

Project Completion Report

Surveys to determine the status of two rare insect species on the Oregon coast:
the Siuslaw hairy-necked tiger beetle (Coleoptera: Cicindelidae: *Cicindela hirticollis*
siuslawensis Graves, Krejci, and Graves, 1988) and the Oregon plant bug (Hemiptera:
Miridae: *Lygus oregonae* Knight, 1944)



Cicindela hirticollis siuslawensis adult and *Cicindela* sp. larva. Photos by Sarina Jepsen, The Xerces Society

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Abstract:

The Siuslaw hairy-necked tiger beetle (*Cicindela hirticollis siuslawensis* Graves, Krejci, and Graves, 1988) is a rare species that is absent from most of the historic and potential habitat surveyed by The Xerces Society along the Oregon coast. In targeted surveys, *C. h. siuslawensis* was found at only one of six historic sites, and at 17 of 49 total sites. Three additional historic sites no longer have suitable habitat to survey. *C. h. siuslawensis* is threatened by recreation, ORV use and development, and populations were found primarily in areas with little to no human activity, low levels of foot traffic, and little to no vehicular traffic. While these were presence/absence surveys, it was noted that *C. h. siuslawensis* could not be considered abundant at any of the survey sites, with the exception of sites located within the New River BLM ACEC, which is relatively pristine, inaccessible, and protected for endangered snowy plovers. To preserve this rare species at known sites, habitat needs for *C. h. siuslawensis* should be taken into consideration in management guidelines on BLM, USFS and Oregon Parks and Recreation Department (OPRD) land, as well as in management guidelines for the endangered western snowy plover with which it co-occurs at several sites.

While conducting tiger beetle surveys, we also searched for the rare Oregon plant bug (*Lygus oregonae* Knight, 1944) at sites where its host plants *Ambrosia chamissonis* and *Abronia latifolia* were also present. One or both of the host plants were present at 13 of the 49 sites surveyed, but *L. oregonae* was found at only a single site (Myrtle Creek, Curry County) on *A. chamissonis*.

We achieved all of the major goals of this project:

- research historic population locations of *Cicindela hirticollis siuslawensis* and *Lygus oregonae*, as well as locations of the plant bug host plant species *Ambrosia chamissonis* and *Abronia latifolia*
- determine the criteria for search areas for each species by consulting the literature and local and regional experts, and to develop a search protocol
- identify and search target sites for both rare insect species
- record all data including documenting where surveys were conducted
- write a complete report that includes detailed maps on the status of the Siuslaw hairy-necked tiger beetle and Oregon plant bug

Project background:*Cicindela hirticollis siuslawensis*

The purpose of this study was to investigate the conservation status of the rare Siuslaw hairy-necked tiger beetle (*Cicindela hirticollis siuslawensis* Graves, Krejci, and Graves, 1988) in Oregon. This species is listed as Critically Imperiled by NatureServe, and is thought to be declining drastically due to recreational use, ATV traffic, and coastal development.

Adult and larval beetles inhabit sandy areas around freshwater outflows onto the Pacific coast. Larvae and adults are predaceous on other invertebrates. The grub-like larvae dig small burrows in moist sand and lie in wait for prey that wanders near the burrow mouth. Adults are extremely mobile visual hunters, and can be seen running across the sand in short fast bursts or moving in short hopping flights. They hold and chew their prey with long, sharp, sickle-shaped mandibles.

C. h. siuslawensis is thought to have been present historically on Pacific coast from central Washington to Eureka, California (Graves *et al.* 1988, Pearson *et al.*, 2006.). Specimens were collected in Oregon prior to 1979 in Lincoln Co. (Waldport and Yaquina Bay, Newport), Tillamook Co. (Neskowin, Sand Lake, Twin Rocks and Woods), Lane Co. (Siltcoos outlet, Westlake and Florence), and Coos Co. (Hauser). Please see Appendix A for a table of historic records in Oregon. Historic records of *C. h. siuslawensis* from Washington include Grays Harbor Co. and Pacific Co.. Unpublished reports from informal surveys conducted within the past five years found *C. h. siuslawensis* in the Bandon/New River area (R. Lyons, pers. comm., 2008-2009), as well as in a few sites in Washington state (Grays Harbor County; W. Steffens, pers. comm.). However, no systematic surveys of historic and potential habitat along the Oregon coast have been conducted recently, and the true status of this species has been unknown.

Lygus oregonae

We also investigated areas of suitable habitat in and around tiger beetle survey sites for the presence of the rare Oregon plant bug (*Lygus oregonae* Knight, 1944). This species is listed as Imperiled by NatureServe and is thought to be threatened by conversion and fragmentation of tidal and floodplain wetlands, loss and degradation of sand dune systems and riparian areas, and encroachment of exotic vegetation.

This species is only known to utilize two host plants, *Ambrosia chamissonis* and *Abronia latifolia* (Schwartz & Foottit, 1998), both of which have a narrow coastal distribution. *Abronia latifolia* (yellow or coastal sand verbena) is a yellow-flowering perennial with a flat to mounding growth habit that grows in the loose, shifting beach sand of foredunes along the coast. *Ambrosia chamissonis* (beach bur or silver beachweed) is a yellow-flowering perennial in the aster family, found primarily in California but also present in other western coastal states. *Lygus oregonae* was first described from specimens taken in Waldport, OR on *A. chamissonis*, and for fifty years no other populations were known until the bug was rediscovered and documented from *A. latifolia* by M. Schwartz (Schwartz & Foottit, 1998). This species is restricted to extreme coastal regions, but specimens are known from Long Beach, WA south to Eureka, CA (Schwartz & Foottit, 1998). More research is needed to determine the current status and distribution of this rare species.

Methods:

Site selection

Cicindela hirticollis siuslawensis

Historic records gathered for *C. h. siuslawensis* specimens were mapped onto GoogleEarth. Local tiger beetle experts and enthusiasts were consulted for recent *C. h. siuslawensis* records (Mike Kippenhan, Ron Lyons, Wayne Steffens, Dana Ross) and these current records were also mapped onto GoogleEarth. Aerial photographs and topographic maps were used to assess the Oregon coastline and identify areas of freshwater outflows onto sandy beaches that were potential tiger beetle habitat. Because funding allowed a total of 11-12 days to cover the length of the Oregon coast, we prioritized historic sites, known sites, and areas of potential habitat within 5-10 miles of historic and known sites.

In the course of determining survey sites, it became apparent that much of the historic and potential *C. h. siuslawensis* habitat overlapped with critical habitat designated for the endangered

western snowy plover (*Charadrius alexandrinus nivosus*). Xerces Society staff participated in an informal consultation on February 17, 2009 with Liz Kelly, Jeffrey Dillon, Kim Garner, Laura Todd (USFWS staff), and Eleanor Gaines (ORNHIC) to assess whether Xerces staff could access areas of snowy plover habitat to survey for tiger beetles during the period that the habitat was closed to the public without causing a negative impact on the birds. The nature of the tiger beetle survey technique (described below) and the small number of staff surveying per site (2) resulted in a finding of Not Likely to Adversely Affect (NLAA) plovers, with the caveats that Xerces staff would not survey in plover habitat until after August 1, 2009, when the brood would likely be off the nest, and Xerces staff would consult regional plover biologists and site managers to determine areas that should still be avoided after August 1 due to nesting activity.

Lygus oregonae

Records were obtained from the Oregon Plant Atlas for both *Lygus* host plants from 1990-2009. These records were mapped onto GoogleEarth and those in close proximity to tiger beetle survey sites were prioritized. The holotype of *L. oregonae* and two other specimens collected from Waldport, Oregon in 1929 and 1935 were examined by Xerces staff at the Smithsonian National Museum of Natural History prior to surveying. During the course of tiger beetle surveys, all *Ambrosia chamissonis* and *Abronia latifolia* encountered were noted, surveyed for *Lygus oregonae*, and GPS coordinates of the locale taken.

