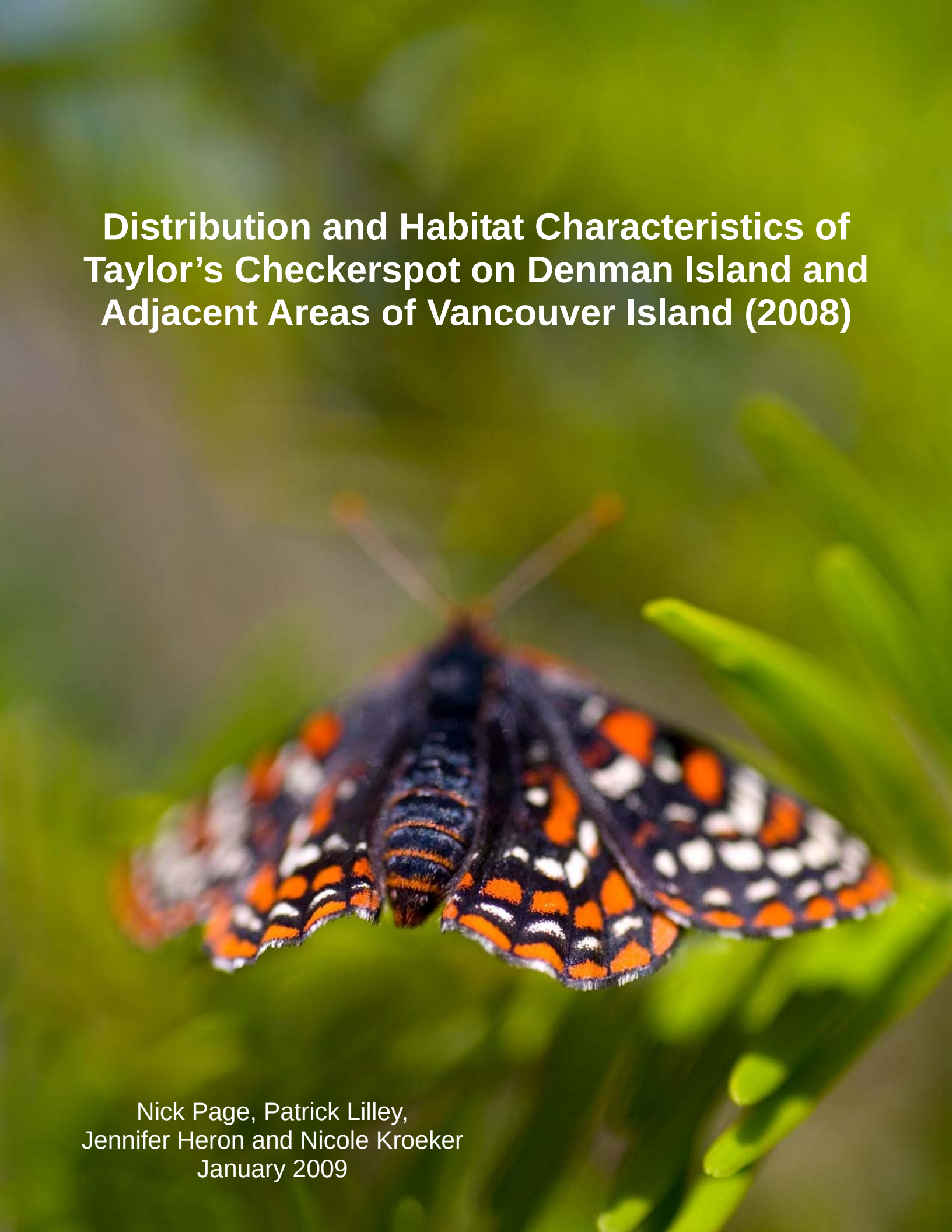
Distribution and Habitat Characteristics of Taylor's Checkerspot on Denman Island and Adjacent Areas of Vancouver Island (2008)



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January 2009

Distribution and Habitat Characteristics of Taylor's Checkerspot on Denman Island and Adjacent Areas of Vancouver Island (2008)

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SUMMARY

Surveys were undertaken in 2008 to assess the distribution and habitat characteristics of the endangered Taylor's Checkerspot butterfly (*Euphydryas editha taylori*) on Denman Island and adjacent areas of Vancouver Island. The project consisted of three primary components: (1) post-diapause larval surveys of previously-occupied habitats on Denman Island; (2) adult surveys in known and potential habitats on Denman Island and in the Courtenay-Comox region of eastern Vancouver Island; and (3) pre-diapause larval survey and habitat characterization of the main subpopulations on Denman Island. The following key findings resulted from each project component:

Post-Diapause Larval Survey

1) The occurrence of post-diapause larvae was patchy and associated with populations of host plants, particularly *Veronica serpyllifolia* and *Veronica scutellata.* Group size ranged from 1 to 153 larvae (mean = 13).
2) Post-diapause larvae were observed feeding on five host plant species: *Veronica scutellata, Veronica serpyllifolia, Plantago lanceolata, Plantago major, and Centaurium erythraea.* The use of *C. erythraea* is considered opportunistic rather than targeted.
3) The most common larval activity observed was resting or basking (69% of all observations) which indicates that thermal habitats are important for post-diapause larvae.
4) Host plant phenology influences post-diapause larval use, and not all host plant species are available at the beginning of the post-diapause period. *Veronica serpyllifolia* is more abundant in early spring than other host plant species.
5) Post-diapause larvae were observed in both disturbed (e.g., roadsides and recently-cleared areas) and undisturbed habitats, including a natural wetland.

Adult Survey

1) Denman Island continues to support a large, apparently stable population of Taylor's Checkerspot composed of interconnected subpopulations.
2) A single Taylor's Checkerspot adult was observed on a B.C. Hydro/Terasen Gas utility right-of-way approximately 5.0 km west of the nearest population on Denman Island; it is the only recent record from Vancouver Island.
3) Suitable habitat for Taylor's Checkerspot is minimal in the Courtenay-Comox area, and only three small sites with suitable habitat were identified during the survey.
4) Taylor's Checkerspot flight season was approximately one week longer in 2008 than in 2007.

Pre-diapause larval Survey and Habitat Characterization

1) *Veronica scutellata* is the most frequently used larval host plant by pre-diapause larvae, with minor use of *V. serpyllifolia*, *V. beccabunga*, and *P. major*.
2) Larval presence and abundance is related to host plant abundance; results suggest a minimum host plant abundance threshold of 1–2% total cover for occupied habitat.
3) Disturbed seasonally wet areas appear to be the highest quality habitats for pre-diapause larvae, with active logging roads, landings, ditches, and swales offering more marginal habitat.
4) Currently occupied larval habitats are threatened by habitat loss due to ongoing wetland and forest succession, as well as inappropriate levels of disturbance.

PART 1 - INTRODUCTION

1.1 Project Objectives

This report describes the methods and results of Taylor's Checkerspot surveys on Denman Island and adjacent areas of Vancouver Island (Courtenay-Comox) in 2008. The four objectives for the surveys were:

1) Search for new populations of Taylor's Checkerspot on Vancouver Island;
2) Re-assess the distribution of Taylor's Checkerspot on Denman Island;
3) Assess post- and pre-diapause larval activity and host plant use including habitat characteristics of sites occupied by pre-diapause larvae; and
4) Survey other butterfly species in the study area.

The report is divided into five parts which reflect the different assessment components:

Part 1 provides a brief introduction;
Part 2 describes an assessment of post-diapause larval activity and host plant use on Denman Island;
Part 3 describes a survey of adult butterflies on Denman Island and adjacent areas of Vancouver Island;
Part 4 describes the results of a detailed assessment of pre-diapause larval use and habitat characteristics; and
Part 5 provides recommendations.

Appendices including spatial datasets in Arcview GIS or summarized data in spreadsheets are attached as hardcopy or digital files.

1.2 Background

Taylor's Checkerspot (*Euphydryas editha taylori*) is a charismatic butterfly which has declined throughout its range of Oregon, Washington, and southwestern British Columbia; it is listed as Endangered in Canada (Shepard, 2000a). Specific historical habitat information is unclear, but the species is thought to have occurred within dry coastal meadows in the Georgia Basin and Puget Sound, as well as oak grasslands in the Willamette Valley. Most historic B.C. records are from southern Vancouver Island near Victoria, near Duncan, and there are records from at least two populations in the northern Georgia Basin (Courtenay; 1931 record; no site available and Hornby Island (Helliwell Provincial Park; records from 1977 and 1995)). The Helliwell Provincial Park population was extirpated in the late 1990s and, at the time, was believed to be the last Taylor's Checkerspot population in Canada.

