Habitat associations of adult Oregon branded skipper, *Hesperia colorado oregonia* (W. H. Edwards, 1883) (Lepidoptera: Hesperiidae), at Cordova Shore, Vancouver Island, British Columbia

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ABSTRACT

Oregon branded skipper, *Hesperia colorado oregonia* (W. H. Edwards, 1883), is a nationally (Canada) endangered butterfly extant at six remaining sites on Vancouver Island, British Columbia, Canada. I studied the habitat associations of this subspecies within a coastal sand ecosystem at Cordova Shore, on southeast Vancouver Island. Little is known about habitat requirements for this butterfly; however, because of its endangered status, information on its habitat is required to help direct conservation action. During the summers of 2013 and 2014, most of the butterflies observed (91%) were found within the dune wildrye–beach pea (*Leymus mollis–Lathyrus japonicus*) terrestrial ecosystem, with 9% observed in the black knotweed–yellow sand verbena (*Polygonum paronychia–Abronia latifolia*) terrestrial ecosystem. To determine the habitat characteristics preferentially selected by the adult butterflies, I compared occupied and simultaneously unoccupied sites. I used conditional logistic regression for matched pairs to investigate relationships between butterfly presence and six habitat variables in 21 occupied and 21 random plots, and used Akaike information criterion (AIC) to identify the best among a set of 20 candidate models. The best-supported model included black knotweed (*Polygonum paronychia*) and Oregon gumweed (*Grindelia oregonia*) as the sole variables predicting the occurrence of Oregon banded skipper. The model predicted that the likelihood that Oregon branded skipper would be present increases with increased cover of Oregon gumweed (OR = 1.5, 95% CI: 0.9–2.6) and black knotweed (OR = 1.6, 95% CI: 0.1–23.6). The two plants are likely important for the skipper as adult nectar sources; however, small sample sizes and model confidence intervals suggest caution should be used when applying the model. In light of these findings, I provide guidance for future conservation of Oregon branded skipper to land managers within Cordova Shore.

Key Words: Lepidoptera, Hesperia, *Hesperia colorado oregonia*, habitat, endangered, British Columbia

INTRODUCTION

About one-third of butterfly species in Canada are at some level of risk from threats such as habitat loss and degradation, pesticides, invasive species, and habitat changes resulting from climate change (Hall 2009). To effectively direct conservation actions towards at-risk butterflies, an understanding of their basic biological needs is required. For many butterflies, basic biology (including resource needs) is not well known (Schultz and Crone 2008). Butterflies have four life stages (egg, caterpillar, pupa, adult), and the resources required to complete each life stage can differ. I examined two aspects of the biology of the adults of a rare butterfly, Oregon branded skipper, *Hesperia colorado oregonia* (W. H. Edwards): ecosystem selection and habitat components used within the ecosystem.

In 2013, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated Oregon branded skipper as endangered based on historic loss of habitat and other threats (COSEWIC 2013). Habitat of the skipper includes Garry oak (*Quercus garryana* Douglas ex Hook) associated ecosystems and sparsely vegetated coastal sand ecosystems (COSEWIC 2013). These ecosystems currently contain many rare and at-risk plant species and communities (BCCDC 2014). Presently, the greatest threats to this subspecies include vegetation succession of

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open habitats and the potential spraying of *Bacillus thuringiensis var kurstaki* (Btk) pesticide to control *Lymantria dispar* Linnaeus, the invasive gypsy moth (COSEWIC 2013). The subspecies is considered at risk globally (G5T3T4; NatureServe 2008) and is on the British Columbia red list (S1; BCCDC 2014).

Oregon branded skipper occurs from California north through west–central Oregon, into the Puget Trough of the state of Washington and onto the southern tip of Vancouver Island in southeastern British Columbia, Canada. The subspecies is known from 20 sites on Vancouver Island, from Greater Victoria north to Cameron Lake. As of 2014, populations remain extant at only six of these sites (Figure 1; Table 1).

The natural history and habitat associations of Oregon branded skipper are not well studied. Related skippers are known to inhabit areas with exposed bare ground and dry, well-drained soil patches (e.g., *Hesperia comma*, Thomas *et al*. 1986; *Hesperia assiniboia*, COSEWIC 2013, and; *Polites mardon*, Pyle 2002). Branded skipper (Hesperiinae) larval foodplants are typically monocotyledons, grasses and sedges (Layberry *et al*. 1998), but foodplants specific to the Oregon branded skipper subspecies are not known. In one case on Vancouver Island, reared larvae consumed hand-fed grasses from the genera *Lolium* and *Bromus* (Hardy 1954). Oviposition substrate is not necessarily good evidence of larval foodplants, because Hesperia will oviposit on other substrates near the host, including fence posts and tree trunks (MacNeill 1964; Pyle 2002). The flight period of Oregon branded skipper is early July to mid-September (Layberry *et al*. 1998; Guppy and Shepard 2001). The species has one generation per year. Oviposition occurs in the summer; eggs overwinter from September to spring and hatch between March and April. Larvae emerge and feed from spring to summer, developing through six instar stages before the pupal (chrysalis) stage, which occurs from early July to late August (Hardy 1954; James and Nunnallee 2011).

