to a minimum of about 10 m

[15] Critical habitat identified for Audouin's Night-stalking Tiger Beetle does not occur within any Federal Protected Areas.

(at Finlayson Point) and a maximum of about 6.5 km (at Boundary Bay). There is no information available on the home range or dispersal ability of Audouin's Night-stalking Tiger Beetle; however, as described in Section 3.2 (Species Population and Distribution), other similar flightless beetles can travel significant distances, so it is likely that Audouin's Night-stalking Tiger Beetles would be able to disperse to unoccupied habitat patches kilometers away as long as no migration barriers exist (e.g. highways, water courses) (Eluk *et al.* 2014).

If the first unsuitable habitat boundary reached during delineation was an unpassable barrier (such as the high tide line, agricultural lands with regular ground disturbance such as tilling, a stream with no crossing opportunities, or a major highway with no crossing opportunities), the geospatial critical habitat area did not extend past the boundary. If the boundary was deemed passable (such as a two lane road or small parking lot), then the geospatial critical habitat area extended past the boundary of unsuitable habitat for a maximum distance of 1 km (the B.C. CDC separation distance for subpopulations across unsuitable habitat) or until any unsuitable habitat was again reached. Areas with small amounts of suitable habitat within otherwise unsuitable terrain (such as housing developments where yards may have some suitable habitat) were not included as critical habitat at this time because it is unclear if these landscapes can maintain beetle populations. This resulted in no critical habitat being identified to support subpopulation #6. Work to determine the suitability of such highly developed locations is included in Table 6.

7.1.3 Geographic information

The geospatial areas containing critical habitat for Audouin's Night-stalking Tiger Beetle are presented in Figures 4-8 (subpopulation numbers are linked with those in Table 2):

- **Subpopulation 1:** Finlayson Point (Figure 4)
- **Subpopulation 2:** Boundary Bay (Figures 5 & 6)
- **Subpopulation 3:** Blackie Spit (Figures 6 & 7)
- **Subpopulation 5:** Swan Lake (Figure 8)

The 1 km x 1 km UTM grid overlay shown on these figures is a standardized national grid system that highlights the general geographic area containing critical habitat, for land use planning.