In 2005, a small population of Taylor's Checkerspot was reported in the central portion of Denman Island in a regenerating logged area (managed by the Denman Conservancy Association (DCA)). The finding of a population in a previously forested area suggests that an unknown population of Taylor's Checkerspot likely occurred nearby and was a source population from which new

subpopulations established following the creation of open habitat by logging activity from 1999–2003. Anecdotal observations of post-diapause larvae and adults in 2006 and spring 2007 also suggest that other areas with similar habitat to the Settlement Lands in north and central Denman Island also supported Taylor's Checkerspot.

In spring 2007, Denman and Hornby Islands were surveyed extensively (288 km of transects; 168 hrs of field time) for Taylor's Checkerspot and other butterflies. Key findings of the survey were: (1) Taylor's Checkerspot was widespread and abundant on north and central Denman Island; (2) occurrences were associated with moist habitats with *Veronica* species; and (3) it was not found on Hornby Island during repeated surveys of suitable dry coastal meadows including Helliwell Provincial Park.

Similar to other checkerspot butterflies, Taylor's Checkerspot occurs in open habitats that support a host plant or group of host plants that are used for larval feeding. These plants include members of the Figwort family such as *Plantago, Mimulus, Castilleja, Collinsia,* and *Veronica* species, as well as some *Lonicera* species and sea blush (*Plectritis congesta*). All host plants contain a group of chemicals called iridoid glycosides which influence ovipositing site selection by adult butterflies, promote larval feeding and growth, and may reduce predation when ingested by checkerspot larvae (Kuussaari et al. 2004). Host plants are used by two different life stages by Taylor's Checkespot: by pre-diapause larvae during the first 4–8 weeks after hatching in late spring and early summer, and by post-diapause larvae in late winter and early spring prior to pupation. The historic host plant for Taylor's Checkerspot in B.C. is unknown; it has previously been speculated that *Castilleja* species were the primary host plants for some populations. Lance-leaved plantain (*Plantago lanceolata*), an introduced plant species, was likely a more recent primary larval host plant for Taylor's Checkerspot populations in B.C., Washington, and Oregon. However, the 2007 survey and work funded by Parks Canada Agency and completed by Guppy (2007) found that *Veronica* species were the primary host plants for pre-diapause checkerspot larvae on Denman Island. *Veronica* plant species are often found in wetlands and moist habitats.

Checkerspot butterflies have been a focus of conservation biologists for many decades and there is a broad range of published literature on population dynamics, taxonomy, host plant use, dispersal, and conservation. A very useful source of information is Ehrlich and Hanski's (2004) book: *On the Wings of Checkerspots.* More relevant sources of information on Taylor's Checkerspot within B.C. and Washington include Parks Canada (2006), Stinson (2005), Miskelly (2003), Grosboll (2003), Guppy (2003), and Shepard (2000b).

Part 2 – POST-DIAPAUSE LARVAL SURVEY

2.1 Introduction

Surveys to assess the distribution and activity of post-diapause checkerspot larvae were completed in March and April 2008 on north and central Denman Island. The post-diapause period in Taylor's Checkerspot occurs in late winter and early spring following diapause (a physiological state of dormancy used by invertebrates during winter or summer to avoid environmental stress) and prior to pupation. The primary larval activity during this period is feeding to maximize growth. This survey was descriptive and focused on observations of larval host plant use, particularly which host plants were used during this portion of Taylor's Checkerspot's life cycle. Previous studies have found that post-diapause checkerspot larvae use a broader range of host plant species than pre-diapause larvae (e.g., Ehrlich et al. 1980), likely due to their increased mobility compared with pre-diapause larvae (Singer 1971).

2.2 Methods

Field Methods. Visual searches to locate larvae in suitable habitat within two large, previously known subpopulations on north and central Denman Island were conducted on March 1, 20, 21, 22, and April 10 and 16, 2008. Taylor's Checkerspot larvae are strikingly coloured (black and red; see Figure 2.1) and easily located. Searches were also completed in habitats that lack known host plants such as dry meadows and shrub thickets.

When larvae were sighted, their location was temporarily marked with flagged bamboo stakes which assisted in re-locating them to record activity, and also to photograph them in relation to habitat conditions. Larvae often occurred in groups and the location of the group was recorded with GPS coordinates which were transferred to an Arcview file for mapping. Each group of larvae was referred to as a site. Photographs of habitat and individual larvae were taken.

Larval activity was observed and recorded. We divided activity into three categories: (1) feeding; (2) resting; and (3) moving, as well as several sub-categories such as resting on rock or soil, and which host plant they were feeding on. In most cases, activity was unambiguous.

Data Analysis. Data was summarized (total number of larvae per site; frequency of activity or host plant use) in Excel and the location of sites with post-diapause larvae were mapped in Arcview.

2.3 Results and Discussion

Summary of Observations. We observed 552 post-diapause larvae at 38 sites (see Figures 2.1 for examples; Maps 1 and 2 in Appendix 1 show site locations). Most larvae (99%) occurred in groups from two to 153 individuals (Figures 2.2–2.4); only six solitary larvae (>20 m from other larvae) were observed. The mean number of larvae per site was 13 (SD = 27). The largest group (153 larvae) occurred in a highly modified swale with patches of *Veronica serpyllifolia* scattered through a dry, pebble covered surface (Figure 2.4). The highest density of post-diapause larvae was approximately

Figure 2.1. Representative photos of post-diapause Taylor's Checkerspot larval activity: (a) basking on rock; (b) resting or basking on dead *Hypochaeris* rosette; (c) group of larvae resting on dead common rush stems; (d) resting on dead red alder leaf; (e) larva feeding on *V. serpyllifolia*; and (f) larva feeding on *Veronica scutellata.* All photos March 2008 by Nick Page.

25 larvae per m^2. All groups of post-diapause larvae observed during the survey were associated with host plant patches in seasonally wet areas or wetlands. While the abundance of host plant resources was not measured during the survey, the number of checkerspot larvae appeared to be proportional to the size of host plant patches.

Most of the occupied sites occurred in roads, skidder trails, and other disturbed areas where host plants have colonized moist, disturbed soils. However, larvae were also observed in natural wetlands including a common rush (*Juncus effusus*) dominated wetland (see Figures 2.1c and 2.4).

Larval Activity and Host Plant Use. The majority of larvae observed were resting (382; 69% of all larvae observed). Forty-five (8%) were observed moving, and 125 (23%) were observed feeding. Of the 382 resting larvae, 165 (43%) were on rock, soil, wood, or bark, 76 (20%) were on the leaves or stems of dead plants, and 141 (37%) were on live plants including known host plants, grass, sedges, or other species. It is unclear how the thermal value or other attributes of these different substrates affects resting activity.

Figure 2.2. Post-diapause larvae were abundant in this highly disturbed drainage swale with scattered patches of *Veronica serpyllifolia* scattered through a dry, pebble covered surface. The location of larvae is indicated with purple dots. Approximately 56 larvae were observed in this portion of the site. Photo taken March 22, 2008 by Nick Page.

Figure 2.3. Two groups of post-diapause larvae associated with patches of *Veronica serpyllifolia* in a seasonally wet and heavily rutted skid trail. The location of larvae is indicated with purple dots. Fourteen larvae were observed at the site. Photo taken March 22, 2008 by Nick Page.

Figure 2.4. Dense group of Taylor's Checkerspot larvae in undisturbed common rush dominated wetland. Some heavily browsed *Veronica scutellata* was present at the site. The location of larvae is indicated with yellow flags. Photo taken March 22, 2008 by Nick Page.

One hundred and twenty-five post-diapause larvae were observed feeding on five plant species during the survey (in order of frequency): *V. serpyllifolia* (73; 58%); *Veronica scutellata* (33; 26%), *Plantago lanceolata* (14; 11%); *Plantago major* (4; 3%); and *Centaurium erythraea* (1; 1%). Representative photos of host plant use are provided in Figures 2.5–2.9. *Centaurium erythraea* (European centaury) is a non-native member of the gentian family (*Gentianaceae*) and is an unlikely host plant for Taylor's Checkerspot because this family lacks iridoid glycosides. Only one observation was made on *C. erythraea* and its use is considered opportunistic use.

Figure 2.5. Active larva feeding on *Veronica serpyllifolia* on March 1, 2008. *V. serpyllifolia* maintains leaves through the winter except for flooded sites. Photo by Nick Page.

Figure 2.6. Larva feeding on the emerging stem leaves of *Veronica scutellata* on March 1, 2008. The photo of *V. serpyllifolia* above provides a good comparison of the early spring growth of these two species of *Veronica*, as both photos were taken the same day. Photo by Nick Page.