To better understand habitat associations of the adult stage of Oregon branded skipper, I investigated relationships between (1) butterfly presence and ecosystem type, and (2) butterfly presence and vegetation and substrate cover. The study area was at "Cordova Shore", the only coastal sand ecosystem in British Columbia from which Oregon branded skipper is known. Cordova Shore is a 437-ha area on southeast Vancouver Island, and contains remnants of rare and

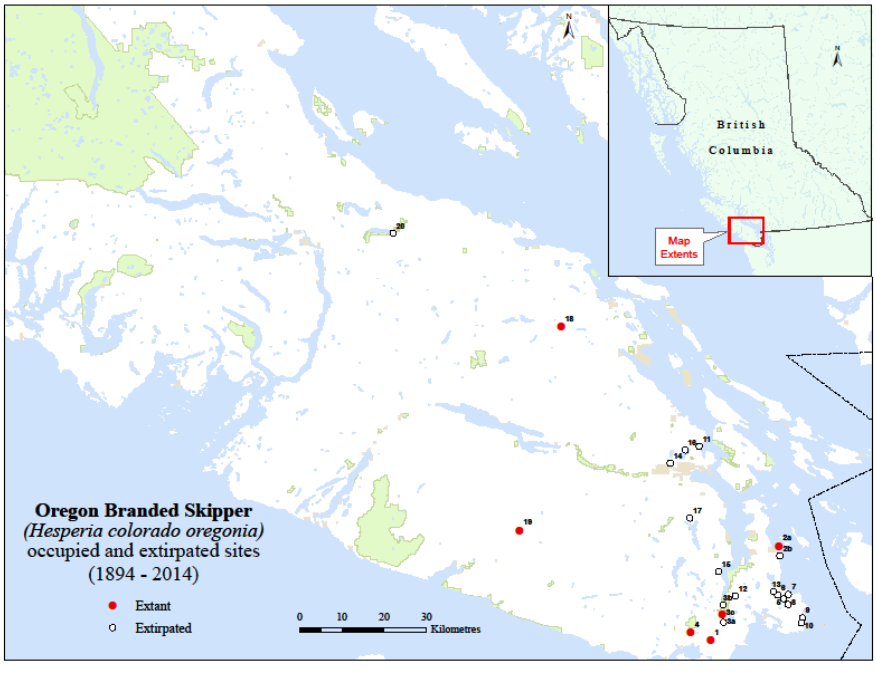

Figure 1. Oregon branded skipper-occupied and -extirpated sites (1894–2014).

Table 1

Historical and current (2014) locations of Oregon branded skipper. (RBCM collection = Royal British Columbia Museum; CDC (2014) = record housed within the BC Conservation Data Centre (http://www.env.gov.bc.ca/atrisk/toolintro.html); * = the UTM coordinate of the historical record has been estimated for mapping purposes.) The data from this table has been archived: (http://dx.doi.org/10.6084/m9.figshare.1569875)

Site	UTM Zone	Easting	Northing	Site Name	Year Last Observed	Current Viability	Source of Record
1	10	455737	5360927	Camas Hill, Metchosin	2011	Extant (COSEWIC 2013)	COSEWIC 2013
2a	10	472597	5382583	Cordova Spit; Saanich	2014	Extant (COSEWIC 2013)	CDC (2014)
2b	10	472927	5380216	Island View Beach Regional Park; Saanich*	1963	Extirpated (COSEWIC 2013)	RBCM collection
3a	10	459000	5365000	Goldstream; Mount Wells Regional Park*	1953	Extirpated (COSEWIC 2013)	RBCM collection
3b	10	459095	5369096	Goldstream Provincial Park*	1952	Extirpated (COSEWIC 2013)	RBCM collection
3c	10	458694	5367074	Goldstream; Humpback Road area	2009	Extant (COSEWIC 2013)	COSEWIC 2013
4	10	451123	5362965	Mt. Manuel Quimper Capital Regional District Park	2014	Extant (COSEWIC 2013)	CDC (2014)
5	10	473400	5370000	Blenkinsop Lake*	1951	Extirpated (COSEWIC 2013)	RBCM collection
6	10	472000	5371000	Rithets Bog; Saanich Park*	1956	Extirpated (COSEWIC 2013)	RBCM collection
7	10	474570	5371016	Mount Douglas Saanich Park*	1953	Extirpated (COSEWIC 2013)	COSEWIC 2013
8	10	474400	5368600	Braefoot; Saanich*	1953	Extirpated (COSEWIC 2013)	RBCM collection
9	10	477600	5365300	Oak Bay (Uplands Park)*	1953	Extirpated (COSEWIC 2013)	RBCM collection
10	10	477324	5364029	Oak Bay (Victoria area)*	1953	Extirpated (COSEWIC 2013)	RBCM collection
11	10	455000	5407000	Maple Bay*	1935	Extirpated (COSEWIC 2013)	RBCM collection
12	10	462000	5371200	Langford, Millstream Road*	1955	Extirpated (COSEWIC 2013)	RBCM collection
13	10	471100	5371800	Royal Oak; Observatory Hill; Saanich*	1955	Extirpated (COSEWIC 2013)	RBCM collection
14	10	447992	5403280	Duncan*	1926	Extirpated (COSEWIC 2013)	RBCM collection
15	10	458332	5377088	Malahat*	1920	Extirpated (COSEWIC 2013)	RBCM collection
16	10	451675	5406270	Quamichan Lake*	1917	Extirpated (COSEWIC 2013)	COSEWIC 2013
17	10	452076	5390053	Shawnigan Lake*	1894	Extirpated (COSEWIC 2013)	RBCM collection
18	10	423541	5436827	Nanaimo River Road	2011	Extant	C. Guppy, personal collection
19	10	411728	5388924	Port Renfrew	2014	Extant	Photo by M. Yip and confirmed by C. Guppy
20	10	5460600	384800	Cameron Lake*	1952	Undetermined	RBCM collection