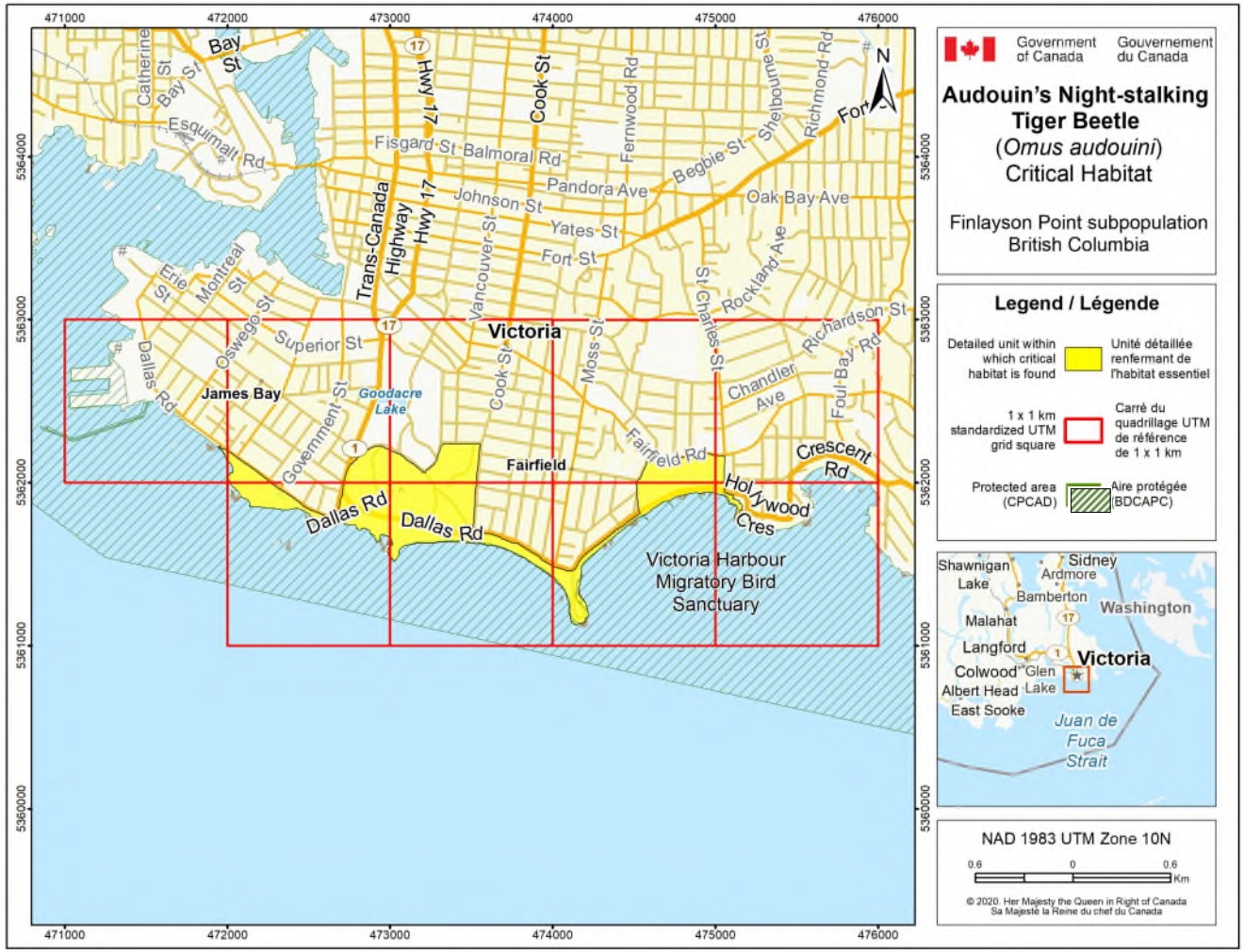

Figure 4. Critical habitat for Audouin's Night-stalking Tiger Beetle (*Omus audouini*) at Finlayson Point, Victoria, B.C. (subpopulation #1), is represented by the shaded yellow polygons, except where unsuitable areas (as described in section 7.1.1) occur. The 1 km x 1 km standardized UTM grid overlay (red outline) shown on this figure is part of a standardized national grid systems used to indicate the general geographical area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat. The green hatched area is a federal Migratory Bird Sanctuary.