Figure 2.7. Browsing on central leaves of *Plantago lanceolata* on April 16, 2008. Taylor's Checkerspot typically feeds on leaves in the central rosette of *P. lanceolata* plants. Photo by Nick Page.

Figure 2.8. Single larva browsing on the margin of *Plantago major* leaf on April 16, 2008. Photo by Nick Page.

Figure 2.9. Larva (left-centre; yellow arrow) resting on a rosette of *Centaurium erythraea* on March 21, 2008. No browsing was observed at this site, but one larva in an adjacent group was observed feeding on *C. erythaea*. There is also minor browsing damage on the plant shown in the photo. Note, two other checkerspot larvae (red arrows) are present in the photo and a small amount of *V. serpyllifolia* (blue arrow). Photo by Nick Page.

Phenology likely influences host plant selection by post-diapause Taylor's Checkerspot larvae as it does in other *E. editha* subspecies (e.g., Dobkin et al. 1987, Williams and Bowers 1987). *V. serpyllifolia* maintains some leaves during the winter and new leaves begin to grow in February or March. *V. serpyllifolia* appears to provide the most abundant food resource for early post-diapause larvae on Denman Island. *V. scutellata* appears to have slower leaf growth in the spring and larval feeding was typically observed on emerging leaf tips. *V. scutellata* is more common in seasonally flooded areas and larvae may be exposed to high water levels at these sites. Both *Plantago* species lose their leaves and dieback during the winter and have leaves that emerge in a central rosette in March or April; they appear to be a limited food source for post-diapause checkerspot larvae until the middle of April (see Figure 2.10).

Figure 2.10. Adjacent *Plantago major* (left) and *Veronica serpyllifolia* (right) in a moist roadside site on March 1, 2008. Checkerspot larvae were observed feeding on the *V. serpyllifolia* plant during the survey. Photo on March 1, 2008 by Nick Page.

2.4 Key Findings

The key findings from the post-diapause larval survey are:

1. **Post-diapause larvae of Taylor's Checkerspot appear to occur in groups associated with host plant patches.** Larval occurrences are patchy and associated with host plants, particularly *V. serpyllifolia* and *V. scutellata.* Most larvae occurred in groups of 2 to 153 individuals (mean = 13). Larvae may group proportional to host plant resources although host plant abundance was not measured.

2. **Post-diapause larvae were observed feeding on five host plant species.** Post-diapause larvae were most common on *V. serpyllifolia* (58% of feeding larvae) but also used *V. scutellata* (26%), *P. lanceolata* (11%); *P. major* (3%), and *C. erythraea* (1%). Based on the lack of iridoids in gentian species, the use of *C. erythraea* is considered opportunistic, rather than targeted.

3. **The most common activity was resting or basking which indicates that thermal habitats are important for post-diapause larvae.** The majority of larvae were observed resting (69% of all larvae observed) on rocks, soil, leaves, bark, dead plants, and live plants (including host plants). It is unclear how the thermal value or other attributes of these different substrates influences resting activity.

4. **Host plant phenology influences post-diapause larval use.** Host plant growth and development is variable in early spring when post-diapause larvae emerge from diapause. *V. serpyllifolia* is more abundant than other potential host plants which likely influences its selection by checkerspot larvae. By the end of the post-diapause period, in the middle to late April, both *Plantago* species and *V. scutellata* appear to be more abundant. The variable use of host plants

during the post-diapause period suggests access to more than one host plant species is beneficial to the survival of populations, as this likely buffers environmental stochasticity (e.g., warmer, colder, drier, or moister conditions in early spring).

5. **Post-diapause larvae were observed in disturbed and undisturbed habitats.** Post-dispause larvae were predominantly observed in roads, skidder trails, and other disturbed sites where host plants have colonized moist, disturbed soils. Yet larvae were also observed in more natural wetlands. Their presence in a common rush (*Juncus effusus*) dominated natural wetland suggests that an isolated population of Taylor's Checkerspot could have occurred in natural wetlands on Denman Island prior to logging.

Part 3 – ADULT SURVEYS

3.1 Introduction

Adult surveys for Taylor's Checkerspot and other butterflies were conducted from May–June 2008 on Denman Island and in the Courtenay-Comox region of eastern Vancouver Island. Because adult habitat represents the largest spatial extent of habitats used among butterfly life stages, observations of adults are useful for determining the maximum distribution of butterfly populations, as well as for assessing general habitat associations. Additionally, adult observations can help to identify particular resource requirements at the adult life stage, such as adult nectar sources. In 2007, observations indicated adults were associated in open, moist to wet habitats, particularly recent clearcuts, and nectaring occurred on a wide range of plant species. Thermal habitats for basking or resting also appeared to be important for adult checkerspots and we observed the butterfly frequently on dry, warm gravel or silty roads, logs, rocks, or clumps of sedges, rushes, or grasses. Because adults are the most conspicuous life stage of the butterfly life cycle and Taylor's Checkerspot can be readily identified in flight, adult surveys are also useful for locating new populations (or subpopulations).

In 2008, adult surveys had two objectives:

1) Re-assess the distribution of Taylor's Checkerspot on Denman Island to determine if the population is expanding or contracting; and
2) Search for new populations or subpopulations of Taylor's Checkerspot, particularly on Vancouver Island.

3.2 Methods

Field Surveys. Foot and car based wandering transects[1] were used to survey for Taylor's Checkerspot and other butterfly species in known and potentially suitable habitats in the two survey areas: (1) Denman Island; and (2) the Courtenay-Comox region of eastern Vancouver Island, ranging from Fanny Bay in the south to Piercy Road in the north, and inland approximately 5 km west of Highway 19 (see Map 3 in Appendix 2 for study area). The study area was approximately 37 km long and 13 km wide. Survey dates corresponded with the previously observed flight period for the population on Denman Island (mid-May to mid-June, approximately one month later than historical records of Taylor's Checkerspot in B.C.) based on surveys conducted in 2007.

For the Denman Island surveys, we revisited previously known locations of Taylor's Checkerspot from 2007 to confirm their locations, general abundance, and further define subpopulation boundaries. It is important to note that this survey method cannot be used to quantify population

[1] Wandering transects follow no fixed route and meander through a range of habitats and often follow routes of convenience such as roads or open areas. They are an efficient method for identifying butterfly presence and the spatial distribution of butterfly populations when little information is available, but the data collected cannot be used to statistically infer population sizes or, if used over time, for population monitoring.

size or trends. To assess the overall distribution on Denman Island and whether populations on Denman were expanding, we revisited potentially suitable checkerspot habitat found unoccupied in 2007, and areas that had not been visited during the 2007 surveys (e.g., southern parts of island). Surveys focused on recent clearcuts, natural wetlands, and other open sites. All transects were conducted by a single observer on foot.

For the Courtenay-Comox surveys, we focused on surveying a range of potentially suitable habitats, such as recent clearcuts, utility rights-of-way, open meadow habitats, and agricultural lands. Initial surveys attempted to cover a wide array of potential habitats across the region. Both walking and driving transects were used to cover maximum territory. However, suitable habitats were limited, particularly in agricultural areas. Further efforts were exerted relative to the general quality of habitat, based on the presence of appropriate larval host plants and adult nectaring plants, openness, exposure, and disturbance level. The highest quality habitats were generally surveyed multiple times on foot.

For both survey areas, potentially suitable habitat was identified from 2005 colour orthophotos (provided by B.C. Ministry of Environment), Google Earth imagery, and the surveyor's local knowledge of the area.

For each wandering transect at each location, the following general information was collected: (1) general location and habitat description; (2) start and end points (GPS points); (3) date and start + end times; and (5) air temperature and weather (e.g., amount of sun, wind). Transect routes were recorded using the tracking function in the handheld GPS (Garmin GPSmap 60) and provided a relatively accurate record of the transect route. Most data was collected during warm, dry and sunny or bright overcast weather between 9 am and 5 pm[2].

Where butterflies were observed, the following data were collected: (1) point location using handheld GPS (typically 5–10 m accuracy); (2) butterfly species and number of individuals observed; and (3) general behavior (flying, perched, sunning, nectaring, mating, territorial behavior). Additional information was collected for species tracked by the B.C. Conservation Data Centre (general habitat type, vegetation, substrates, etc.). Identification of butterflies was generally undertaken visually without capture or collection. Some species (e.g., anglewings (*Polygonia* species) and some skippers) were difficult to identify in flight and were thus lumped in the data. Photographs were taken of representative butterflies to confirm identification. No specimens were collected during the survey.

There is some overlap between the wandering transects, often on different days, and it is likely that some butterflies were recorded more than once.

Adult surveys in 2008 were undertaken by Nick Page (62% of survey time) and Patrick Lilley (38%).