sensitive sand dune and estuarine ecosystems (Stacey and Filatow 2009). It has been—and continues to be—affected by changes to natural ecological processes and vegetation by hydrological forces, recreation, invasive species, disruption to coastal sediment transport processes, and development (Page 2010). Oregon branded skipper has been reported from Cordova Shore since the 1950s, from two locations labelled "Cordova Spit" (called TIXEN by Tsawout First Nation) and "Island View Beach" (Table 1). Inventory from 2001 to 2014 confirmed the skipper's continued existence at Cordova Spit, but the species has not been reported from Island View Beach since 1963. A better understanding of the habitat relationships of this species will aid in management and conservation for this endangered butterfly within Cordova Shore.

MATERIALS AND METHODS

The study site was a 36-ha area within Cordova Shore on the east side of the Saanich Peninsula on Haro Strait (Figure 2a). At the north end is a sandspit, which is bordered on the west by Saanichton Bay and on the east by Cordova Channel. South of the spit is a coastal inland area surrounded by residential housing and agricultural fields. The site consists of a variety of broad ecosystem types, including coastal sand dune, beach, wetland, estuary and forest, with many smaller ecosystems contained within them. It is under the jurisdiction of three landowners: Tsawout First Nation, the District Municipality of Central Saanich, and the Capital Regional District (Island View Beach Regional Park; Figure 2b).

Butterflies are most active when they have warmed from the sun (Guppy and Shepard 2001); thus, I surveyed between approximately 10:00 and 16:00 hours under conditions ranging from full sun to overcast days with air temperatures above 19°C. To locate Oregon branded skipper, one or two surveyors searched for butterflies by walking along a systematic, continuous transect that consisted of a series of parallel east–west oriented survey lines 25 m apart. The survey transect extended from the north tip of TIXEN/Cordova Spit to the south end of the Island View Beach parking lot. The transect was surveyed in alternate directions; from north to south on one survey, and from south to north on the subsequent survey. Because one full transect took more than one day to complete, I used a GPS coordinate to mark my finish location at the end of each day and resumed the route on the next field day.

When an Oregon branded skipper was observed, I captured it with a net to confirm identification, and then released it. The very similar woodland skipper, *Ochlodes sylvanoides* (Boisduval, 1852), was often abundant and made identification of Oregon branded skipper difficult until specimen capture. I recorded the plant or substrate it was using or landed on (if initially observed in flight) and established a 5m2 plot centred at each observation point. I recorded and measured the percent cover of the abiotic and biotic variables within each plot (Table 2). For each plot in which a butterfly was recorded, I established a second, paired plot, located in a random compass direction and distance (up to 30 m from the butterfly detection point). This plot was sampled using the same methods. I overlaid the geo-coordinates of all butterfly locations on existing terrestrial ecosystem maps (Stacey and Filatow 2009) to determine which ecosystem units they occurred in.

I evaluated habitat factors that affected the probability of a site being used by an Oregon branded skipper using a variety of inferential techniques. I used an information-theoretic approach to identify the model from a candidate set that best predicted the occurrence of butterflies at a site, based upon a variety of habitat factors. To select variables for model building, I calculated correlation coefficients among all measured habitat variables and screened out variables that were too highly correlated to retain in the same model (coefficients of <0.4 or >0.4; Ballinger 2004). I also excluded variables that did not show a significant difference in percent cover between occupied and random plots (i.e., $P \geq 0.05$). I retained variables that were previously thought to be important for *Hesperia* spp. (monocotyledons, grasses and bare ground) and those I observed being used by the butterfly during field observation. The final variables selected for the analysis were 1) Oregon gumweed (*Grindelia stricta*), 2) black knotweed (*Polygonum paronychia*), 3) yarrow (*Achillea millefolium*), 4) red fescue (*Festuca rubra*), 5) moss spp., and 6) sand.