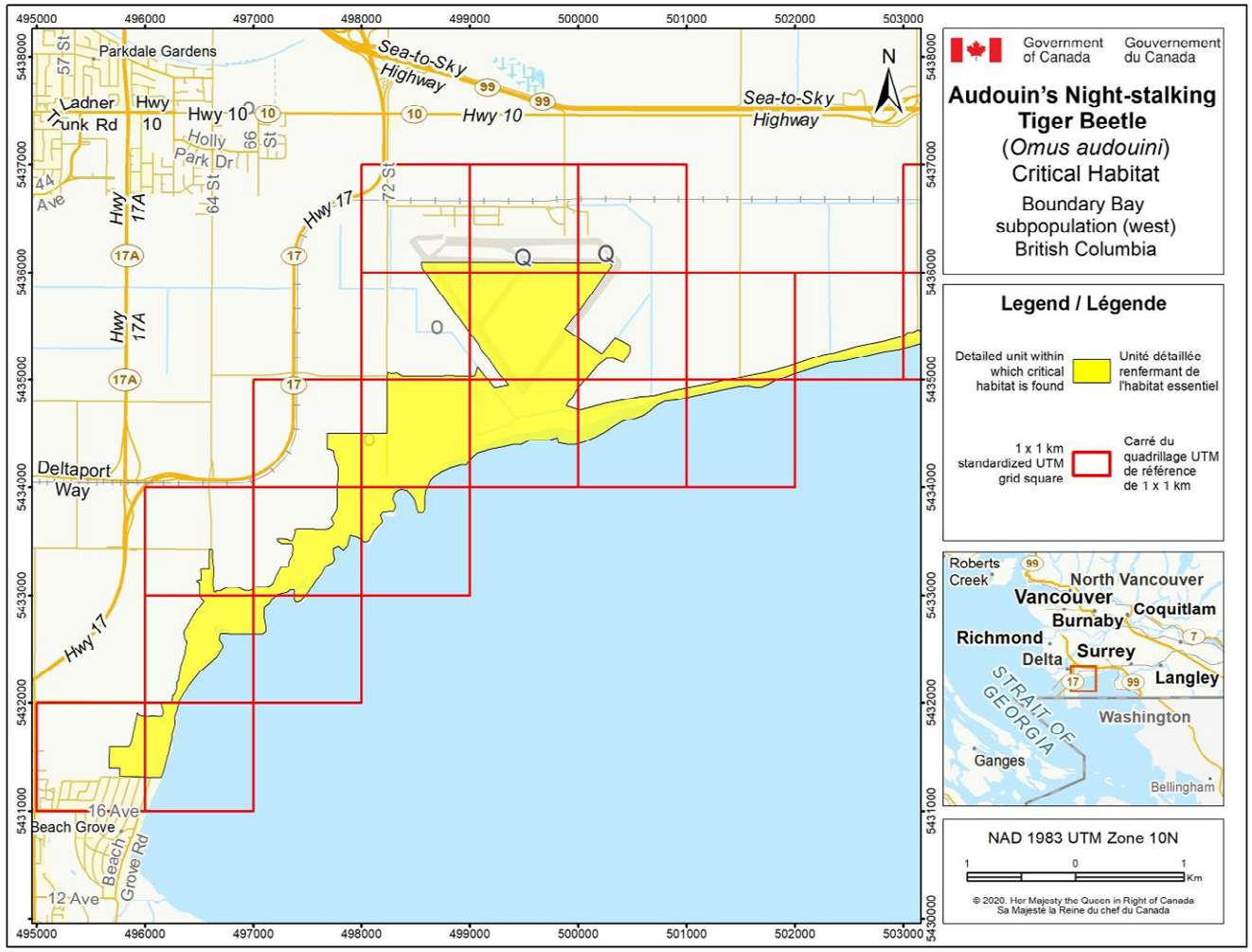

Figure 5. Critical habitat for Audouin's Night-stalking Tiger Beetle (*Omus audouini*) at Boundary Bay, Delta, B.C. (western portion of subpopulation #2), is represented by the shaded yellow polygons, except where unsuitable areas (as described in section 7.1.1) occur. The 1 km x 1 km standardized UTM grid overlay (red outline) shown on this figure is part of a standardized national grid systems used to indicate the general geographical area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