Sampling

Cicindela hirticollis siuslawensis

Surveys monitored presence/absence of the target species, although numbers of individuals were recorded. Adult sampling is done using a long-handled aerial sweep net. Optimal conditions include air and sand temperatures above 62-65°F. Beetles are more active on sunny days, but will still fly under cooler, more cloudy conditions if the sand is sufficiently warmed. Surveyors walked slowly through the habitat, scanning the ground ~5-20 m ahead and to the side. Most survey transects were linear; the start and end coordinates were marked using a Rino 120 GPS unit, NAD 83 coordinates. For polygon transects, the coordinates of each corner were recorded.

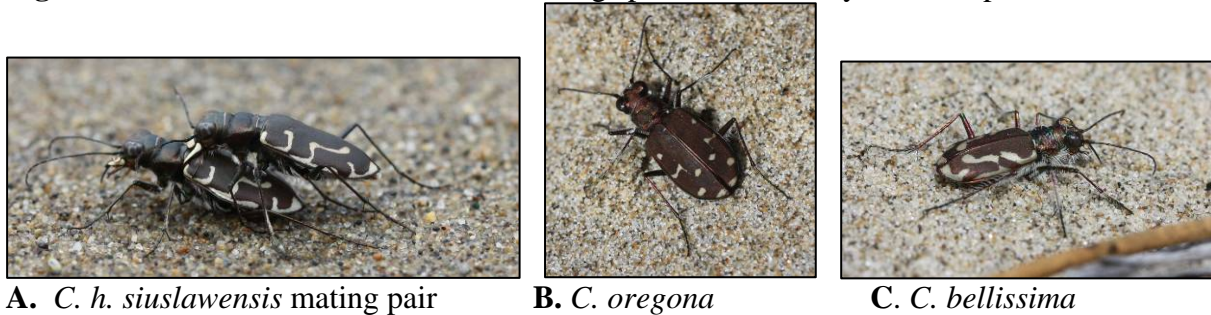
The short, hopping flight of adult beetles provides a visual cue to their presence, and walking slowly through the habitat often “flushes” beetles into flight; they are then followed until they come to rest and can be identified. Because the beetles are easily startled, surveyors approached resting beetles slowly until close enough to either identify on the ground, or capture to confirm identification. Beetles are captured by moving slowly towards the subject with the net extended, oriented mouth-up and close to ground level. Once close enough to the beetle, the net is slapped quickly overhand over the insect; when possible, the net hoop is pressed into the sand to eliminate any gaps between the hoop and substrate through which a captured beetle could escape. The specimen in the net is then gently grasped and placed in a glass vial for observation.

The adult appearance is distinctive enough that visual identification on the ground upon close approach is frequently possible without requiring netting. However, for future surveys we recommend the use of close focus binoculars, especially on warm still days, when the beetles fly more frequently and further; and at sites with dark or wet sand, which makes beetles much more difficult to see. On windy days the beetles stay close to the ground or make only short flights, as they are less able to control their direction, but on still, sunny days beetles are extremely active

and rest on the sand for very short periods of time. Close focus binoculars would allow an observer to maintain position and scan for beetles; this would result in reduced walking through the transect, which would startle fewer beetles into long flights. Extensive photographs were taken of individuals at all sites, but voucher specimens were taken only at sites that appeared to have larger populations.

Field markings of *C. h. siuslawensis* make identification straightforward. Adults have brown to brownish-green elytra (forewings) with distinctive cream-colored markings (maculations). Maculations are thin; the front maculation is strongly curved with a slight tail, resembling a capital “G”, and the middle maculation is elbowed, parallel sided, and complete (Figure 1A, Graves *et al.* 1988). Two co-occurring tiger beetle species have similar coloration but differing maculations. *Cicindela oregona* (western tiger beetle) has thinner, more irregular maculations, with the front maculation reduced to a dot, and the middle maculation with a thin downstroke, giving adults a dotted appearance from a distance (Figure 1B). *Cicindela bellissima* (Pacific coast tiger beetle) has much thicker maculations; the front maculation is a short curve without a hook or tail, resembling a parenthesis, and the middle maculation may be much narrower before the elbow (Figure 1C). The presence of all three *Cicindela* species was noted in our surveys.

Figure 1. *C. h. siuslawensis* and co-occurring species. Photos by Sarina Jepsen, Xerces.



In addition to scanning for adult beetles, surveyors noted the presence of the shallow, crescent-shaped burrows that adults dig in dry sand (Figure 2). These shelters may be made by any of the co-occurring *Cicindela* species described above, but their presence supported our assessment of potential habitat even if no adult beetles had yet been seen. In a few cases, the presence of several adult burrows in what appeared to be suitable habitat caused us to extend our survey time, often resulting in successful sighting of at least one adult beetle. On one occasion, a *C. h. siuslawensis* adult was observed using its hind legs to excavate a burrow (Figure 2B).

Figure 2. Adult tiger beetles using burrows



A. empty burrow in sand

B. *C. h. siuslawensis* excavating burrow

The presence of larval tiger beetle burrows was also noted in the course of surveying. A variety of invertebrates dig holes in beach sand, but tiger beetle larvae usually locate their burrows in

moist, firm sand near freshwater outflow areas. Burrows may also be found in slightly dryer sand further upland from a stream, but generally not in areas with dense vegetation. Larval burrows may occur in high density, especially in sheltered areas such as the lee of driftwood (Figure 3A). Larval tiger beetle burrows have small (1-4 mm), extremely round openings, and are several inches deep. Suspected burrows were confirmed by “fishing”, which involves slowly inserting a blade of grass down into the hole until the larva garbs hold with its mandibles and can be pulled carefully out of the burrow (Figure 3C). If burrows are approached with sufficient caution to avoid disturbance, the flat, coppery, sclerotized, hairy head of the larva can often be seen level with the top of the hole, awaiting prey (Figure 3B). No key exists for *Cicindela* larvae, so identification to species of larvae removed from their burrows was not possible.

Figure 3. Tiger beetle larval burrows. A & C by Sarina Jepsen; B courtesy of Ron Lyons.



A. Multiple larval burrows



B. *Cicindela* larva in burrow

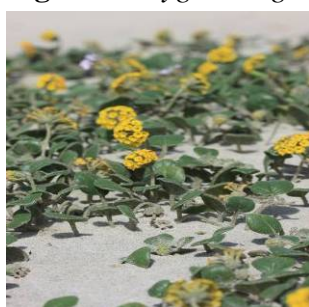


C. Larva “fished” from burrow

Lygus oregonae

We surveyed for this species based on host plant presence. Individual plants and patches of *Abronia latifolia* or *Ambrosia chamissonis* (Figure 4) were identified in the course of tiger beetle surveys and swept using aerial nets. Plants were also inspected visually, especially around flower heads, as *Lygus oregonae* was collected previously on flowers and developing flower heads of *A. chamissonis* (Schwartz & Footitt, 1998). Net bag contents were examined, and any plant bug nymphs and adults captured were collected using an aspirator. *Lygus oregonae* is a pale, yellowish-green bug with darker brown mottling on the dorsal surface and pale wing tips (Figure 5). Because unequivocal identification of plant bugs is challenging, all captured plant bugs were placed into vials and frozen for later identification by experts in the genus.

Figure 4. *Lygus oregonae* host plants



A. *Abronia latifolia*



B. *Ambrosia chamissonis*

Figure 5. Dorsal and lateral views of *Lygus oregonae* holotype specimen. Photographs courtesy of Thomas Henry, Smithsonian National Museum of Natural History, Washington DC.