Table 2
Percent cover (standard deviation) and origin for all variables measured in occupied and random plots. Variables with * were retained for statistical analysis.

Plant Species/ Substrate	Origin	Occupied	Random	Plant Species/ Substrate	Origin	Occupied	Random
Abronia latifolia	native	1(4)	<1 (0.2)	Leymus mollis ssp. mollis	native	20(17)	20(28)
Achillea millefolium var pacifica	native	2(2)	2(4)	Lomatium nudicaule	native	<1(1)	<1(0.1)
Aira caryophyllea	non-native	<1(0.7)	0	Malus fusca	native	1(3)	1(5)
Aira praecox	non-native	2(6)	<1(1.5)	moss spp. *	undetermined	26(17)	35(20)
Ambrosia chamissonis *	native	5(10)	3(8)	Plantago maritima ssp. juncoides	native	0	<1(0.2)
Ammophila arenaria	non-native	0	<1(0.2)	Poa pratensis	non-native		<1(0.2)
Anthoxanthum odoratum	non-native	<1(0.9)	<1(0.1)	Polygonum paronychia *	native	8(13)	2(5)
Armeria meritima var maritima	non-native	3(9)	<1(1)	Puccinellia nutkaensis	native	0	3(9)
Atriplex gmelinii	native	<1(0.2)	<1(0.5)	Rosa rugosa	non-native	<1(2)	<(0.2)
Cakile edentula	non-native	0	<1(0.7)	Rubus armeniacus	non-native	2(10)	2(7)
Calystegia soldanella	native	<1(2)	<1(0.1)	Rumex acetosella	non-native	1(7)	<1(1.1)
Carex macrocephala	native	3(9)	8(19)	Sarcocornia pacifica	native	<1(1.5)	4(13)
Cytisus scoparius	non-native	1(2)	2(3)	Vicia nigricans ssp. gigantea	native	0	<1(0.1)
Dactylis glomerata	non-native	<1(0.1)	0	Vulpia microstachys var. pauciflora	native	0	<1(0.7)
Distichlis spicata var spicata	native	4(10)	1(5)	sand *		17(14)	25(34)
Festuca rubra ssp. rubra *	non-native	19(21)	12(20)	pebbles		<1(0.2)	<1(0.5)
Grindelia stricta *	native	9(8)	2(4)	cobble		<1(0.1)	<1(2.2)
Holcus lanatus	non-native	1(1)	2(6)	coarse woody debris		2(4)	8(10)
Honckenya peploides ssp. major	native	0	<1(0.1)	garbage		4(13)	0(0)
Hypochaeris glabra	non-native	0	<1(0.1)	short turf grass		3(6)	<1(1.5)
Hypochaeris radicata	non-native	<1(0.9)	<1(0.1)	long grass		41(26)	36(35)
Lathyrus japonicus var maritimus	native	0	<1(0.2)	shrubs		12(2)	59(8)
Lepidium densiflorum	native	<1(0.3)	<1(0.1)				