[2] We generally followed the guidelines of the UK Butterfly Monitoring Scheme, which recommends that surveys be undertaken during dry conditions where temperatures are 13°C or greater if there is at least 60% sunshine, or more than 17°C if overcast.

Public Involvement in Surveys. To further raise awareness about Taylor's Checkerspot and to encourage the general public to report potential sightings of the butterfly, we displayed full-colour 11x17 posters were posted at a variety of highly visible locations in the Courtenay-Comox area (e.g., gas stations, community notice boards, mail boxes, grocery stores, etc.) and distributed flyers to interested individuals as part of landowner contact efforts. Posters were also sent to conservancy groups and biologists on Hornby Island, Salt Spring Island, Galiano Island, Mayne Island, Thetis Island, Garry Oak Ecosystems Recovery Team, Capital Regional District Parks, Department of National Defense (Goose Spit facility, Canadian Forces Base Comox), Comox Regional District, B.C. Ministry of Environment, B.C. Parks, Parks Canada Agency, and other organizations throughout southern Vancouver Island. The poster and flyers provided information on the project, how to identify Taylor's Checkerspot (including photos), and contact information for reporting sightings to the B.C. Conservation Data Centre. Approximately 50 posters and 15 flyers were distributed over the course of the adult flight season.

Data Summary and GIS Mapping. Transect survey information and relative frequency of butterfly observations by species across the different regions was summarized and the general distributions of species were mapped as shapefiles in Arcview GIS 3.2.

3.3 Results and Discussion

Survey Intensity. A total of 72.5 km of transects (58.6 km by foot; 13.9 km by car) were traversed between May 15 and June 14, 2008 encompassing 64.3 hrs of field time. Greater sampling effort was spent on Vancouver Island than on Denman Island: 35.2 hrs (55%) of survey time occurred on Vancouver Island compared to 29.1 hrs (45%) on Denman Island. Appendix 2 provides maps showing the locations of the wandering transects (Map 3 and 6) and butterfly observations (Map 4–7). Appendix 3 provides a summary of transect by date, length of time, and observer.

Summary of Adult Butterfly Observations. A total of 1,106 adult butterflies were observed during the 2008 surveys, 525 (47%) on Denman Island and 581 (53%) in the Courtenay-Comox survey area (see summary table in Appendix 4). Observations encompassed a total of 21 species. On Denman Island, the observations were divided among 14 different species. This species total was lower than in 2007, when 16 species were observed on Denman Island. Cedar Hairstreak and Mourning Cloak were observed on Denman Island during the 2007 surveys but were not observed in 2008. In the Courtenay-Comox area, we observed 19 species in total. Species totals include some observations not identified to species, but were nonetheless unique taxonomically and therefore are included in the totals: several Skippers, a Fritillary (possibly a Zerene Fritillary although this identification was not confirmed), and an unknown black-and-white species (likely *Parnassius clodius*). Species observed only on Denman Island were Western Pine Elfin and Anise Swallowtail. Species unique to the Courtenay-Comox surveys were Cabbage White (an introduced species) and Western Tailed Blue.

Taylor's Checkerspot was the most frequently observed butterfly during the Denman Island surveys, accounting for 65% (340) of observations. The most common species in the Courtenay-Comox area was Western Spring Azure (61% of observations). Mylitta Crescent was the second most commonly

observed species in both survey areas (24% of observations on Denman Island, 12% of observations in the Courtenay-Comox area). All other species accounted for less than 10% of observations in each survey area (see Appendix 4).

Flight Season Weather. While the Taylor's Checkerspot flight season in 2008 was widely believed to be cooler and wetter than in 2007, a review of weather data from the Environment Canada's station at Comox found that temperature and precipitation were similar. The total precipitation between May 10 and June 15 in 2008 was 49.8 mm compared to 51.6 mm in 2007. Mean temperature was 13.5°C in 2008 and 13.7°C in 2007. Mean daily maximum temperatures was slightly lower in 2008 (17.2°C) compared to 2007 (18.0°C), and there were only 15 days warmer than 17°C in 2008 versus 21 days in 2007.

New Vancouver Island Record for Taylor's Checkerspot. The most noteworthy sighting for the surveys in 2008 was a positive identification of a Taylor's Checkerspot on Vancouver Island (Figure 3.1 and Map 7 in Appendix 2). A single individual was observed on May 28 along the main B.C. Hydro/Terasen Gas utility transmission corridor, immediately east of Highway 19 and approximate 5.5 km north of Buckley Bay (see VI Site 1 on Map 9 in Appendix 2). This represents the first record of Taylor's Checkerspot on Vancouver Island since 1989 (at Mill Bay), and the first in the Courtenay-Comox area since 1931. This sighting was approximately 5.0 km from the closest known location of Taylor's Checkerspot on Denman Island. Based on general habitat conditions and host plant presence, the site had been identified early in the survey as having suitable habitat for checkerspots. It was visited repeatedly during May culminating in the observation of the single adult Taylor's Checkerspot on May 28. Follow-up visits in May and June did not yield additional sightings.

Figure 3.1. Single adult Taylor's Checkerspot observed on Vancouver Island in utility right-of-way along Highway 19, north of Buckley Bay. Photo on May 28, 2008 by Nick Page.

Figure 3.2. Habitat where Taylor's Checkerspot was observed in B.C. Hydro/Terasen Gas transmission corridor (VI Site 1), north of Buckley Bay. Photo on May 28, 2008 by Nick Page.

Habitat at the Vancouver Island site (called VI Site 1) consists of moist grass or shrub-dominated communities with disturbance from roads on both edges of the corridor (Figure 3.2). Wet ruts (bottom left of Figure 3.2) with some standing water were present on the western side (Terasen Gas portion of corridor) in May 2008; moist ditches are present on the eastern side. All host plants known to be used by the Denman Island Taylor's Checkerspot occur at VI Site 1: *Veronica scutellata* (present in wet ditches), *Veronica beccabunga* (sparse in wet road ruts), *Veronica serpyllifolia* (rare), *Plantago lanceolata* (common in meadow areas), and *Plantago major* (present in meadow areas). The central strip of the transmission corridor is shrub-dominated with oceanspray, Nootka rose, huckleberry, and willow species; it is mowed infrequently as part of B.C. Hydro's vegetation management program.

There are two possible explanations for the sighting of a Taylor's Checkerspot on Vancouver Island: (1) the existence of a population of Taylor's Checkerspot on Vancouver Island unknown in recent years; or (2) a very recent and potentially within-year long-distance dispersal event from the Denman Island population. In general, migrations of individual butterflies across various species in the *Euphydryas* genus have been rarely found to exceed 2–3 km (Wahlberg et al. 2004). For *Melitaea cinxia*, a related species of butterfly from Europe, 95% of observed habitat recolonizations occurred within 2.3 km from the near population source, however, the longest known colonization distance was 6.8 km (van Nouhuys and Hanski 2002). Thus, while long-distance migrations within checkerspot species are rare, they can occur.

Given the survey intensity undertaken in 2008 around the record location (suitable nearby habitats were repeatedly surveyed) and the fact that only a single Taylor's Checkerspot was observed, the most probable explanation for the Vancouver Island record is within-year long-distance dispersal from the Denman Island population. The Denman population is large and some dispersal is likely to occur. The distance between the nearest Denman location and the Vancouver Island location is within known colonization distances (unlike the distance between known Denman locations and

recently-extirpated Hornby population in Helliwell Provincial Park, which is greater than 12 km). If this individual does represent a long-distance dispersal event, it is not yet known whether this event will result in a new population of Taylor's Checkerspot colonizing the area. Surveys should be undertaken in 2009 and future years to assess whether successful colonization has occurred.

Two alternate explanations are possible. It is less likely that the record represents an existing population of Taylor's Checkerspot within the survey area or is a migrant from a source population elsewhere on Vancouver Island. Given the survey intensity exerted in 2008 around the record location (suitable habitats were surveyed in all directions for several km's), this record is unlikely to represent an existing population. No source populations on Vancouver Island are currently known. It is also possible that Taylor's Checkerspot was purposely transported from Denman Island and introduced to the site (i.e., assisted migration) but there is no additional information to support this explanation. Efforts could be made to look for Taylor's Checkerspot in other areas on Vancouver Island.