A. Pinned adult, dorsal view



B. Pinned adult, lateral view

Results:

Surveys confirmed that *C. h. siuslawensis* is a rare species that is absent from most of the historic and potential habitat surveyed. Xerces staff surveyed 49 sites in 11 days, in survey periods occurring on June 29, July 14-15, July 20-23, and August 3-6, 2009. Surveys covered the length of the Oregon coast nearly evenly, from Astoria (Fort Stevens) down to Brookings (Whalehead Creek). Between-site gaps ranged from 4–15 miles; the three longest survey gaps were under 45 miles each (~30 miles from Camp Rilea to Nehalem Bay; ~22 miles from Twin Rocks and Sand Lake; and 33 miles from Salmon Creek—Cascade Head to Thiel Creek). The longest between-site distances are accounted for by absence of suitable potential habitat or distance from known or historic sites. See Appendix B for maps of all survey sites and species found.

Cicindela species were absent from 14 of the 49 sites surveyed (29%). Adult *C. h. siuslawensis* were found at 17 sites (35%) within a relatively small area; six of these were sites where the species was known to be extant. Surveys included six known historic sites for *C. h. siuslawensis* in Oregon: Waldport (Lincoln Co.), Pacific City (Tillamook Co.), Sand Lake (Tillamook Co.), Twin Rocks (Tillamook Co.), Florence (Lane Co.) and Siltcoos Bay (Lane Co.). *C. h. siuslawensis* was found at only one of these six historic sites, Siltcoos Bay outlet. Additional sites at which *C. h. siuslawensis* was not previously known but was found in Xerces surveys include Sutton Creek (Lane Co.), Tahkenitch (Douglas Co.), Tenmile (Coos Co.), and multiple sites along New River from Floras Lake through the area where New River is met by Twomile Creek and flows into the Pacific Ocean (Coos & Curry Co.). Detailed site survey descriptions are presented below, running from north to south along the coast. Specific details of air and sand temperature, weather conditions, and complete transect coordinates can be found in the associated GeoBob data sheets.

Host plant species for *Lygus oregonae* were present at thirteen of the sites surveyed (27%). Although a variety of insects were noted associated with the host plants at these sites, including ants, small parasitic wasps, and picture-winged flies, adult plant bugs were only present at a single site, Myrtle Creek (Curry Co.), in an area with many large contiguous patches of *Ambrosia chamissonis* (Figure 6). Voucher specimens taken at this site were confirmed by a mirid expert to be *Lygus oregonae* (Dr. Michael Schwartz, Research Affiliate, Insect Biosystematics, Canadian National Collection of Insects).

Figure 6. *Lygus oregonae* specimen collected at Myrtle Creek (Curry Co.), July 2009. Photos by Sarina Jepsen, Xerces Society.



A. Pinned adult, dorsal view **B.** Pinned adult, lateral view

Site surveys

Fort Stevens State Park, 07/13/09

Site 1: Swash Lake. *No Cicindela species or L. oregonae host plant found.* This appeared to be poor habitat. Although there was abundant sedge and native blackberry at the edge of the lake, there was also a great deal of Scotch broom, and the channel seemed like a drainage ditch with sandy banks that had been cut into a forested area.

Site 2: Clatsop Spit. *No Cicindela species or L. oregonae host plant found.* We surveyed a sandy area consisting of ~50-75 feet between vegetation and Clatsop Spit on the shore side of the Columbia River. Although conditions may have been too cloudy and cool for beetle activity, the habitat was also very impacted by human use, as evidenced by easy beach access, many human and dog prints, ATV tracks, and people driving onto the sand for clamming.

Camp Rilea Military Reservation, 07/13/09

This site did not contain suitable habitat for tiger beetles, but was a site record for *Abronia latifolia* from the Oregon Plant Atlas. Two patches of *Abronia latifolia* were observed in this area, each with ~35 plants, but no plant bugs were observed.

Nehalem Bay State Park, 07/13/09

No Cicindela species or L. oregonae host plant found. We surveyed a strip of beach strip ~50 ft wide, running from the boat launch south to the end of the spit, where the sand gives way to thick river rock. This site is heavily impacted by human use.

Twin Rocks—Watseco Creek, 07/13/2009

No Cicindela species or L. oregonae host plant found. This is a historic site for *C. h. siuslawensis* (07/10/40). The outflow area from the road to halfway down the beach is totally blocked by dense logpiles which have a damming effect, so there is little flow and the water is very still. There is evidence of substantial human use. Click beetles and ground beetles were active on the beach.

Sand Lake, 07/14/09

One C. bellissima and two unidentified Cicindela were observed. No L. oregonae host plant was seen. This is a historic site for *C. h. siuslawensis* (08/24/41). This site is close to a campground

and has moderate human use, including ATV activity. ATV tracks were observed on the beach. Because this is a historic site it was surveyed extensively, especially in an area that appeared to have suitable habitat and was further away from the campground, with fewer human tracks. The historic record did not specify the region of Sand Lake from which *C. h. siuslawensis* was collected. We chose the most suitable habitat and spent approximately 8 person hours (4 people x 2 hours) surveying the site. However, there are other areas around Sand Lake that could also be surveyed for the presence of *C. h. siuslawensis*.

Bob Straub State Park—Pacific City, 07/14/09

No Cicindela species or L. oregonae host plant found. This is a historic site for *C. h. siuslawensis* (5/26/1934; 6/26/1938), although the exact collection locale is not specified. We surveyed from the parking lot on the east side of the peninsula at the northernmost border of park along the sandy freshwater shore side of the Nestucca River.

Cascade Head—Salmon Creek, 07/14/09

No Cicindela species or L. oregonae host plant found. This site is recorded in the Oregon Plant Atlas as having both *A. latifolia* and *A. chamissonis* within the past 10 years. We surveyed around the atlas coordinates as well as around the boat launch parking lot off of Three Rocks Road and found no host plants and no open sandy habitat that looked as if it would support them.

Thiel Creek, 07/14/09

Six C. bellissima, 15 C. oregona, and one unidentified Cicindela were seen. No L. oregonae host plant was observed. Tiger beetles were found on the sandy wet ground just below a sand cliff with freshwater seeps located ~30 m from shore. There is little apparent recreational use at this site.

Lost Creek State Park, 07/14/09

No Cicindela species or L. oregonae host plant found.

Ona Beach State Park, 07/14/09

One C. bellissima and one C. oregona were observed. Two patches of A. chamissonis were seen, but no mirids were observed on the plants. Some dog tracks, bonfire remnants, and old ATV tracks were seen, although this site doesn't appear to have excessive recreational use.

Driftwood Beach State Recreation Site, 07/15/09

Three C. bellissima and one unidentified Cicindela were seen. No L. oregonae host plants were found. We surveyed both Fox Creek and Buckley Creek. The dunes from the parking area to Fox Creek appeared to be suitable habitat for *A. chamissonis* and *A. latifolia*, but we found neither plant. Larvae, larval burrows and an adult *Cicindela* were observed on a shelf of compacted wet sand just above the Fox Cr. outflow and just below the vegetated cliffside. The habitat appears to be suitable for tiger beetles, as there is little recreational use on this part of beach, although there is more use (evidenced by footprints and sand castles) closer to ocean. There is also a house just above the site. This site was surveyed intensively for 1.5 hours, but the weather was cool, overcast and foggy and conditions were not ideal for tiger beetle activity. Based on the appearance of the habitat, this site should be re-surveyed.

Waldport—Alsea Bay, 07/15/09

No Cicindela were observed. One large isolated large patch of Abronia latifolia (110 x 80 x 130 in. mound) was found. This site is historic for both C. h. siuslawensis (06/22/30, 8/10/41, and 7/5/42) and L. oregonae (8/18/1929; 7/11/1935), but no collection locales were specified. This area appears to be degraded, and no suitable tiger beetle habitat was seen. We surveyed the dry and moist sand at the base of a natural ledge with many areas of freshwater seepage. The site was filled with driftwood, and there were many houses on the ledge above. The A. latifolia patch was searched thoroughly, but we found only weevils and parasitic wasps.