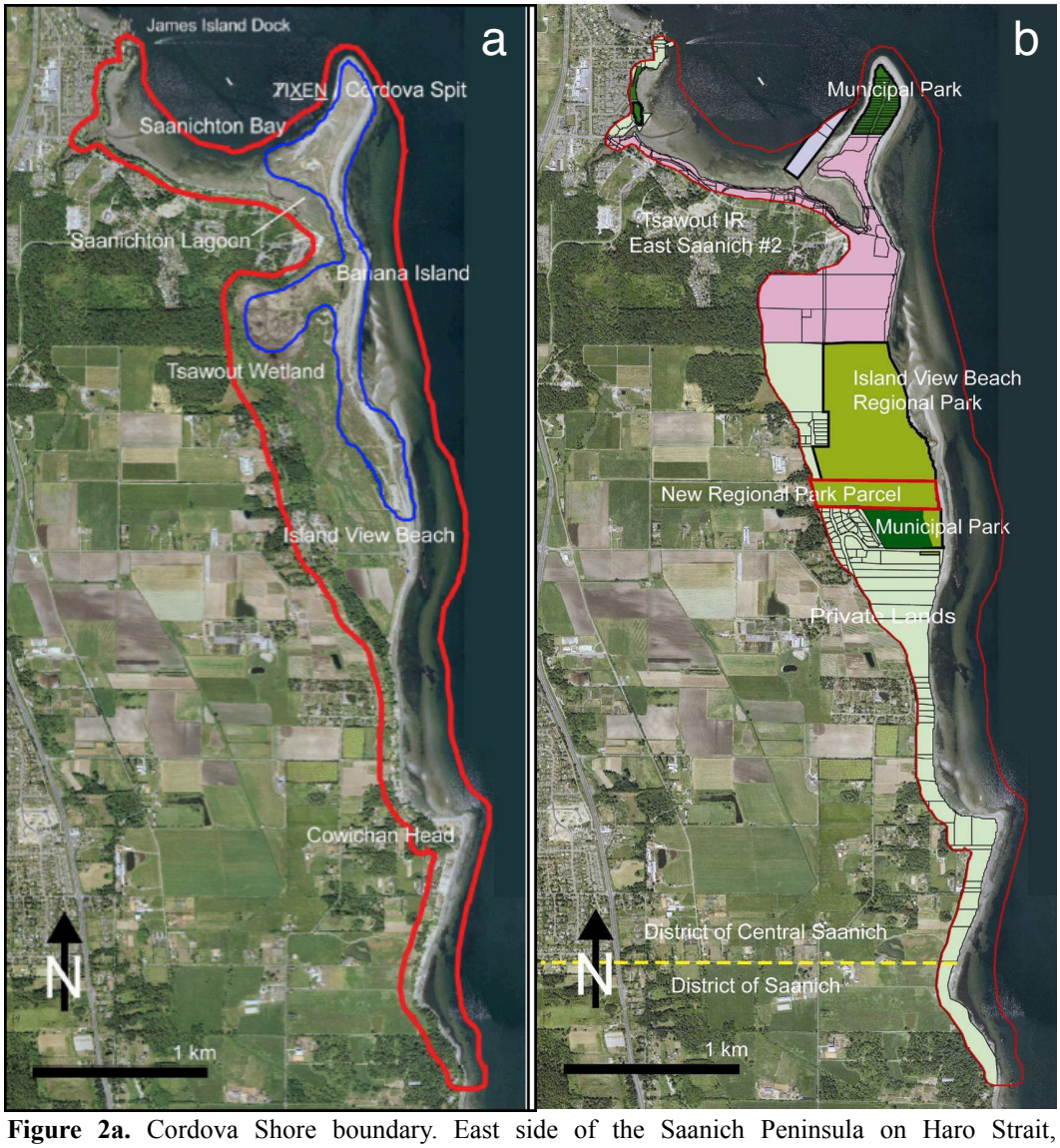

Figure 2a. Cordova Shore boundary. East side of the Saanich Peninsula on Haro Strait, Vancouver Island, British Columbia (exterior outline). The interior outline is the study area. Maps from Cordova Shore Conservation Strategy (with permission).

Figure 2b. Land ownership and property boundaries within Cordova Shore: Tsawout First Nation, CRD Regional Parks (Island View Regional Park), Central Saanich municipal parks, and private property.

I used conditional logistic regression for matched pairs to investigate the relationships between the six selected variables in both occupied and random plots. I utilized combinations of up to two variables (one variable for each of the 10 observations) as per Peduzzi *et al*. (1996), resulting in 20 hypothetical models that I tested with information-theoretic methods using Akaike information criterion (AIC; Table 3). This method does not assume that the true model is in the set; however, it provides the best fit candidate model, based on thoughtful selection of variables (Burnham and Anderson 1998). I conducted all statistical analyses in R (R Core Team 2014).

Table 3

Candidate models evaluated for predicting Oregon branded skipper presence at Cordova Shore. Model scores are ranked based on relative Akaike's Information Criterion values (Delta_AIC). The number of parameters (K), log likelihood value (LL), AIC-corrected for small-sample bias (AICc); likelihood function of the model (ModelLik); AIC weights (AICcWt), and; cumulative weights (Cum.Wt) are reported for each model.

Model	K	AICc	Delta_AICc	ModelLik	AICcWt	LL	Cum.Wt
Polygonum paronychia + *Grindelia oregonia*	2	8.943	0.000	1.000	0.928	–2.284	0.928
Polygonum paronychia + *Ambrosia chamissonis*	2	16.261	7.318	0.026	0.024	–5.943	0.952
Festuca rubra + *Grindelia oregonia*	2	18.020	9.077	0.011	0.010	–6.823	0.961
moss_cover + *Grindelia oregonia*	2	18.175	9.231	0.010	0.009	–6.906	0.971
Polygonum paronychia	1	18.559	9.616	0.008	0.008	–8.219	0.978
Festuca rubra + *Polygonum paronychia*	2	20.159	11.216	0.004	0.003	–7.892	0.982
Festuca rubra + *Ambrosia chamissonis*	2	20.185	11.242	0.004	0.003	–7.905	0.985
sand + *Polygonum paronychia*	2	20.378	11.435	0.003	0.003	–8.001	0.988
Grindelia oregonia	1	20.558	11.615	0.003	0.003	–9.220	0.991
moss_cover + *Polygonum paronychia*	2	20.610	11.667	0.003	0.003	–8.118	0.994
sand + *Grindelia oregonia*	2	20.910	11.967	0.003	0.002	–8.273	0.996
Festuca rubra	1	22.017	13.074	0.001	0.001	–9.948	0.997
Grindelia oregonia + *Ambrosia chamissonis*	2	22.757	13.814	0.001	0.001	–9.197	0.998
Festuca rubra + *moss_cover*	2	23.582	14.639	0.001	0.001	–9.603	0.999
sand + *Festuca rubra*	2	24.162	15.218	0.000	0.000	–9.893	0.999
moss_cover	1	25.671	16.728	0.000	0.000	–11.777	0.999
sand	1	25.833	16.889	0.000	0.000	–11.858	1.000
Ambrosia chamissonis	1	26.335	17.391	0.000	0.000	–12.108	1.000
moss_cover + *Ambrosia chamissonis*	2	27.232	18.289	0.000	0.000	–11.434	1.000
sand + *Ambrosia chamissonis*	2	27.312	18.368	0.000	0.000	–11.474	1.000