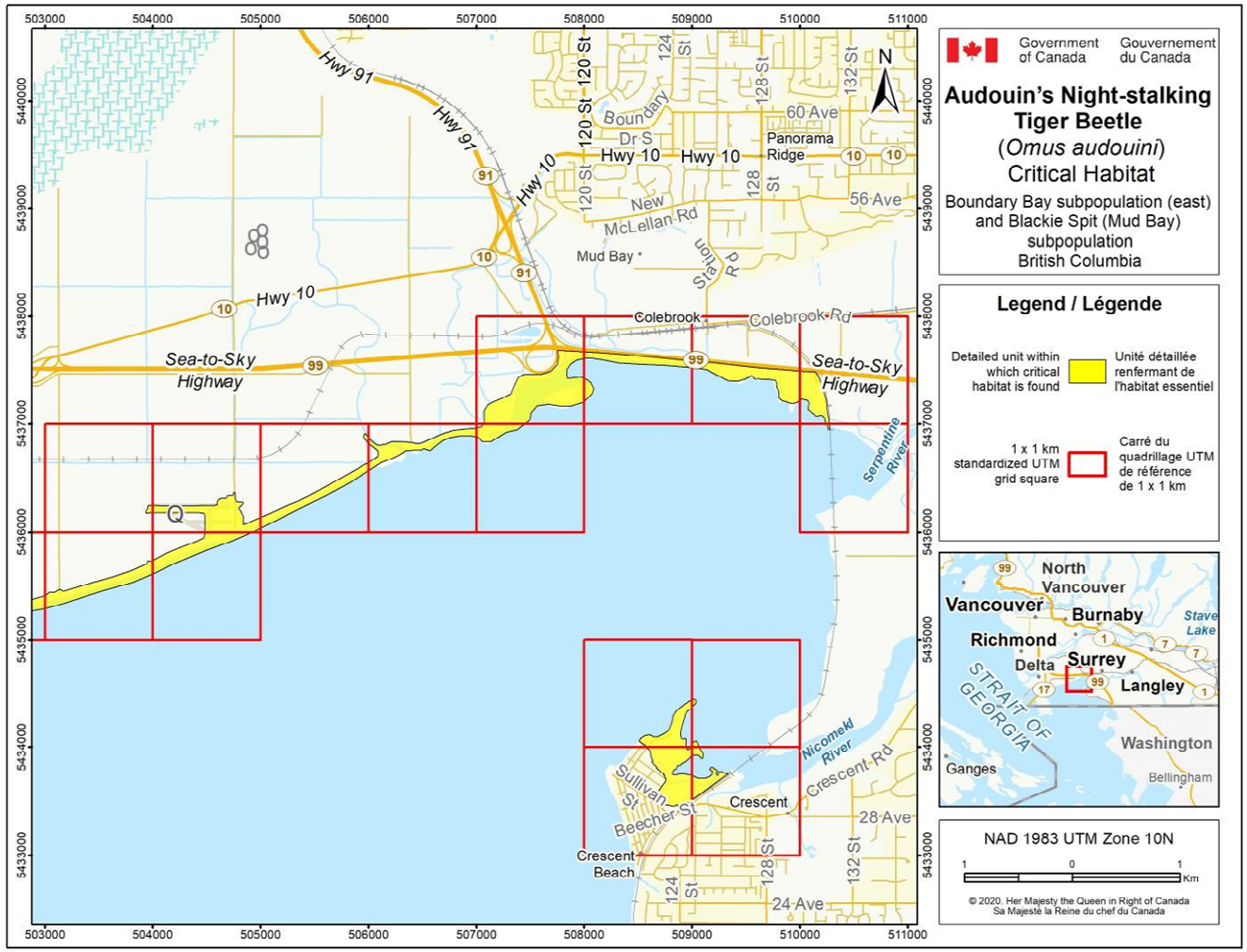

Figure 6. Critical habitat for Audouin's Night-stalking Tiger Beetle (*Omus audouini*) at Boundary Bay, Delta, B.C. (eastern portion of subpopulation #2) and Blackie Spit, Surrey, B.C. (subpopulation #3), is represented by the shaded yellow polygons, except where unsuitable areas (as described in section 7.1.1) occur. The 1 km x 1 km standardized UTM grid overlay (red outline) shown on this figure is part of a standardized national grid systems used to indicate the general geographical area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