Wakonda Beach, 07/15/09

No Cicindela species or L. oregonae host plant found. This site experiences heavy recreational use. There is a great deal of debris on the sand, and many houses in close proximity to the beach area. It did not appear to be good tiger beetle habitat.

Smelt Sands—Starr Creek

No Cicindela species or L. oregonae host plant found. The site is very rocky and steep with many small tide pools, and doesn't appear to be good habitat for Cicindela or L. oregonae. We surveyed two freshwater outflows but both were steep and rocky, with little distance between the outflow and the edge of the ocean.

Yachats State Natural Site, 07/15/09

No Cicindela species or L. oregonae host plant found. Physically, the site appears to be good potential tiger beetle habitat, but is impacted by high levels of human activity.

Neptune State Recreation Area, 07/15/09

Found 40 C. oregona and one unidentified Cicindela. No L. oregonae host plants were seen. Numerous C. oregonae were observed on the rocks and sandy cliffs, on both wet and dry sand. C. oregona were most abundant along a firm sand cliff with multiple small trickles of freshwater on its face. Little human impact was noted in the rocky area where beetles were active.

Stonefield Beach, 07/15/09

No Cicindela species were observed. Multiple patches of A. latifolia and A. chamissonis were seen, but no plant bugs were observed. This site contains records from the Oregon Plant Atlas within the past 10 years for both L. oregonae host plants. Extensive patches of A. latifolia and A. chamissonis were present throughout the site, mixed in with European beach grass and low-growing conifers. Close visual inspection of all plant parts followed by net sweeping yielded no plant bugs. Sandy areas around the outflow of Tenmile Creek at the site were surveyed for Cicindela, but no tiger beetles were seen.

Berry Creek, 08/03/09

Two C. bellissima, three C. oregona, and 14 unidentified Cicindela were observed. No L. oregonae host plants were seen. This site appeared to be suitable for C. h. siuslawensis, as it has multiple dunes, moist sand, a long stream meander, and the level of human use doesn't seem excessive. The tiger beetles we observed were flying very quickly and were extremely difficult to identify or net. Both of the C. bellissima observed were seen along the path leading to the creek; the C. oregona and unidentified Cicindela were present in the vegetated areas. After

completing the transect survey, we observed four additional tiger beetles up-close, all of which were *C. oregona*.

Sutton Creek, 07/20/09

Two C. h. siuslawensis, 62 C. bellissima, 65 C. oregona, and 17 unidentified Cicindela were observed. No L. oregonae host plants were seen. This site has apparently little or no human activity. Clouds of *C. bellissima* were seen in the dry sand areas just upland of the creek, and *C. oregona* was abundant in the moist sand areas near the creek edge. Two *Cicindela* larvae were fished from their burrows. The *C. h. siuslawensis* specimens were netted on wet, hard-packed sand.

Siuslaw River south jetty—Florence, 07/20/09

Two C. bellissima were observed. No L. oregonae host plants were observed. This is a historic *C. h. siuslawensis* site (9/5/1948), although exact collection locality is not specified. It does not appear to be good tiger beetle habitat, as there is a high level of foot traffic, human-made rock impoundments along part of the river, and a road nearby.

Cleawox Lake, 07/23/09

16 C. bellissima, three C. oregona, and two unidentified Cicindela were seen. No L. oregonae host plants were found. There is high recreational use around the entire sandy shore area of the lake surveyed. We surveyed this site after learning that *C. h. siuslawensis* had been found around lakes in Honeyman. However, upon further clarification, we learned that *C. h. siuslawensis* had been found around temporary wetlands in the sand dunes of Honeyman State Park that generally are dry by July. We recommend future surveys of temporary freshwater wetlands in Honeyman State Park beginning in late May or early June.

Siltcoos River, 08/03/09

Five C. h. siuslawensis, 63 C. bellissima, and 79 unidentified Cicindela were seen. No L. oregonae host plants were seen. We were accompanied at this site by Daniel Farrar (ORNHIC) as the tiger beetle habitat coincided with snowy plover habitat. One of the *C. h. siuslawensis* individuals observed appeared mutated, with abnormal, curled elytra.

Tahkenitch, 08/03/09

Five C. h. siuslawensis, 10 C. bellissima, 59 C. oregona, and 23 unidentified Cicindela were seen. No L. oregonae host plants were seen. The area seems very undisturbed. Numerous *C. bellissima* were observed on the trail on the way to the creek but were not included in the transect count. We surveyed only one section of the east/south side of the creek. The habitat on the other side of the creek looked even better for *C. h. siuslawensis*, as it was broad, flat, and sandy with firm sand and dunes behind), but we did not survey there as Daniel Farrar (ORNHIC) had informed us there was a plover nest about to hatch on that side of creek.

Threemile Creek, 07/20/09

One unidentified Cicindela seen. No L. oregonae host plants observed. The area has much logging and ATV activity, although the stream outflow is in a region where ATVs are not allowed. There is very high human use around the creek (structures built from driftwood, burned driftwood, trash), and a great deal of garbage and much woody debris in the creek. However,

three *Cicindela* larvae were observed: one “fished” from its burrow, one crawling in sand, and one in its burrow. Numerous potential larval burrow holes were also seen. The site was surveyed in the late afternoon, and it may have been too foggy and cold for adults to be active. Although this site seems very impacted, it may be worthwhile to re-survey here, as it is in fairly close proximity to other survey sites where *C. h. siuslawensis* was found by Xerces in 2009.

Tenmile Creek, 08/04/09

Site 1: upland/inland stream banks. *Nine C. h. siuslawensis, three C. bellissima, and one C. oregona observed. No L. oregonae host plants seen.* The area appears to have little to no human use, and the river here has numerous freshwater spring upwellings and mineral deposits at its edge. The site was reached in the morning when the air and sand temperatures were still low. Many *C. bellissima* were seen active on the dunes on the hike in. Larval burrows were seen at high density at the creek site, and the heads of the larvae were visible within. One adult *C. h. siuslawensis* was observed sitting perfectly still on the chilly wet sand by river, but no additional *Cicindela* were seen at that time. We crossed this site again in the afternoon on the hike out, and because weather conditions were ideal (warm and sunny), we surveyed the same area again and saw multiple *C. h. siuslawensis*, including two entering the crescent-shaped adult burrows. *C. h. siuslawensis* adults were seen mainly on the flat dry shelf of sand above the riparian area, but below the main dune.

Site 2: outflow. *One C. h. siuslawensis, 18 C. bellissima, and 11 unidentified Cicindela observed. No L. oregonae host plants seen.* The *C. h. siuslawensis* adult was observed just where a smaller creek enters Tenmile. The water here had an oily sheen. A snowy plover adult male and youngster were observed; when the male became agitated, the survey was terminated and we returned to Site 1.

North Bend North Spit, 07/21/09

No Cicindela species or L. oregonae host plant found. The habitat follows the jeep trail along the spit, and is bordered by "No ATV/hiking only" areas. Some shallow scrapes in the sand resembling adult burrows were observed, but no *Cicindela* were seen. A few round holes in the moist sand in the lee of driftwood were examined, but “fishing” for larvae was unsuccessful, and many of the holes were shallower than larval burrows observed at other sites. We did not survey into snowy plover habitat, as it was too early in the summer to allow access, but the area that we did survey receives high human and vehicular traffic.

Seven Devils State Park, 07/21/09

Observed 55 C. oregona and 25 unidentified Cicindela. No L. oregonae host plants observed. The site receives moderate human use, and a full school bus arrived during our survey. There was less apparent human use past the parking lot area. We also observed numerous probable larval burrows and one larva. Past the creek outflow we surveyed along a bank of firm but crumbly shale soil, with numerous freshwater seeps. Most beetles were found on the sand by the bank and near freshwater seeps or outflows, ~5-10 m east of the high tide mark.