RESULTS

I conducted surveys on 24 days between 16 July and 13 September 2013. In 2014, I revisited the Cordova Spit on three days to ensure that the population remained extant and to collect additional data (30 July and 4, 5 September 2014). I recorded 22 Oregon branded skipper in 21 separate plots (20 in 2013, and 2 in 2014). Based on terrestrial ecosystem map boundaries and field verification, most occurrences (91%) were within the dune wildrye–beach pea (*Leymus mollis–Lathyrus japonicus*) ecosystem unit (Stacey and Filatow 2009). Two skippers (9%) were

Table 4

Odds ratio coefficients (OR), standard errors (SE), and 95% confidence intervals for black knotweed and Oregon gumweed variables used in the final model.

Variable	OR	SE	C.I.
Black knotweed	1.6	1.38	0.1–23.6
Oregon gumweed	1.5	0.28	0.9–2.6

detected in the black knotweed–yellow sand verbena (*Polygonum paronychia–Abronia latifolia*) ecosystem to the north (Figure 3). I observed skippers primarily between 12:00 and 16:00. One individual was seen at 09:20. I observed them nectaring and resting primarily on Oregon gumweed, but they also rested on yarrow (*Aquillea millefolium*), moss spp, black knotweed, red fescue, seashore saltgrass (*Distichlis spicata*), and sand.

The probability of use by Oregon branded skipper was related to the cover of several habitat features. The best model from the candidate set was that which predicted probability of use from the cover of black knotweed and Oregon gumweed, which scored 8 AIC units better than the next best model (Table 3). The relationship was positive (both odds ratio coefficients were greater than 1); however, because both 95% confidence intervals included 1 and the standard error of the black knotweed odds ratio was high, the relationship was not conclusive. The best model estimated that the probability of use by Oregon Banded Skipper increased with increasing cover of both black knotweed (OR: 1.6, 95% CI: 0.1–23.6) and Oregon gumweed (OR: 1.5, 95% CI: 0.9–2.6; Table 4). An odds ratio of 1.6 for black knotweed suggested that a 1% increase in cover increased the odds of use by a butterfly by 60% (1.6 times higher than the odds of a butterfly not being present). For Oregon gumweed, an odds ratio of 1.5 suggested that a 1% increase in cover increased the probability of use by a butterfly by 50% (1.5 times higher than the odds of a butterfly not being present). Occupied plots also had a higher mean percent cover of black knotweed than in random