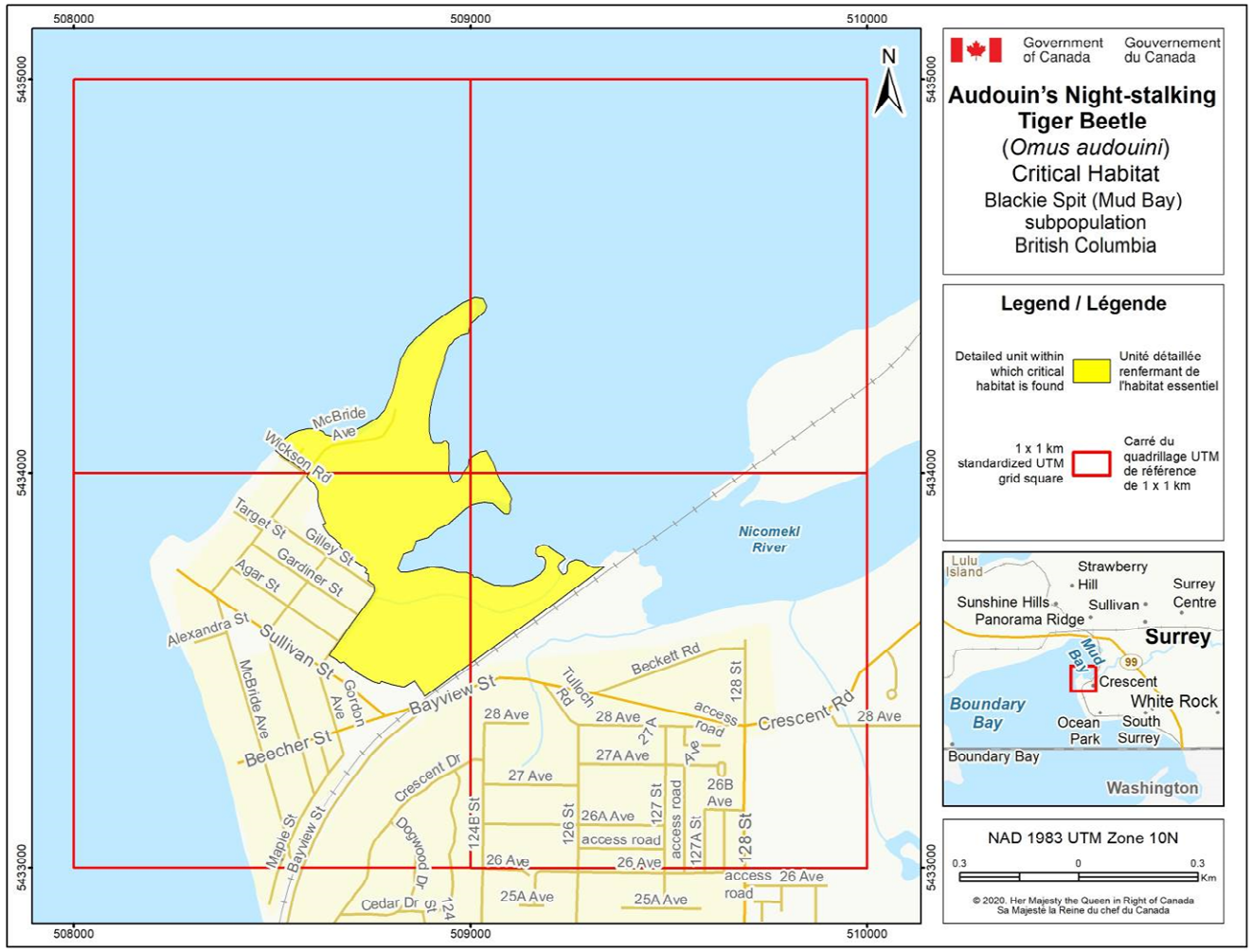

Figure 7. Critical habitat for Audouin's Night-stalking Tiger Beetle (*Omus audouini*) at Blackie Spit, Surrey, B.C. (subpopulation #3), is represented by the shaded yellow polygons, except where unsuitable areas (as described in section 7.1.1) occur. The 1 km x 1 km standardized UTM grid overlay (red outline) shown on this figure is part of a standardized national grid systems used to indicate the general geographical area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