Whiskey Run Creek, 07/21/09

Two C. oregona were observed. No L. oregonae host plants were seen. Whiskey Run is a small rocky creek with a fairly rapid outflow. ATVs are not allowed in this area, but we observed tire

tracks on the beach and a jeep out on the sand. Five larvae were seen, along with multiple probable larval burrows.

Johnson Creek, 07/21/09

Four C. h. siuslawensis, seven C. bellissima, two C. oregona, and one unidentified Cicindela were observed. No L. oregonae host plants were seen. Prior to Xerces' surveys, we knew that *C. h. siuslawensis* were present at this site (Ron Lyons, pers. comm.). Xerces staff also visited this site with Ron Lyons on 06/29/09 and observed 11 *C. h. siuslawensis* and one unidentified *Cicindela*. There is a great deal of foot traffic in this area, and a row of houses directly across the creek. Adult *C. h. siuslawensis* were seen burrowing in small crescent-shaped shelters in the sand. One pale individual was clearly identified as *C. h. siuslawensis*, and was thought at first to be a newly-eclosed adult that had not yet sclerotized. However, we continued to observe this specimen during our surveys, and no change in color was seen. In addition, the body was seriously malformed, and the beetle had only one eye, with the head retracted abnormally into the thorax, so it is possible that this individual was a mutant (Figure 7). Many larval burrows were observed along creek, and one larva was observed in a burrow.

Figure 7. Mutated adult *C. h. siuslawensis* at Johnson Creek



Devil's Kitchen, 08/05/09

One C. h. siuslawensis, two C. oregona, and five unidentified Cicindela observed. No L. oregonae host plants seen. Xerces staff also visited this site with Ron Lyons on 06/29/09 and observed one dead *C. h. siuslawensis*. Prior to this visit, Lyons had not seen *C. h. siuslawensis* at this site (Ron Lyons, pers. comm.), and he considered that Crooked Creek may be too impacted for *C. h. siuslawensis*. This site receives very heavy human traffic; two full school buses were leaving as we arrived.

China Creek, 08/05/09

One C. h. siuslawensis, three C. bellissima, three C. oregona, and six unidentified Cicindela were observed. No L. oregonae host plants were seen. Prior to Xerces' surveys, we knew that *C. h. siuslawensis* were present at this site (Ron Lyons, pers. comm.). Xerces staff visited this site with Ron Lyons on 06/29/09 and observed two *C. h. siuslawensis*, two *C. oregona*, and one unidentified *Cicindela*. Many larval burrows were seen at this site; in several areas we observed ATV tracks that were likely from snowy plover predator control running through the larval burrows. This site receives high human use, with many footprints and garbage outside of the roped-off plover habitat areas.

New River—Lost Lake, 08/05/09

Observed 27 C. h. siuslawensis, four C. bellissima, 30 C. oregona, and at least 39 unidentified Cicindela. Numerous small patches of A. chamissonis and A. latifolia were seen along the Lost Lake trail but no plant bugs were observed. Prior to Xerces' surveys, we knew that C. h. siuslawensis were present at this site (Ron Lyons, pers. comm.). One of the C. h. siuslawensis observed had very deformed wings and may have been a mutant. Some areas where we found C. h. siuslawensis appeared to have a lot of foot traffic.

Twomile Creek, 08/05/09

Five C. h. siuslawensis, 13 C. bellissima, 13 C. oregona, and 19 unidentified Cicindela were observed. One small A. latifolia was seen, but no plant bugs were present. Prior to Xerces' surveys, we knew that C. h. siuslawensis were present at this site (Ron Lyons, pers. comm.). This appeared to be excellent habitat with very little human use. Many larval and adult burrows were seen, and adult counts are likely underestimated as conditions were cool and overcast, and the approach of high tide did not allow us to survey longer.

New River, 08/06/09

Xerces staff was accompanied by Heather Lester (BLM, New River Education Center) at all the New River survey sites. We surveyed at sandy breaches along New River. *C. h. siuslawensis* was present at every breach site. The majority of adult beetles were found in the moist firm sand immediately adjacent to the river channel.

Croft Lake: Six C. h. siuslawensis, four C. bellissima, 12 C. oregona, and 15 unidentified Cicindela were seen. One patch of A. chamissonis was seen, but no plant bugs were present. The stream had a high density of 2-4 mm dark brown snails which are likely New Zealand mud snail, although no snail specimens were taken.

New Lake: Four C. h. siuslawensis, 20 C. bellissima, and seven C. oregona were identified. Unidentified Cicindela were too numerous to count. No L. oregonae host plants were seen. Excellent Cicindela habitat; no visible signs of human use, and it is relatively inaccessible to foot traffic and ATVs.

Hammond: Two C. h. siuslawensis, 15 C. bellissima, and seven C. oregona were identified. Unidentified Cicindela were too numerous to count. One patch of A. chamissonis was found, but no plant bugs were observed. Excellent habitat, with little to no human use. There was evidence of Canada goose, and tiger beetles were not found in areas that were full of goose footprints and scat.

Bono/Clay Island: Observed 19 C. h. siuslawensis, seven C. bellissima, and two unidentified Cicindela. No L. oregonae host plants were seen. Excellent habitat, with little to no human use. There was evidence of Canada goose.

Historic Breach: Observed 44 C. h. siuslawensis, 14 C. bellissima, one C. oregona, and too many unidentified Cicindela to count. One A. latifolia was found, but no plant bugs were seen. Little human use was apparent, although a herd of cows was seen on the opposite side of the

river. Canada goose scat and tracks and otter scat were present. *C. h. siuslawensis* were concentrated on mudflats by river edge, and there were many larval and adult *Cicindela* burrows.

Floras Lake, 08/05/09

One C. h. siuslawensis and one unidentified Cicindela were observed. One patch of A. latifolia and 8-10 large patches of A. chamissonis were seen, and three unidentified true bug nymphs were collected via sweeping. Lygus nymphs are extraordinarily difficult to identify, although the true bug nymphs collected at Floras Lake appear markedly different than those collected from Myrtle Creek. Adult true bugs collected at Myrtle Creek were confirmed by a mirid expert to be L. oregonae. This area receives high levels of human use; it is adjacent to a campground and boat launch, a foot trail runs through the sandy area, and many human and dog prints were seen. One potential larval burrow was noted in the wet sand among footprints.

Cape Blanco State Park, 07/23/09

Observed 18 C. bellissima, 36 C. oregona, and 16 unidentified Cicindela. No L. oregonae host plants were found. Two transects were surveyed: one along a small freshwater outflow adjacent to the campground, the second further south on the beach around the Elk River outflow. Vehicles are allowed on the beach by the campground, and some tire tracks were seen. There is moderate human traffic around the campground area, but it decreases quickly away from the camp. Elk River seems very pristine, with little human traffic, as access is more than 1 mile from nearest parking lot.

Hubbard Creek, 07/22/09

Two C. oregona were observed. One A. chamissonis patch was found, but no plant bugs were seen. We surveyed along the southern/eastern edge of stream. Trucks and tire tracks were observed on the beach.

Myrtle Creek, 07/22/09

Observed 21 C. oregona and 12 unidentified Cicindela. About 30 A. chamissonis patches were seen, and several L. oregonae were collected. We surveyed the creek along both a steep cliff with soft red soil, and the sand bank along the creek edge with both wet and dry sand. About 30 large patches of *A. chamissonis* were found. Sweeping these patches yielded numerous plant bug adults and nymphs, several of which were taken as voucher specimens. Two representative adult specimens were later pinned and photographed, and the photos were confirmed as *L. oregonae* (Michael Schwartz, pers. comm., 10/2009).

Hunter Creek, 07/22/09

No Cicindela species or L. oregonae host plants were observed. This site shows light to moderate human use, but the creek is a deep green color, which may indicate nutrient enrichment. Some potential habitat was seen on the opposite side of the creek, but was inaccessible without a boat.