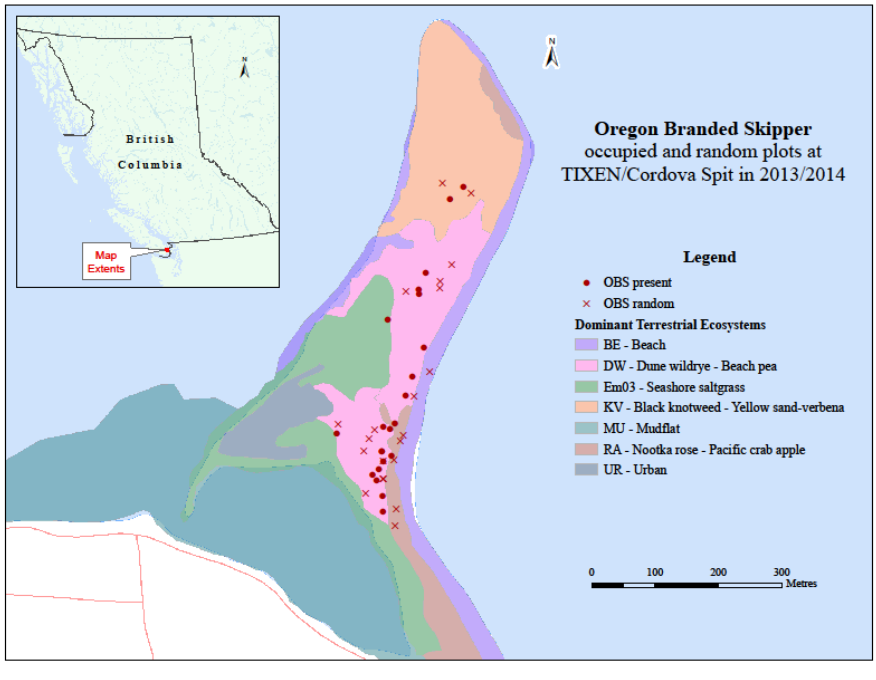

Figure 3. Oregon branded skipper-occupied and random plots at TIXEN/Cordova Spit in 2013/2014. Ecosystem spatial data from Stacey and Filatow (2009).

plots (paired t-test: 8%; t= 2.12; df = 20; p = 0.04). Occupied plots had a higher mean percent cover of Oregon gumweed than random plots (paired t-test: 9%; t= 3.32; df = 20; p = 0.003).

DISCUSSION

My results suggest that Oregon branded skipper is more likely to occupy ecosystems at TIXEN/Cordova Spit where black knotweed and Oregon gumweed occur together. Oregon gumweed is a common perennial herbaceous species found on beaches, rocky bluffs, and disturbed sites (BCCDC 2014; E-Flora 2014). This plant flowers throughout the summer and likely plays an important role in providing a nectar source for Oregon branded skipper and other butterflies within Cordova Shore. Black knotweed is a small, low-lying, flowering perennial shrub that is restricted to moist sand dunes and beaches on southern Vancouver Island and the Gulf Islands (BCCDC 2014; E-Flora 2014). Black knotweed also likely provides nectar for Oregon branded skipper.

Factors other than black knotweed and Oregon gumweed may affect the probability of use by the butterfly. I found only two individuals within the black knotweed–yellow sand verbena ecosystem that makes up a large part of the north end of TIXEN/Cordova Spit (Figure 3). Although this area contains both black knotweed and Oregon gumweed, it is exposed to the elements, with bare, shifting sand, erosion and deposition from wind and waves (Stacey and Filatow 2009). These conditions may be favorable for the plants; however, they may be too volatile for the butterfly. Most skippers were observed within the dune wildrye–beach pea ecosystem in the central part of the spit. Within this large ecosystem, a smaller unit of black-knotweed–yellow sand verbena contains Oregon gumweed and black knotweed. The butterflies appear to be concentrated there. To the east of this unit, paralleling the beach, there is a natural slope with dense tall grasses, blackberry, rose, and crabapple. This may have created a favorable

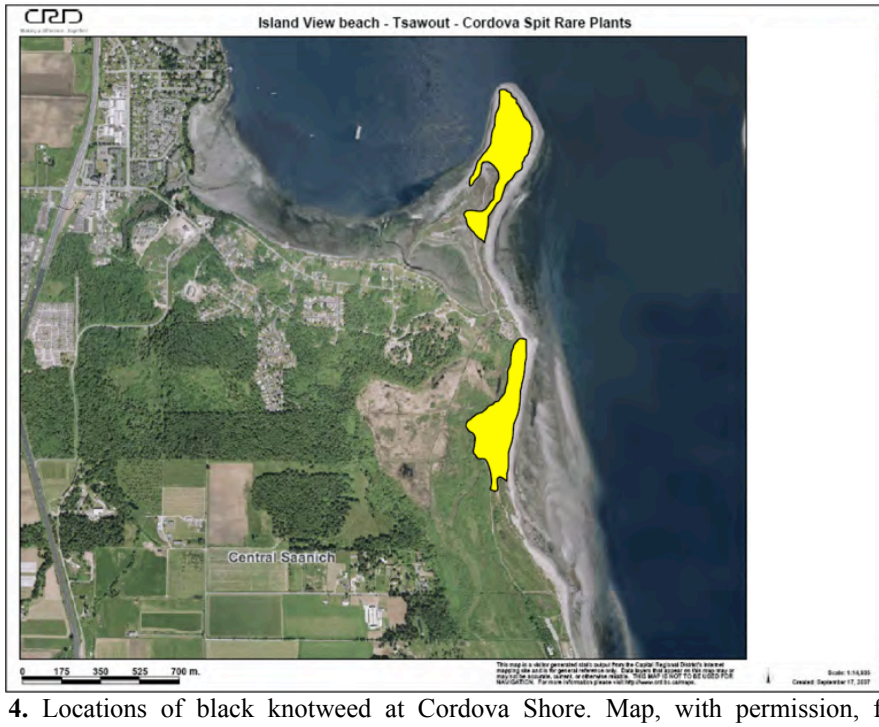

Figure 4. Locations of black knotweed at Cordova Shore. Map, with permission, from the Cordova Shore Conservation Strategy (Page 2010). Photo is south of the boundary between Tsawout First Nations and Capital Regional District lands.

patch of habitat for the butterflies, in that they can utilize the plants while remaining protected by the slope from wind and sand deposition coming off the ocean.