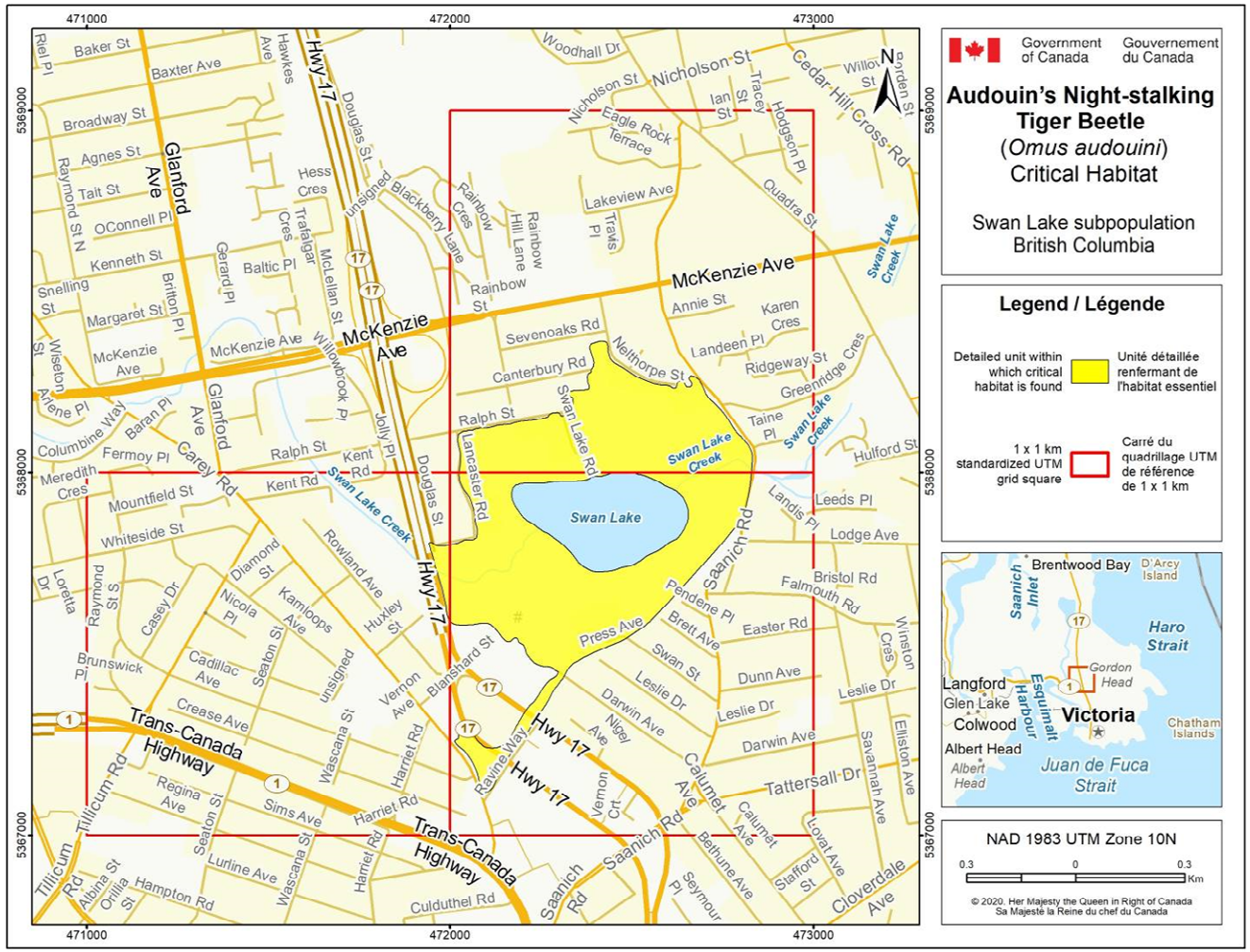

Figure 8. Critical habitat for Audouin's Night-stalking Tiger Beetle (*Omus audouini*) at Swan Lake, Victoria, B.C. (subpopulation #5), is represented by the shaded yellow polygons, except where unsuitable areas (as described in section 7.1.1) occur. The 1 km x 1 km standardized UTM grid overlay (red outline) shown on this figure is part of a standardized national grid systems used to indicate the general geographical area within which critical habitat is found. Areas outside of the shaded yellow polygons do not contain critical habitat.