Suitable Checkerspot Habitat on Vancouver Island. While there are a variety of open habitats – clearcuts, old fields, active agricultural lands, cleared development lands, and dry meadows – between Fanny Bay and Oyster River, very few areas are considered suitable habitat for Taylor's Checkerspot. Most areas lack adequate host plants or appear too small to provide adequate resources to support a checkerspot population. Many sites that have superficially suitable habitat, such as clearcut areas west of Buckley Bay, lack moist habitat with *Veronica*, and most do not support any *Plantago*, even on roadsides and landings (see Figure 3.3 for representative habitat examples). Sites in the Courtenay-Comox area are generally grass-dominated and lack host plants, nectar sources, and thermal habitats (Figure 3.3). Few butterflies were observed in these sites generally, and no Taylor's Checkerspot. While a few remnant Garry oak meadows exist in the area, they are also small and do not appear to contain adequate larval host plant resources to support a *Castilleja*- or *Plantago*-feeding checkerspot population. Overall, the results of the survey suggest that the physiographic and habitat conditions on north and central Denman Island, including undulating topography and poorly draining shallow soils, are uncommon in the study area.
Three small sites north of Buckley Bay were located and are considered suitable habitat for Taylor's Checkerspot (see VI Sites 1, 2, and 3 on Map 9 in Appendix 2; and Figure 3.3a–c). All are recently or periodically disturbed moist sites with abundant *Veronica scutellata*, weedy plants communities with nectar plants, and thermal habitat along roads, trails, or associated with wood debris. All are on private land. Their total area is 1.9 ha (VI Site 1 = 0.4 ha; VI Site 2 = 0.5 ha; and VI Site 3 = 1.0 ha).

Denman Island Taylor's Checkerspot Population Structure, Extent, and Size: The 2008 surveys confirmed the existence of a single patchily-distributed population on Denman Island. The population is composed of several subpopulations, linked by open habitats, such as linear wetlands, road corridors, and recently-logged areas. Areas where observations were concentrated (subpopulations) are not separated by distinct topographic barriers or large areas of unsuitable habitat, and some observations were made in areas between the general subpopulation boundaries. Four main subpopulations have been identified: (1) the Northwest (NW) subpopulation along the west side of the North Denman Lands (on the northwest portion of the island); (2) the

a

b

c

d

e

f

Figure 3.3. Representative photos of suitable (a–c) and unsuitable (d–f) Taylor's Checkerspot habitat in the Courtenay-Comox area: (a) VI Site 1 in which one Taylor's Checkerspot was observed; (b) *Veronica scutellata* at VI Site 2; (c) disturbed wetlands at VI Site 3; (d) dry, regenerating clearcut near Buckley Bay; (e) old farm north of Courtenay with dense grass; and (f) dry roadside area south of Buckley Bay. All photos by Nick Page, 2008.

East (E) subpopulation on the east side of the North Denman Lands (including the Aaronson Ranch and other adjacent properties); (3) the Settlement Lands (SL) subpopulation; and (4) the Central Park (CP) subpopulation (including the adjacent private property) (Map 8 in Appendix 2 shows estimated subpopulation boundaries from 2008 and 2007 sightings). Several smaller subpopulations have also been located, particularly in areas south of the main subpopulations. The total area occupied by Taylor's Checkerspot is 32.6 ha; the NW (12.9 ha) and E (11.9 ha) subpopulations account for 76% (24.8 ha) of the total area occupied.

In 2008, a previously unrecorded subpopulation of Taylor's Checkerspot was located on a private property on the east side of Lacon Road, south of Triple Rock Drive. This is 1.5 km further south than previously known locations on Denman Island. This area was also surveyed in 2007, but no checkerspots were found. Four observations were made in a moist meadow area surrounding a narrow strip of slough sedge marsh. This site was logged in the early 2000s and has similar habitat conditions to the North Denman Lands and the Settlement Lands.

Comparing survey coverage and Taylor's Checkerspot observations between the 2007 and 2008 surveys, at least one of the subpopulations may be expanding. Several checkerspot adults were observed in habitat southeast of the previous boundary of the NW subpopulation. This habitat is similar to the main habitats of the NW subpopulation (hummocky clearcut with a mix of wet and dry habitats). The observations suggest that Taylor's Checkerspot may likely be expanding into habitats created by logging in the last 10 years. Due to time and access constraints, several sites were not visited in 2008 which made it more difficult to determine changes to the overall spatial extent of the Taylor's Checkerspot population on Denman Island.

Due to the survey methods used, reliable estimates of population size cannot be calculated based on the 2007 and 2008 survey data. The total number of Taylor's Checkerspot sightings declined from 622 in 2007 to 321 in 2008, however, sampling intensity was less in 2008. In relation to sampling intensity, we observed 11.7 checkerspots per transect hour and 15.0 checkerspots per transect kilometer in 2007, versus 10.2 checkerspots per transect hour and 2.7 checkerspots per transect kilometer in 2008. Anecdotally, there appeared to be fewer Taylor's Checkerspot in suitable habitats in May 2008 than in 2007 but they appeared to be more abundant in early June 2008 than during June 2007.

Flight Season. Observations for Taylor's Checkerspot on Denman Island in 2008 ranged from May 15 to June 14. However, an earlier adult checkerspot sighting was reported on May 11 (Andrew Fyson, pers. comm.). No reports of sightings were received after surveys ended on June 14. However, on this date, adult checkerspots were still quite abundant at several sites. It is likely that adult checkerspots were still present on Denman for 5–10 days after this survey[3]. Thus, the 2008 flight season extended from May 11 to mid-June and was likely longer than 35 days. This is longer than the 2007 flight season, which ranged from May 10 to June 13 (31 days).

[3] Further surveys were not conducted during this period as the main purpose of the surveys was not to determine the length of the flight period and time constraints prohibited further work on the Denman sites.

Both the 2007 and 2008 flight seasons were later than the estimated flight season based on the capture dates of specimens of Taylor's Checkerspot in collections. These records range from April 13 to June 22, with most records concentrated between April 30 and May 16, and an estimated peak around May 5. The later flight period of the Denman Island population may reflect host plant phenology and/or effects of latitude.

Adult Nectar Plants. Fewer adult checkerspots were observed nectaring in 2008 versus 2007. Nine observations of nectaring were made on four species: woodland strawberry (*Fragaria vesca*; four times), oxeye daisy (*Leucanthemum vulgare*, twice), hairy cat's-ear (*Hypochaeris radicata*, once), and trailing blackberry (*Rubus ursinus*, once). Nectaring by adult Taylor's Checkerspot appears to occur on a broad range of species and use appears to reflect the phenology of available nectar sources, rather than specific nectar plant preferences. Woodland strawberry appears to be the most common nectar source for Taylor's Checkerspot on Denman Island.

Additional Butterfly Species of Conservation Significance. In addition to Taylor's Checkerspot, one other butterfly species tracked by the B.C. Conservation Data Centre was observed during the 2008 surveys. Western Pine Elfin (*sheltonensis* subspecies) is a blue-listed species (S3) which was found on both Denman and Hornby Islands in 2007. All four records from 2008 were in dry clearcut areas (often ridges) on the North Denman Lands with young shorepine stands. Propertius duskywing was not observed during the 2008 surveys. We did not survey any sites with Garry oak trees (larval host plant), including the sites on Hornby Island where it was observed in 2007.

Public Involvement in Survey. Two reports of Taylor's Checkerspot in the study area were received in 2008: the first from the Kitty Coleman area northeast of Courtenay, and the second from an unknown farming area north of Courtenay. The first was investigated via a brief habitat assessment and was not substantiated. There was inadequate information on the second report to follow it up.

3.4 Key Findings

The key findings from the adult survey are:

1) **Denman Island continues to support a large, stable population of Taylor's Checkerspot composed of interconnected subpopulations.** The Denman Island Taylor's Checkerspot occupies approximately 32.6 ha and is composed of two main subpopulations: Northwest and East, and several smaller subpopulations. Most of the population occurs in the north central portion of the island on private land. The NW subpopulation appears to have expanded slightly between 2007 and 2008. A small subpopulation was also recorded further south on Denman Island than had been previously found. Taylor's Checkerspot appeared to be as abundant in 2008 as in 2007, although no quantitative population estimates were undertaken.

2) **A single Taylor's Checkerspot was observed on a B.C. Hydro/Terasen Gas utility corridor approximately 5.5 km north of Buckley Bay and 5.0 km west of the nearest checkerspot population on Denman Island.** This is the first record of Taylor's Checkerspot on Vancouver

Island since 1989 (at Mill Bay), and the first in the Courtenay-Comox area since 1931. Given the survey intensity undertaken in 2008 around the record location (suitable nearby habitats were repeatedly surveyed) and the fact that only a single Taylor's Checkerspot was observed, the best explanation for the Vancouver Island record is within-year long-distance dispersal from the Denman Island population.