Myers Creek, 07/22/09

Observed two C. bellissima, two C. oregona, and one unidentified Cicindela. No L. oregonae host plants were seen. We surveyed the edge of the Myers Creek outflow from bridge to the high tide mark on each bank.

Pistol River, 07/22/09

Observed 18 *C. bellissima*, two *C. oregona*, and 14 unidentified *Cicindela*. No *L. oregonae* host plants were found in the two transects surveyed, but a single small *A. chamissonis* plant was found as we walked from transect 1 to 2, at the edge of Highway 101 above Pistol River, just south of Myers Creek Road. The plant was not in flower and no plant bugs were seen. All *C. bellissima* were observed where the river elbows to run parallel to the ocean, and the *C. oregona* and unidentified *Cicindela* were observed along the outflow onto the beach.

Whalehead Creek, 07/22/09

Observed 10 *C. oregona* and six unidentified *Cicindela*. Found 11 patches of *A. chamissonis*, but no plant bugs were seen. This area has low to moderate human use. Many potential larval burrows were seen; one larva was “fished” successfully to confirm that the hole was a *Cicindela* burrow. The sand here is dark, making it hard to see and track beetles when they are not moving.

Discussion & Conclusions:

Cicindela hirticollis siuslawensis

The Siuslaw hairy-necked tiger beetle is a rare species that is absent from most of the historic and potential habitat surveyed by The Xerces Society along the Oregon coast. Populations of *C. h. siuslawensis* were found primarily in areas with little to no human activity, low levels of foot traffic, and absence of vehicular traffic.

Distribution

The Xerces Society targeted surveys at sites where *C. h. siuslawensis* was known to be present historically, where the species was currently known (within the past 5 years), and sites with potential habitat in close proximity to known and historic locations. *C. h. siuslawensis* was absent from five of the six historic sites surveyed, and absent from 32 of the 49 total sites surveyed. The most recent known range for *C. h. siuslawensis* in Oregon was concentrated across ~8 miles in the Bandon area (Ron Lyons, pers. comm.). A single *C. h. siuslawensis* was also reported from the historic Siltcoos River outlet (Mike Kippenhan, pers. comm.). Xerces Society surveys found *C. h. siuslawensis* at 17 sites located within a 90-mile expanse, from near Florence to south of Bandon. *C. h. siuslawensis* occurred at low numbers at most sites, and was most abundant along the New River ACEC, in the most remote locations with the least human use and access.

Life History and Habitat Needs

The habitat needs of *C. h. siuslawensis* include: freshwater outflows into the Pacific Ocean; areas with wet, firm sand and drier, upland areas (such as sand dunes); and lack of compaction in larval burrow areas by human foot or ATV traffic.

Adults

The life history of *C. h. siuslawensis* in comparison to the two co-occurring *Cicindela* species make it even more vulnerable to stream degradation and high levels of human traffic along the beach. Adults are mobile, but apparently prefer the moist, firm sand on the edges of freshwater outflows, and do not range far into the drier or more vegetated upland areas, at least during the days in July and August when we observed them. This is the area that is most frequently used by recreationists on beaches. In contrast, *C. oregona* also uses freshwater seeps at sandy cliff faces,

and *C. bellissima* can range much further upland into drier and more vegetated areas of sand. All adult *Cicindela* observed seem to make and use the crescent-shaped burrows as temporary shelters, but the burrows are generally empty during daylight hours, and thus trampling is less likely to impact adults using the shelters.

Larvae

Although *Cicindela* larvae cannot be keyed to species, larval burrows that are most likely inhabited by *C. h. siuslawensis* are often highly concentrated in the moist firm sand near the stream outflow area. Burrows are visible as small (1-4 mm diameter) holes in the sand with very round, smooth-edged openings. The larva's flattened, coppery, hairy head may be visible at the burrow opening as it lies in wait for prey. Larval burrows may occur at high density in areas of firm moist sand, and are often seen in the lee of large pieces of driftwood.

Threats

The primary threats to *C. h. siuslawensis* are human and vehicle traffic around the stream outflow areas used by this beetle. *C. h. siuslawensis* is typically absent from habitat with high levels of foot and ATV traffic, as both adults and larvae are vulnerable to this type of habitat damage. We found only a single *C. h. siuslawensis* at the two most heavily utilized sites in the Bandon/New River area (Floras Lake and Devil's Kitchen), even though both are very close to other sites with large *C. h. siuslawensis* populations. Other subspecies of *Cicindela hirticollis* have been extirpated from their historic ranges due to excessive foot traffic and development (e.g. southern California, New Hampshire and the Great Lakes region; reported in Graves *et al.* 1988), suggesting that this species is very sensitive to human activity.

Recent work indicates that repeated trampling and soil compaction may decrease the number of larval tiger beetle burrows in an area (Cornelisse & Hafernik, 2009), although whether this is due to decreased oviposition by gravid females or to larval movement or mortality is not known. Larval burrows are often concentrated in the areas of firm moist sand immediately adjacent to or very near the stream outflow area; this is also a preferred area for human and dog traffic and thus likely to be impacted by even moderate levels of human recreational use. Larval burrows were seen at several beaches in areas where foot prints and tire tracks were apparent (Figure 8). Cues for larval movement to a new burrow site have not been characterized, but we observed a larva crawling on the sand at one site, and if larvae are moving out of a trampled burrow to relocate to a new area they will be additionally vulnerable to trampling and predation.

We also observed adult beetles excavating and inhabiting shallow crescent-shaped burrows in dry sand slightly upland from larval burrow habitat. These adult burrows are generally empty during the day when beetles are hunting and mating, making adults less likely than larvae to be trampled in their burrows. However, adult *C. h. siuslawensis* were observed in the greatest numbers at the New River breaches in the moist sand immediately adjacent to the stream channel, suggesting that this may be preferred habitat for hunting and mating, and would also be selected by females as oviposition sites. All of these adult activities would be negatively impacted by high levels of traffic adjacent to the stream outflow. The location of larval burrows combined with the adult preference for moist sand near the stream channel likely makes *C. h. siuslawensis* particularly vulnerable to foot and vehicle traffic. The low numbers seen at several

high-traffic Bandon-area beaches are likely due to repeated re-colonization of impacted areas from the larger populations found in nearby protected habitat for several miles along New River.

Figure 8. Potential *Cicindela* sp. larval burrows in area impacted by foot traffic.



Relationship with snowy plover habitat

Populations of *C. h. siuslawensis* were found primarily in areas where human presence was highly restricted either for protection of snowy plover nests, or from lack of easy access. Overlap with snowy plover critical habitat likely provides some level of protection for this species, but *C. h. siuslawensis* is more frequently observed on the wet sand adjacent to coastal stream outflows, whereas snowy plover critical habitat frequently only includes dry sand areas. We observed predator control vehicles driving on the wet sand to avoid snowy plover nests, although this is precisely the area where *C. h. siuslawensis* larval burrows occur. Interestingly, although *C. h. siuslawensis* is thought to be present only at the beach area of stream outflows, our observations indicate that if the habitat is pristine they can occur at both the stream outflow as well as further inland along same stream (up to 0.25 – 0.9 miles upstream/inland observed in this study at two different streams). This suggests that stream management practices for this species should address upstream areas as well as habitat around the stream mouth.

Potential inbreeding effects

Small populations may experience a loss of genetic variability and reduced fitness due to the unavoidable inbreeding that occurs. Although a systematic study of has not been done, our observations during the course of surveys suggest the possibility that *C. h. siuslawensis* has declined to the point that extant populations are experiencing inbreeding effects. Noticeably deformed *C. h. siuslawensis* were observed at three different sites, while similar deformities were not seen for *C. oregona* or *C. bellissima*.