7.2 Schedule of Studies to Identify Critical Habitat

The following schedule of studies (Table 6) outlines the activities required to complete the identification of critical habitat for Audouin's Night-stalking Tiger Beetle. Although it is hoped that additional surveys will result in the discovery of additional subpopulations (Table 5), studies to identify critical habitat at such locations are not included here due to the uncertainty that additional extent subpopulations will be found.

Table 6. Schedule of studies to identify additional critical habitat for Audouin's Night-stalking Tiger Beetle (*Omus audouini*) .

Description of Activity	Rationale	Timeline
Obtain information on local habitat requirements for subpopulation #6 and map critical habitat as appropriate.	This activity is required to ensure that sufficient critical habitat is identified to meet the population and distribution objective.	2022-2032
Verify the current status of two 'historical' subpopulations (# 4 and 7), and, if determined to be extant, obtain information about local habitat requirements and map critical habitat as appropriate.	This activity is required to ensure that sufficient critical habitat is identified to meet the population and distribution objectives.	2022-2032

7.3 Activities Likely to Result in the Destruction of Critical Habitat

Understanding what constitutes destruction of critical habitat is necessary for the protection and management of critical habitat. Destruction is determined on a case by case basis. Destruction would result if part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single or multiple activities at one point in time or from the cumulative effects of one or more activities over time. Activities described in Table 7 include those likely to cause destruction of critical habitat for the species; however, destructive activities are not limited to those listed.

Table 7. Activities likely to result in destruction of critical habitat for Audouin's Night-stalking Tiger Beetle (*Omus audouini*).

Description of Activity	Description of Effect	Details of Effect
Activities resulting in complete conversion or permanent removal of suitable habitat features, e.g., for urban, industrial, recreational, or agricultural development activities; upgrading of dyke infrastructure; deliberate flooding	The removal, replacement, compaction or burying of suitable habitat features (i.e., vegetation and/or substrate biophysical attributes) can result in destruction of critical habitat through causing direct and permanent loss of the biophysical features and attributes required by Audouin's Night-stalking Tiger Beetle to support all life functions.	Related to IUCN-CMP Threats # 1.1, 1.2, 1.3, 2.1, and 7.2 May occur within or outside the bounds of critical habitat to cause destruction of critical habitat. For example, adjacent development may alter hydrological patterns and cause erosion within critical habitat; damming or water diversion up or down-stream my result in flooding within critical habitat. Destruction of critical habitat by this activity can be caused at any time of the year. Destruction may be permanent.
Activities that (independently or cumulatively) result in significant disturbance or compaction of soil, e.g., recreational activities such as motorized vehicle use or intensive biking or hiking; heavy equipment use	Disturbance, compaction or degradation (e.g., erosion or changes to moisture regimes) of substrates with the features and attributes to enable burrowing can result in destruction of critical habitat through causing direct and permanent loss of the biophysical features and attributes required by Audouin's Night-stalking Tiger Beetle to support oviposition, incubation, larval development, and pupation.	Related IUCN-CMP Threats # 1.1, 1.2, 1.3, 2.1, and 6.1 Most likely to occur within the bounds of critical habitat to cause destruction of critical habitat. Destruction of critical habitat by this activity can be caused at any time of the year. Destruction may be permanent.
Activities resulting in partial or temporary removal of suitable surface vegetation, e.g., vegetation clearing for fire suppression, deliberate setting of fire, intensive/sustained livestock grazing, extensive herbicide use	Significant removal of suitable vegetation can result in destruction of critical habitat through causing direct and permanent loss of the biophysical features and attributes required by Audouin's Night-stalking Tiger Beetle to support hunting.	Related IUCN-CMP Threats # 2.3, 7.3 and 9.3 Most likely to occur within the bounds of critical habitat to cause destruction of critical habitat. More likely to result in destruction if activity is sustained over a prolonged period (e.g., year-round versus rotational grazing). Destruction may be temporary, if unmodified habitat remains within the area, and the activity is temporary, allowing modified vegetation to recover.