3) **Suitable habitat for Taylor's Checkerspot is rare in the Courtenay-Comox area.** Three small sites north of Buckley Bay were considered suitable for Taylor's Checkerspot (the single sighting on Vancouver Island occurred in one of these sites). All are recently or periodically disturbed moist sites with abundant *V. scutellata*, weedy plant communities with nectar plants, and thermal habitat along roads, trails, or associated with wood debris. All are on private land. Most sites surveyed lacked adequate host plants or are too small to provide an adequate resource pool to support a checkerspot population. Very few butterflies were found in these sites generally. The results of the survey suggests that the physiographic and habitat conditions on north central Denman Island including undulating topography and poorly draining shallow soils are uncommon in the study area.

4) **The flight season for Taylor's Checkerspot was slightly longer in 2008 than in 2007.** The 2008 flight season began around May 10 and extended into mid June; approximately 1 week longer than in 2007.

PART 4 – PRE-DIAPAUSE LARVAL SURVEY AND HABITAT CHARACTERIZATION

4.1 Introduction

The activity patterns and habitat preferences of pre-diapause checkerspot larvae in the two main subpopulations on Denman Island were surveyed in July 2008. The pre-diapause period in Taylor's Checkerspot begins in early summer when eggs oviposited during the preceding adult flight period hatch and ends with larvae entering diapause in late summer. During this two to three month period, young larvae live colonially within silken webs and grow rapidly by consuming host plant resources in their surrounding vicinity, prior to plant species senescence from summer drought. Larval checkerspots feed preferentially on a limited suite of species which contain iridoid glycosides (Ehrlich and Hanski 2004) and are from four plant families: *Acanthaceae*, *Asteraceae*, *Schrophulariaceae*, and *Plantaginaceae* (Wahlberg 2001). Knowledge of host plant use and relationships for Taylor's Checkerspot in the Denman Island population has only been preliminarily investigated (Raincoast Applied Ecology 2007). Furthermore, the specific habitats of pre-diapause larvae have not been well-characterized.

Pre-diapause surveys were more quantitative than the post-diapause surveys and focused on understanding relationships between potential larval host plants and larval and web presence/abundance, as well as characterizing habitats used by pre-diapause larvae, relative to their availability within the study area.

4.2 Methods

Field Sampling. We used paired known and random plots (24 pairs total) to characterize the habitats (vegetation and substrates) used by pre-diapause larvae relative to the proportional availability of habitats in the landscape. Larval searches and plot sampling were conducted July 8–9 and July 16–17, 2008. Initial searches were conducted to identify 12 known larval locations in each of the Northwest (NW) and East (E) subpopulations (Maps 1 and 2 in Appendix 1). At each occupied site, a 2 m x 2 m plot, centred on the location of one or more larvae, was sampled for the following parameters: (1) number of pre-diapause larvae (located from careful searches of the plot); (2) number of larval webs (unoccupied or occupied); (3) activity level (feeding, resting, or moving) and substrate of all larvae present; (4) percent cover of all vascular plant species (including larval host plants); (5) percent cover of moss, wood, rock, soil, water, leaf litter, and forest duff; and (6) soil depth. For each known plot, a paired random plot, located in a random compass direction (0–360^{o}) and distance (0–50 m) from the known plot, was also sampled for the same parameters listed. All plots were mapped using GPS and known plot centres were marked with a 6" galvanized iron spike and washer.

Data Analysis. In addition to looking at the total numbers and frequencies of larvae, webs, and

individual host plants, logistic regression[4] was used to look for potential relationships between hostplant abundance and larvae and web presence/absence and linear regression[5] was used to look for relationships between host plant abundance and larval and web abundance.

Paired t-tests were used to look for differences in host plant and habitat characteristics between known and random plots. Non-metric multidimensional scaling (NMDS; an ordination method)[6] and indicator species analysis (Dufrene and Legendre 1997) were used to assess differences in plant community composition between occupied and unoccupied plots. For the NMDS, we used Bray-Curtis similarities and eliminated species found in less than five plots from the data matrix.

4.3 Results and Discussion

Summary of Observations. Three hundred and fifty-six pre-diapause larvae were counted within the 24 pairs of sampled plots. One larva was discovered during searches of a random plot, but the rest were located in known plots. The number of larvae per plot among the 25 occupied plots ranged from one to 50 (0.25-12.5 larvae/m^2), with an average of 14.2 larvae/plot (average larval density = 3.6 larvae/m^2; median = 11 larvae/plot or 2.8 larvae/m^2). Maps 1 and 2 in Appendix 1 on show the location of the known and random plots (in relation to post-diapause larval sites).

We found 57 larval webs within 14 plots (12 known sites + 2 random sites). Among plots with webs found, the number of webs per plot ranged from one to 11, with an average of 4.1 webs per plot (median = 4 webs/plot).

Larval Activity and Host Plant Use. In terms of activity level, 200 (56%) larvae were found feeding on host plants, 105 (29%) were found resting, 24 (7%) were found moving, and 27 (8%) were located in larval webs (see Figure 4.1a–d).

Pre-diapause larvae were observed feeding on four plant species: *Veronica scutellata* (Figure 4.1b) *Veronica serpyllifolia*, *Veronica beccabunga*, and *Plantago major* (Figure 4.1c). The majority of feeding larvae were found feeding on *V. scutellata* (171; 86% of observations), with only minor numbers of larvae feeding on *V. serpyllifolia* (20; 10% of observations), *V. beccabunga* (5; 3% of observations) and *P. major* (4; 2% of observations). For the latter three species, all observations of

[4] Logistic regression is a statistical modeling technique used to determine whether a dichotomous (or binomial) response variable, such as the presence/absence of a species in study plots, can be predicted by a continuous variable, such as the abundance of specific plant species. See Hosmer and Lemeshow (1989) for more information.

[5] Linear regression, like logistic regression, is a statistical modeling technique used to determine the relationship between two variables. However, in the case of linear regression, both the predictor and response variables are continuous, such as the adundance of a species in study plots. See Kutner et al. (2005) for more information.

[6] Non-metric multi-dimensional scaling (or NMDS) is one of a several ordination methods used to visualize similarities or dissimilarities among sites or plots characterized by multi-dimensional data (e.g., plant communities with large numbers of species of varying abundances. See McCune and Grace (2002) for more information.

feeding occurred within a single plot only. Furthermore, observations of feeding on *V. serpyllifolia* and *P. major* occurred within the same plot and this plot had no *V. scutellata* present.

Figure 4.1. Pre-diapause Taylor's Checkerspot larval activity: (a) pre-diapause larva moving across *P. major*; (b) pre-diapause larvae feeding on *V. scutellata*; (c) pre-diapause larvae feeding on *P. major*; and (d) active larval web on *V. scutellata*.

Of the 105 resting larvae recorded, 45 (43%) were found on *V. scutellata*, 2 (2%) were found on *P. major*, and all others were on non-host plant substrates, such as *Juncus effusus*, wood, soil, and grass. Of the 24 moving larvae, 4 (17%) were moving on *V. scutellata*, 1 (4%) was moving on *P. major*, and all others were on non-host plant substrates. All larval webs, including those occupied by larvae, were found exclusively on *V. scutellata* or, in one case, on a combination of plants including *V. scutellata*, *Mimulus moschatus*, *Myosotis laxa*, and *Oenanthe sarmentosa*.

No larval feeding was observed on *Plantago lanceolata* and the plant was not present in any of the known or random plots sampled. We located several dense patches of *P. lanceolata* in both the NW

and E subpopulations where post-diapause larvae had been observed previously but no pre-diapause larvae were found on or near these plants. However, previous to the pre-diapause study, on May 29, 2008, several egg clusters were found on a patch of *Plantago lanceolata* located on a road within the NW subpopulation (Figure 4.2a–b). This patch was searched several times during the pre-diapause larval period but no larvae were ever encountered and the is unknown.

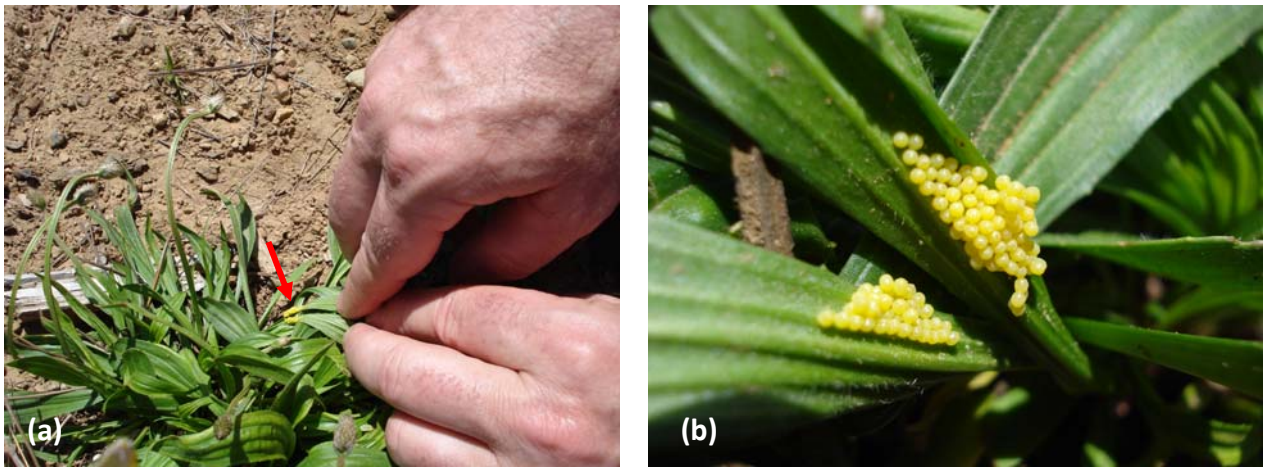

Figure 4.2. Egg clusters of Taylor's Checkerspot found on *Plantago lanceolata* during additional surveys on May 29, 2008: (a) location of egg clusters on bottom of leave (red arrow) near base of rosette; and (b) close-up of egg clusters. Photos by Jennifer Heron.