Future surveys

After the surveys were completed, additional research discovered two more historic localities for *C. h. siuslawensis* that should be surveyed in the future: Neskowin (Tillamook Co.) and Hauser (Coos Co.). The freshwater outflow of the Neskowin River onto the beach appears to be an area with heavy foot traffic, so it is unlikely to support *C. h. siuslawensis*. Nonetheless, since that area is a historic locality and was not surveyed, it should be examined. Additionally, the town of Hauser is listed as a historic locality from 1939. There does not appear to be any suitable habitat in the town of Hauser, but there is a large stretch of sand dunes just south of the city, partially within the Oregon Dunes NRA, that was not surveyed. Temporary or permanent freshwater lakes within this stretch of open sand dunes may provide *C. h. siuslawensis* habitat and should be surveyed.

Lygus oregonae

This species is extremely rare; based on Xerces surveys, it may have been extirpated from the type locality and was absent from all sites but one where the host plant was found. The positive Myrtle Creek site had an abundance of large patches of host plant, and a larger expanse of host plant is likely necessary for populations of the Oregon plant bug to persist.

Recommendations:

C. h. siuslawensis is a rare and threatened species that appears to be declining due to the effects of habitat destruction. It is critically important that existing habitat at known sites is protected from excessive foot and vehicular traffic, and that considerations for tiger beetle habitat protection are factored into management guidelines developed for BLM, USFS and OPRD land, as well as management plans developed by the USFWS for the endangered snowy plover. The Xerces Society recommends the following actions:

Habitat management

- USFWS should address habitat management considerations for *C. h. siuslawensis* and incorporate these into the upcoming revisions to the snowy plover habitat management plans.
- BLM/ISSSSP should make a concerted effort to protect *C. h. siuslawensis* habitat at and near sites on public lands where this species is currently known. For example, Xerces staff frequently observed ATV tracks from snowy plover predator control vehicles running through areas of *Cicindela* larval habitat. Predator control is a critical part of supporting western snowy plover recovery; however, at sites where this rare tiger beetle species is known to occur, a focused effort should be made to avoid areas of firm moist sand adjacent to stream channels that are their preferred habitat. Predator control employees could also be trained to identify adult tiger beetles, as well as larval burrows, so that the impacts from ATVs can be minimized.
- BLM/ISSSSP should develop specific management plans addressing habitat protection of *C. h. siuslawensis* for known *C. h. siuslawensis* sites on public lands, as well as for any applicable sites on USFWS lands where BLM and FS projects are planned or implemented.

Additional surveys

- The two historic *C. h. siuslawensis* sites not surveyed during this project that still appear to have suitable habitat should be visited.
- The survey sites that were indicated as having potential suitable habitat and meriting re-survey should be visited again. This includes sites that were surveyed during weather conditions that were not optimal for tiger beetle activity, and sites at which additional and/or more suitable potential habitat was inaccessible from the area surveyed.
- BLM/ISSSSP and USFWS should conduct additional surveys in areas of potential habitat on public and federal lands around lakes and seasonal wetlands with sandy shores and in dune habitat, and at sandbars up to 0.5-1 mile further upstream and inland of streams at or near known or historic sites.
- Because the largest known series of *C. h. siuslawensis* was collected at Waldport (from ~1925-1941), but no detailed locality was given beyond city and county, this region should be surveyed more exhaustively to know whether *C. h. siuslawensis*, as well as *L. oregonae*, has been locally extirpated.

- Based on Xerces' observations of *C. h. siuslawensis* at both the outflow and at the undisturbed upstream reaches of a river with high-quality habitat, additional surveys should be conducted at suitable sandbars up to 0.5-1 mile further upstream and inland of streams at or near known or historic sites.
- In light of reports of *C. h. siuslawensis* from sandy lake shores (including the historic Sand Lake site), areas of potential habitat around lakes and seasonal wetlands with sandy shores and in dune habitat should be surveyed.
- USFWS and BLM/ISSSSP should conduct surveys for *C. h. siuslawensis* in areas of suitable habitat that coincide with western snowy plover critical habitat in southern Washington and northern California. These surveys would provide a clearer picture of the status of *C. h. siuslawensis* throughout its entire reported historic range on the Pacific Coast, and indicate whether habitat protection for the endangered western snowy plover is providing a refuge for *C. h. siuslawensis*.

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- Oregon Parks and Recreation Department

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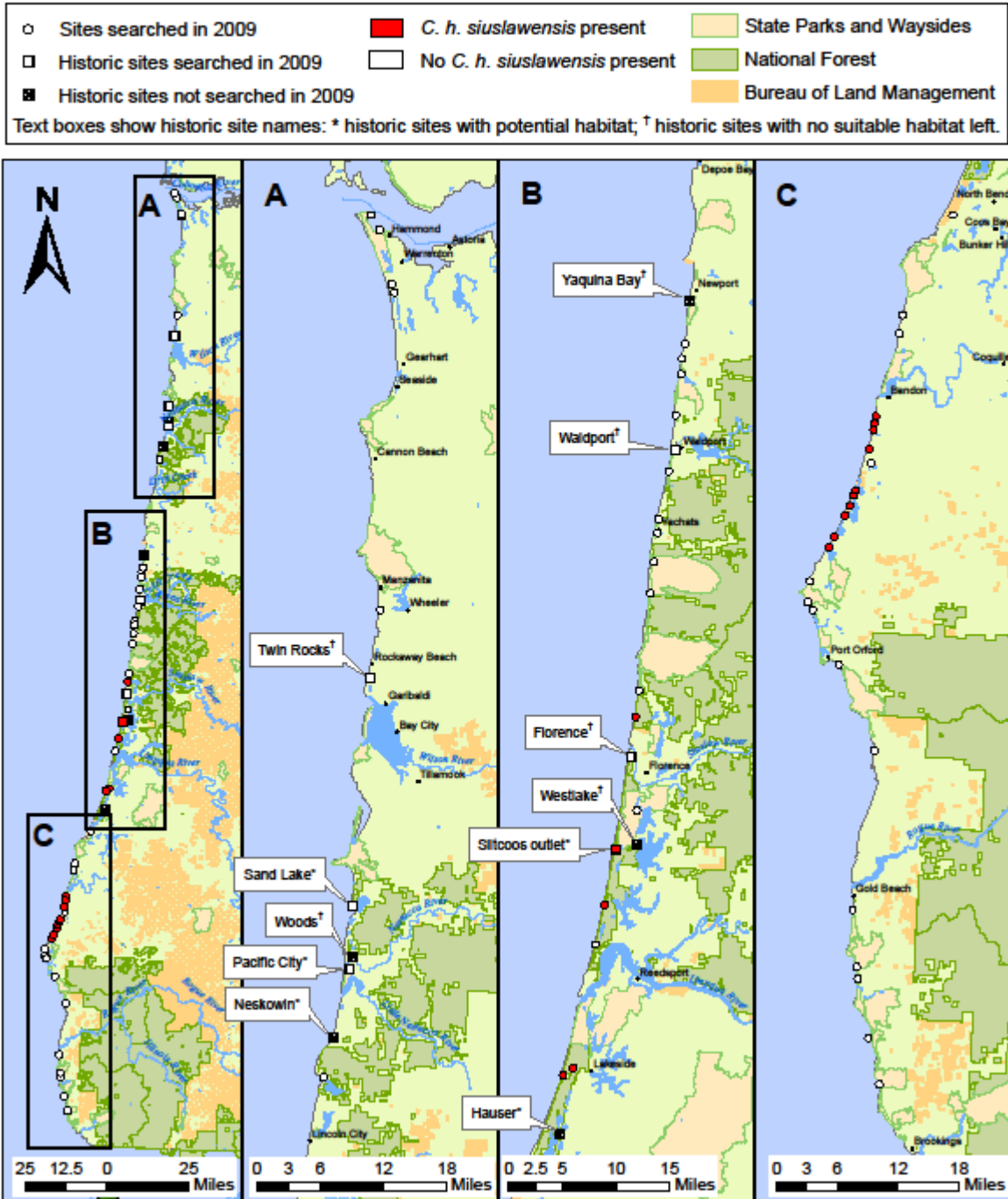
Appendix A. Historic collection localities of *C. h. siuslawensis* in Oregon