Bunchgrasses, such as red fescue (*Festuca rubra*), are suspected to be larval foodplants of Oregon branded skipper (COSEWIC 2013). Red fescue is a characteristic component of the dune wildrye–beach pea ecosystem (Stacey and Filatow 2009), in which the majority of skippers occurred. Based on the model analysis, red fescue did not appear to have a significant effect on the probability of the skipper being present (Table 3). This may be because adults tend to focus on nectar sources, and only females actively ovipositing would potentially use red fescue. No ovipositing females, eggs, or larvae were observed during this study.

Cordova Spit is one of best intact examples of the extremely rare coastal dune ecosystems on Vancouver Island (Page 2010). The Oregon branded skipper population at the spit has persisted since at least 1952. Hill *et al*. (1996) investigated *Hesperia comma* metapopulations in 69 patches over 9 years in Surrey, United Kingdom. They found that local populations in small (<1 ha), isolated patches were more likely to go extinct than if the patches were large and close (<1 km) to other patches. The patch at TIXEN/Cordova Spit is 6 ha. This is apparently large enough to sustain a population of Oregon branded skipper even without another nearby population. Oregon branded skipper is not migratory, and maximum dispersal distance is unknown. Rescue from other populations is unlikely as the closest extant population is the Goldstream site, 18 km southwest of TIXEN/Cordova Spit. No other known extant populations in British Columbia occur in coastal sand ecosystems. In the U.S.A., the closest population is 40 km east of Cordova Spit, at Orcas Island, Washington (A. Potter, pers. comm. 2013). Populations on San Juan Island (Washington, U.S.A.) are now extirpated (COSEWIC 2013).

MANAGEMENT RECOMMENDATIONS

Cordova Shore is the only known coastal sand ecosystem in British Columbia that supports Oregon branded skipper. Future monitoring on Cordova Spit should focus on the ecosystems in which the species was recorded in this study. To retain and recover this species, it is likely necessary to protect the remaining habitat and restore what has been degraded. Implementing the recommendations from the Cordova Shore Conservation Strategy to maintain sparsely vegetated sandy habitats by removing invasive plants, sustaining sand movement, and reducing intensive recreation (Page 2010) should aid efforts to conserve and recover this butterfly subspecies. Property managers should focus on restoration and protection of ecosystems that contain Oregon gumweed and black knotweed, as well as the likely larval foodplant(s) of red fescue and other native grasses. This can be done by preventing and reducing ecosystem damage, targeting areas for restoration, and managing pesticide application if a gypsy moth outbreak occurs in the area.

Signage can aid in preventing ecosystem damage. Two Tsawout First Nation signs at the parking lot entrance to Cordova Spit likely help protect the butterflies' habitat. One prohibits dogs, horses, camping, fires and dumping and the other brings awareness to sensitive habitat(s) in the area. There is a black knotweed–yellow sand verbena ecosystem containing both Oregon gumweed and black knotweed that straddles the Tsawout First Nation- and CRD-managed lands (Island View Beach; Figure 4). It is partially fenced on the Island View Beach property. There is a single sign at the upper west end of the fence that states that the area is closed for restoration. An additional sign on the fence facing the main path closest to the beach would be beneficial, because it sees the most foot traffic. A Tsawout First Nation sensitive-ecosystem sign at the property line would also improve awareness.

There is fencing near sensitive vegetation and gated barriers to restrict access by off-road vehicles to Cordova Spit, which has allowed natural vegetation to re-establish. On the Island View Beach land, the patch of black knotweed–yellow sand verbena ecosystem is not completely contained by fencing and is surrounded by metre-wide paths (Figure 4). Although the patch is small (~770 m2), it may be the only site at Island View Beach that could potentially provide suitable habitat. Across from this patch, a natural slope with tall vegetation borders the beach, similar to the habitat where the butterflies are currently found. Extending or moving the fence to

include the entire ecosystem, and reducing the number of paths surrounding it, would be helpful in diverting traffic away from this area.

Throughout Cordova Shore, non-native plant species such as European beachgrass (*Ammophila arenaria*), gorse (*Ulex europaeus*), Scotch broom (*Cytisus scoparius*), and Himalayan blackberry (*Rubus armeniacus*) have become established and need to be monitored and controlled to prevent encroachment into the butterflies' habitat.

One of the greatest potential threats to Oregon branded skipper is pesticide application (COSEWIC 2013). *Bacillus thuringiensis* var *kurstaki* (Btk) pesticide, used to control the invasive gypsy moth, has been shown to eliminate the larval stage of non-targeted lepidoptera on Vancouver Island (Guppy and Shepard 2001; Boulton 2004). If a gypsy moth (or other lepidopteran pest) outbreak occurs, it will be important to avoid spraying skipper habitat to avoid harming the larvae.

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