Differences in larval phenology likely influences host plant selection during the pre-diapause life stage. In many cases, *P. lanceolata* had dried out and was senescing, likely affecting its quality as a host plant during this period. Similarly, at many locations where post-diapause larvae had been observed on *V. serpyllifolia*, *V. serpyllifolia* was also senescing. Both species are more common on drier sites. In constrast, *V. scutellata* and *P. major*, which emerge in spring and grow during the summer months, appear to be at their highest availability during the pre-diapause phase, as these plants generally inhabit wetter sites that do not dry out as quickly in spring.

Relationship Between Larval/Web Abundance and Larval Host Plant Abundance. Ninety-six percent (24 out of 25) of the plots occupied by larvae contained *V. scutellata*, compared with 24% which contained *P. major* (6 out of 25), 8% which contained *V. serpyllifolia* (2 out of 25), and 4% contained *V. beccabunga*. *V. scutellata* abundance ranged from 1–8% in occupied plots with a mean abundance of 3.2%. Total host plant abundance (sum of percent cover of host plant species) ranged from 1.5–8.5% with a mean of 3.9%.

Among all plots, the presence of larvae was predicted by *V. scutellata* abundance (logistic regression: $R^2 = 0.76$; $X^2 = 50.7$, $p < 0.0001$) and total host plant abundance (logistic regression: $R^2 = 0.88$; $X^2 = 58.7$, $p < 0.0001$). From the logistic models, the probability of presence of larvae is greater than 0.5 when *V. scutellata* abundance is greater than 1.2% or total host plant abundance is greater than 1.5%, suggesting possible thresholds for suitable larval habitat. The abundance of other individual larval host plants did not predict larval presence.

Across occupied plots, larval abundance is positively related to *V. scutellata* abundance (linear regression: $R^2 = 0.10$; $F = 2.6$, $p = 0.12$; intercept = 5.4%) and total host plant abundance (linear regression: $R^2 = 0.15$; $F = 4.0$, $p = 0.06$; intercept = 3.7%), but the relationships were only marginally significant. No other predictive relationships between larval abundance and the abundance of individual host plant species were found. Larval web abundance was also not significantly related to the abundance of any host plant species or total host plant abundance.

General Differences Between Known and Random Plots. In terms of the four host plant species identified previously, known plots had higher abundance of *V. scutellata* than random plots (paired t-test: $t = 2.94$, $df = 23$, $p = 0.007$) but did not significantly differ in the abundance of other host plant species. Known plots also had higher total abundance of larval host plants (paired t-test: $t = 3.20$, $df = 23$, $p = 0.004$) than random plots but this relationship was driven mostly by the abundance of *V. scutellata*.

In terms of general habitat characteristics, known plots had lower total tree and shrub cover (paired t-test: $t = 2.50$, $df = 23$, $p = 0.020$), larger amounts of bare soil (paired t-test: $t = 2.31$, $df = 23$, $p = 0.030$) and moss cover (paired t-test: $t = 2.19$, $df = 23$, $p = 0.039$), and deeper soils (paired t-test: $t = 12.25$, $df = 23$, $p < 0.001$) than random plots. They did not differ in total herbaceous cover (includes forbs, graminoids, and ferns), or total cover of rock or wood.

Plant Community Composition and Indicator Species Analysis. The NMDS ordination analysis showed that unoccupied and occupied plots vary predictably in their plant community composition and occupy different parts of ordination space (Figure 4.3). The first axis appears to represent a strong successional gradient (open to shrubby); tree and shrub cover (plotted as a vector on the ordination diagram) correlated strongly with the first axis. The second axis likely represents a combined moisture-disturbance gradient within the sites and distinguishes several distinct community types. Clustering in the data suggests four general plant community or habitat types (denoted in Figure 4.3 and described in Table 4.1) and that occupied plots were predominantly found in wet to moist, open habitats, either associated with disturbed seasonally wet areas or roads and roadsides. Plots in dry clearcuts on rocky, shallow soil sites or in clearcut areas with dense regenerating shrub and tree cover were generally unoccupied.

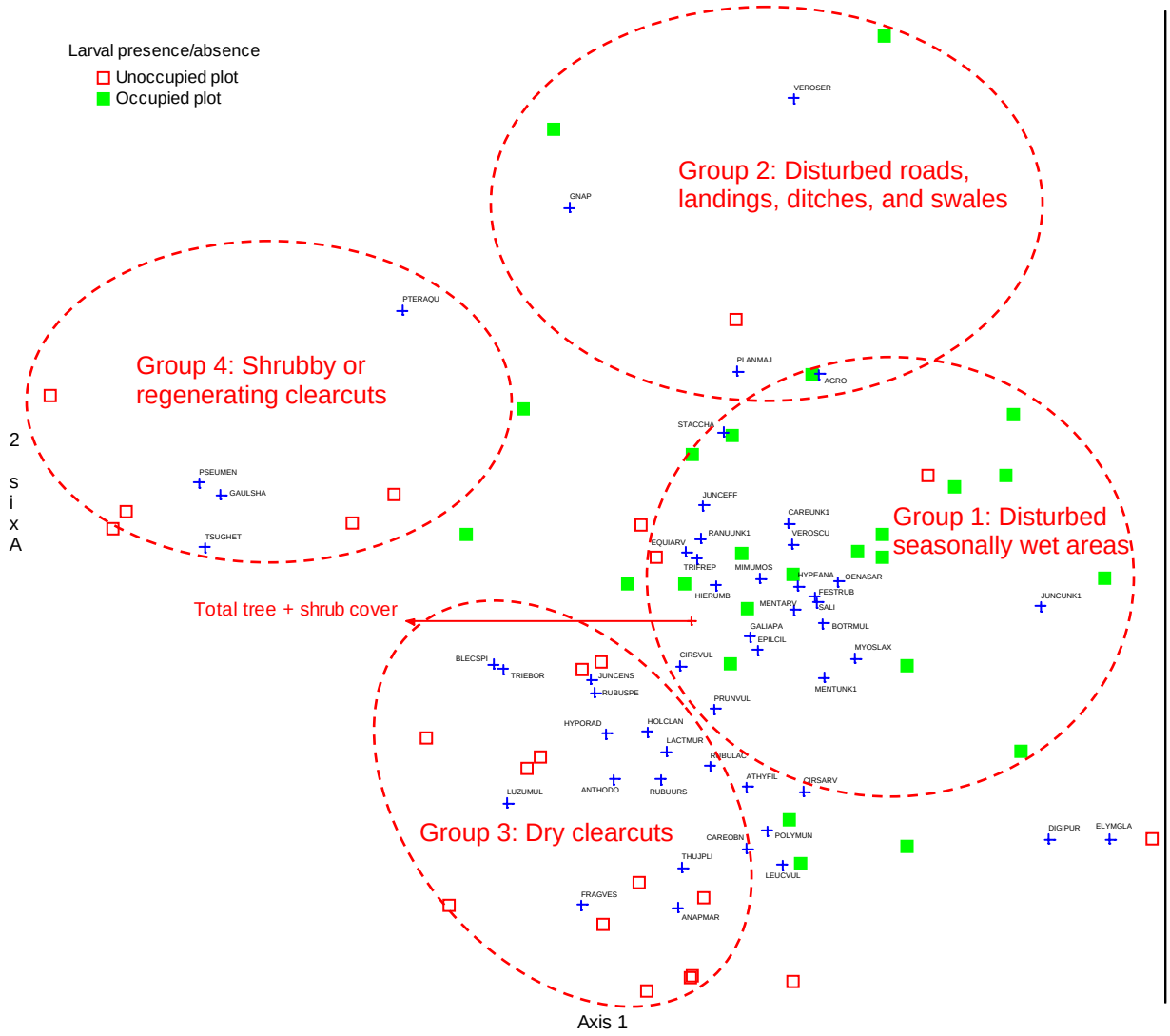

Figure 4.3. NMDS ordination of plant community cover for 48 plots on NW and E subpopulations on Denman Island, with plots grouped by plant community/habitat type.