County	Locality	Date	Collection and number of specimens	Reference
Coos	Hauser	May 6, 1939	AMNH (1)	Graves <i>et al.</i> 1988
Lane	3 Mi. N. Florence	September 5, 1948	AMNH (17)	Graves <i>et al.</i> 1988 (holotype male)
Lane	Westlake	pre-1979	VC	Leffler 1979
Lane	Siltcoos outlet	5/18/1957	OSAC (1)	Specimen examined by S. Foltz, Xerces
Lane	Siltcoos outlet	5/19/1957	AMNH (1)	Graves <i>et al.</i> 1988
Lincoln	Waldport	-	ODA (1)	J. LaBonte pers. comm.
Lincoln	Waldport	9/27/1925	ODA (1)	J. LaBonte pers. comm.
Lincoln	Waldport	5/6/1928	ODA (1)	J. LaBonte pers. comm.
Lincoln	Waldport	7/7/1925	WJC (1)	Graves <i>et al.</i> 1988
Lincoln	Waldport	4/25/1926	WJC (1)	Graves <i>et al.</i> 1988
Lincoln	Waldport	7/5/1942	OSAC (5)	Specimen examined by S. Foltz, Xerces
Lincoln	Waldport	August 10, 1941	OSAC (3)	Graves <i>et al.</i> 1988
Lincoln	Waldport	July 23, 1934	RRMC (2)	Graves <i>et al.</i> 1988
Lincoln	Waldport	6/22/1930	OSAC (1)	Paratype
Lincoln	Waldport	8/6/1928	UWS (1)	Graves <i>et al.</i> 1988
Lincoln	Waldport	6/6/192+	AMNH (1)	Graves <i>et al.</i> 1988
Lincoln	Yaquina Bay, Newport	pre-1979	U. Nebraska	Leffler 1979
Lincoln	Yaquina Bay	September 8, 1907	AMNH (1), USNM (1)	Graves <i>et al.</i> 1988
Lincoln	Newport	July 17, 1921	USNM (1)	Graves <i>et al.</i> 1988
Tillamook	Neskowin	pre-1979	J. Knudsen coll.	Leffler 1979
Tillamook	Pacific City	June 26, 1938	AMNH (1)	Graves <i>et al.</i> 1988
Tillamook	Pacific City	May 26, 1934	RRMC (7)	Graves <i>et al.</i> 1988
Tillamook	Sand Lake	8/24/1941	OSAC (1)	Specimen examined by S. Foltz, Xerces
Tillamook	Twin Rocks	7/10/1940	OSAC (1)	Specimen examined by S. Foltz, Xerces
Tillamook	Woods	pre-1979	OSU	Leffler 1979

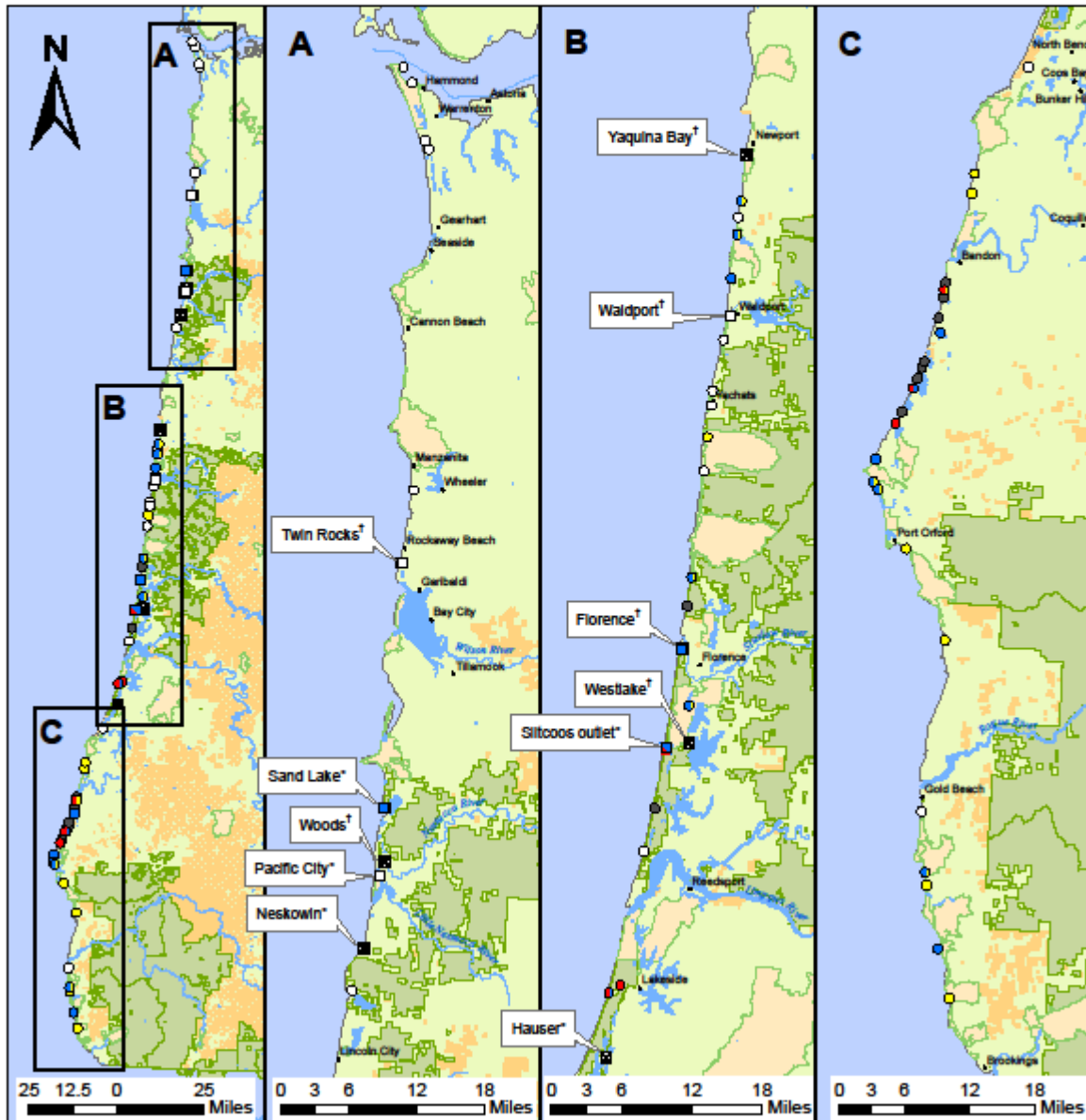
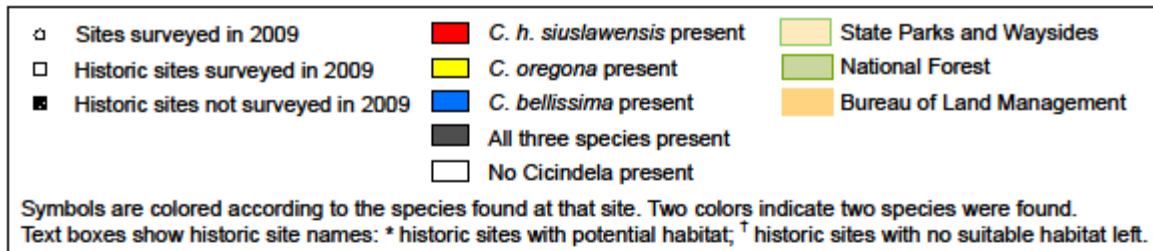
Appendix B. Survey maps

I. *C. h. siuslawensis*

Siuslaw hairy-necked tiger beetle *Cicindela hirticollis siuslawensis*



II. All *Cicindela* species



III. *Lygus oregonae* and host plants

Oregon plant bug *Lygus oregonae*