Description of Activity	Description of Effect	Details of Effect
Deliberate introduction of invasive species	Invasive species can outcompete sparse/open native vegetation, and disturb the soil structure required for burrowing, causing destruction of critical habitat by causing direct and permanent loss of the biophysical features and attributes required by Audouin's Night-stalking Tiger Beetle to support hunting, oviposition, incubation, larval development, and pupation.	Related IUCN-CMP Threat #7.3 May occur within or outside the bounds of critical habitat to cause destruction of critical habitat. It is not possible to determine the exact distance at which an introduction of an invasive species will cause destruction of critical habitat, but the probability of destruction will increase with proximity to the critical habitat and the invasiveness of the species introduced. Destruction of critical habitat by this activity can be caused at any time of the year Destruction may be permanent.
Heavy use of pesticides in areas accessible by prey populations	The use of pesticides can reduce the densities of key prey species (e.g., ants, centipedes and similar species) causing destruction of critical habitat by causing direct and permanent loss of the biophysical features and attributes required by Audouin's Night-stalking Tiger Beetle to support hunting.	Related IUCN-CMP Threat #9.3 May occur within or outside the bounds of critical habitat to cause destruction of critical habitat. It is not possible to determine the exact distance at which the heavy use of a pesticide will cause destruction of critical habitat, but the probability of destruction will increase with proximity to the critical habitat and the relative toxicity of the chemical used. Destruction of critical habitat by this activity can be caused at any time of the year Destruction may be permanent.

8. Measuring Progress

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives.

1. Human-caused threats that would cause further loss in the quantity or quality of the habitat needed for recovery have been ceased for all extant subpopulations.
2. Threat abatement or mitigation measures for non-habitat human-caused threats have been initiated for all extant subpopulations.
3. Habitat restoration, where deemed required and feasible, has been initiated.

9. Statement on Action Plans

One or more actions plans will be posted on the Species at Risk Public Registry for Audouin's Night-stalking Tiger Beetle within 10 years of the posting of this strategy.

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Appendix A: Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[16]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[17] (FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

Conservation actions at these sites must take these species into consideration when any physical actions occur so as to prevent any disturbance. Overall, conservation actions to protect Audouin's Night-stalking Tiger Beetle are expected to also benefit other co-occurring species. The general habitat types with which Audouin's Night-stalking Tiger Beetle is associated - sparsely vegetated sand ecosystems and Garry Oak and associated ecosystems – are more wide ranging than the Audouin's Night-stalking Tiger Beetle observations. More widely both these habitat types are host to many species at risk. At least 70 species at risk have been recorded from Garry Oak and associated ecosystems and 12 species at risk have been recorded in sparsely vegetated sand ecosystems (B.C. Ministry of Environment and Climate Change Strategy 2017). Efforts to conserve and restore these habitat types will benefit a wide range of species. Audouin's Night-stalking Tiger Beetle occurs within coastal sand ecosystems and Garry Oak and associated ecosystems. Both of these ecosystems together have hundreds of federal and provincial species at risk. Some of the co-occurring species include Green Heron (*Butorides virescens*), Golden Paintbrush (*Castilleja levisecta*), Kincaid's Lupine (*Lupinus oreganus* var. *kincaidii*) and Dense-flowered Lupine (*Lupinus microcarpus* var. *microcarpus*).

[16] www.canada.ca/en/environmental-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html
[17] www.fsds-sfdd.ca/en#/en/goals/

Appendix B: Photographs of Similar Species

Figure B1. Greater Night-stalking Tiger Beetle (*Omus dejeani* Reiche 1838) taken June 1, 2009 on Denman Island, B.C. Photo J. Heron.

Figure B2. Greater Night-stalking Tiger Beetle (*Omus dejeani* Reiche 1838) taken June 1, 2009 on Denman Island, B.C. Photo J. Heron.