Table 4.1. Plant community/habitat types within the study area of the NW and E subpopulations on Denman Island. Groups correspond to those denoted in Figure 4.2.

Group 1: Disturbed seasonally wet areas
Open, seasonally wet areas in depressions and lowland areas disturbed by skidder use and other logging activity. The wet ruts created by skidder use appear to be ideal habitat for *V. scutellata.* This habitat type is characterized by a range of typical wetland species, such as *Juncus effusus*, *Carex* sp., and *Agrostis* sp. These are the highest quality habitats for pre-diapause larvae.

Group 2: Disturbed roads, landings, ditches, and swales
Logging roads and other areas subject to past heavy disturbance and continued infrequent use. Seasonally wet puddles and runoff areas on roads support some *P. major* and *V. serpyllifolia.* Seasonally wet ditches and swales infrequently contain *V. scutellata*. These habitats are characterized by weedy, disturbance-tolerant plant species and a large amount of bare soil. These are marginal habitats for pre-diapause larvae.

Group 3: Dry clearcuts
Dry, shallow soil sites where open habitat has been created by logging activity and regeneration has yet to occur. Some areas are rocky or with exposed bedrock. These sites are often dominated by *Anthoxanthum odoratum*, *Hypochaeris radicata*, and *Rubus ursinus*. Due to the lack of host plants, these are generally unsuitable habitats for pre-diapause larvae.

Group 4: Shrubby or regenerating clearcuts
Moist to mesic logged sites where tree or shrub cover is regenerating rapidly. These sites are dominated by *Gaultheria shallon*, *Pteridium aquilinum,* and/or regenerating *Pseudotsuga menziesii* and *Tsuga heterophylla*. Due to the lack of openness and host plants in these habitats, these are unsuitable for pre-diapause larvae.

From the indicator species analysis, the most effective single species for indicating plot occupancy by pre-diapause larvae is *V. scutellata*. Table 4.2 lists statistically significant indicator species (α = 0.05) with their indicator values, in order of their ability to predict the presence (or absence) of larvae.

Table 4.2. Statistically significant indicator species for the presence and absence of pre-diapause larvae. Maximum observed indicator values reported represent a relative measure of the usefulness of the species as an indicator. *P*-values are from a Monte Carlo test of significance of the observed maximum indicator values for each species, based on 4999 randomizations. See McCune and Grace (2002) for more info.

Indicator Species	Maximum Observed Indicator Value	*P*-value
Species indicating larval presence		
Veronica scutellata	93.1	0.0002
Hypericum anagalloides	68.6	0.0002
Agrostis sp.	63.0	0.0004
Juncus effusus	53.3	0.0186
Carex sp. 1	52.0	0.0012
Mentha arvensis	43.5	0.0016
Equisetum arvense	41.1	0.0314
Myosotis laxa	33.9	0.0490
Mimulus moschatus	33.0	0.0354
Salix sp.	24.0	0.0232
Botrychium multifidum	20.0	0.0484
Species indicating larval absence		
Anthoxanthum odoratum	57.5	0.0428
Gaultheria shallon	38.0	0.0216
Tsuga heterophylla	26.1	0.0112
Leucanthemum vulgare	25.9	0.0216
Elymus glaucus	21.7	0.0188
Lapsana communis	17.4	0.0452

4.4 Key Findings

The key findings from the pre-diapause larval habitat characterizations are:

1) ***Veronica scutellata* is the most frequently used larval host plant by pre-diapause larvae, with minor use of *V. serpyllifolia*, *V. beccabunga*, and *Plantago major*.** Greater than 85% of observations of larval feeding were on *V. scutellata* and all larval webs were found on *V. scutellata* (or combinations of plants including *V. scutellata*). Use of *P. lanceolata* was not observed during the pre-diapause period and use of *V. serpyllifolia* was infrequent, likely due to senescence of these species during the pre-diapause period. These data suggest that host plant relationships are more specific at the pre-diapause stage than at the post-diapause stage. Our observations confirm pre-diapause use of *V. scutellata* and other *Veronica* species by Taylor's checkerspot as a previously unknown host plant for this subspecies.

2) **Larval presence and abundance is related to host plant abundance.** Total host plant abundance, driven by the abundance of *V. scutellata* in most plots, predicted the presence and abundance of larvae. Results suggest a minimum host plant abundance threshold of 1–2% for occupied habitat, with greater cover of host plants supporting larger numbers of larvae. This threshold may be an appropriate indicator of potential but currently unoccupied habitat (i.e., reintroduction sites).

3) **Disturbed seasonally wet areas appear to be the highest quality habitats for pre-diapause larvae, with active logging roads, landings, ditches, and swales offering more marginal habitat.** Open habitat and seasonally wet conditions appear to be important general characteristics for supporting larval host plants, but other conditions, such as the level of disturbance and site exposure (for thermal habitats), are also likely important.

4) **Currently occupied larval habitats are threatened by habitat loss due to ongoing wetland and forest succession, as well as inappropriate levels of disturbance.** The two habitat types where the majority of larvae were found have different threats to their continued existence within the Denman Island subpopulation areas. Disturbed seasonally wet areas are vulnerable to wetland and forest succession, increasing the density of plant cover and shrub and tree cover. Without some intervention, both processes will decrease habitat for host plants, such as *V. scutellata*, ultimately affecting the viability of these populations. In contrast, occupied road and landing habitats are also vulnerable to unsuitably high levels of disturbance from human use, and direct mortality of larvae and host plants. Forest succession may also occur in these areas over time but these impacts are likely to be less immediate.

PART 5 – RECOMMENDATIONS

There are five main tasks for future work on Taylor's Checkerspot:

1) **Initiate planning for population re-introducton (or augmentation) at multiple sites .** It is prudent for the long-term success of Taylor's Checkerspot in Canada to have multiple populations. Existing small areas of suitable habitat on Vancouver Island provide a connected network of sites that could be improved and expanded through active management. Although the recently extirpated population on Hornby Island at Helliwell Provincial Park was not the focus of this report, re-introduction efforts should also be pursued concurrently at this site. The large Taylor's Checkerspot population on Denman Island provides a short-term opportunity for re-introducing checkerspots. Re-introduction planning should occur soon to make use of this opportunity. Advice from invertebrate conservation biologists should be sought on the number of individuals that can be removed from the Denman Island population without affecting the viability of this population. Consultations with land owners and land managers should also be undertaken.
2) **Manage suitable habitat on Vancouver Island as a first step in re-introduction to these sites.** Improvements to habitat at one or more of the Vancouver Island sites (VI Sites 1–3) in which suitable habitat for Taylor's Checkerspot was identified should be undertaken in 2009 (see Map 9 in Appendix 2). It is prudent to treat initial actions as an adaptive management pilot project where monitoring the results of initial activities influence future management. In particular, B.C. Ministry of Environment should collaborate with B.C. Hydro and Terasen Gas to manage vegetation and habitat at VI Site 1 including selective mowing of shrub vegetation, scalping of dense grass cover, preventing recreational access by vehicles, and increasing host plant resources through seeding or planting. Some of these management actions have been used to restore and enhance habitat for Taylor's Checkerspot populations in Washington and Oregon.

3) **Monitor habitat change in regenerating logged areas on Denman Island.** A series of permanent plots should be designated in checkerspot habitat on Denman Island to evaluate the rate of plant community change including host plant abundance as succession accelerates in logged areas. Plots used for pre-diapause larvae habitat characterization could be used as a basis for ongoing monitoring as these plots were permanently marked in 2008. Photodocumentation should be incorporated into the monitoring program.

4) **Quantitatively monitor the Taylor's Checkerspot population on Denman Island.** A quantitative (grid or fixed transect) method for assessing and monitoring the size and distribution of the Denman Island Taylor's Checkerspot population, as well as other butterfly populations, should be selected and implemented in May 2009.

5) **Test habitat management methods for the Denman Island population.** Regeneration of trees and shrubs in the logged areas where Taylor's Checkerspot is currently abundant will likely result in a population decline in 5–10 years. Methods of managing habitats to maintain suitable conditions should be tested in 2009. Essential components of habitat management will be minor soil disturbance to keep wet depressions from infilling with dense vegetation and continued tree removal to maintain the open nature of the landscape in these areas. Establishing larger host plant populations on roads and landings should also be attempted.

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