

SPECIES FACT SHEET

Scientific Name: *Erpetogomphus compositus* (Hagen in Selys 1858)

Common Name: White-belted Ringtail

Phylum: Arthropoda

Class: Insecta

Order: Odonata

Suborder: Anisoptera

Family: Gomphidae (clubtails)

Conservation Status:

Global Status (1990): G5

Rounded Global Status: G5 - Secure

National Status: N5

State Statuses- Arizona (SNR), California (SNR), Idaho (SNR), Nevada (SNR), New Mexico (SNR), **Oregon (SNR)**, Texas (SNR), Wyoming (SNR). Utah ranks the species as SH (Possible extirpated, historical), and in **Washington** it is ranked as **S1** (Critically imperiled because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation).

(NatureServe 2008)

Technical Description:

Adult: Characteristic of the family Gomphidae, this species has small, widely separated eyes and enlarged posterior abdominal segments (often less apparent on females). The conspicuously pale-ringed abdomen and pale green thorax with four distinct dark stripes are diagnostic for this species (Paulson 1999). The thorax is whitish between one pair of stripes (Paulson 2007a). The wings are clear with a slight yellowing at their bases (Abbot 2007). Total length: 46-55 mm (1.8-2.2 in.); abdomen: 31-39 mm (1.2-1.5 in.); hindwing: 26-32 mm (1-1.3 in.). Additional descriptive information for the adult can be found at OdonataCentral:

<http://www.odonatacentral.org/index.php/FieldGuideAction.get/id/46076>
(last accessed 5 Oct. 2008).

Immature: *Erpetogomphus* in the Pacific Northwest can be identified by the following traits: prementum and palpal lobes flat (as opposed to cup-shaped), antennae 4-segmented, wing pads divergent, labium wide (maximum width more than half maximum width of head across eyes), tips of cerci extending at least 0.9 times (as opposed to 0.75 times) the distance to the tip of epiproct (Tennessen 2007). Species identification is difficult for a non-expert.

Life History:

Adult flight period varies by region: 19 June - 13 September in Oregon (Johnson and Valley 2005); 11 July -17 August in Washington (Paulson 2007b). The egg-laying strategy of this species involves hovering motionless

over water and tapping the abdomen to the water surface (Abbott 2007). Like all odonates, the majority of the life cycle is spent as aquatic larvae. Larvae are predators of aquatic animals, mainly insect larvae, while adults prey on flying insects. NatureServe (2008) designates sightings more than 3 kilometers apart as separate populations, but little is known about the dispersal and colonization ability of this species.

Range, Distribution, and Abundance:

Range-wide: Distribution extends from northwestern United States to northern Mexico. United States species records in: AZ, CA, ID, NM, NV, OR, TX, UT, WA, WY (NatureServe 2008).

Washington: Known from only Crab Creek, Grant Co., and the Yakima River, Benton Co. (Paulson 2007b).

Oregon: Primarily confined to areas east of the Cascade Range, up to 1370 m (4500 ft). Present in Gilliam, Grant, Harney, Malheur, Sherman, Wasco, and Wheeler counties (Abbott 2007). Particularly common along the John Day River in the Columbia Basin, a regional “hotspot” for lotic odonates. It has been found at many locations along the John Day River, from its confluence with Rock Creek, to at least its confluence with North Fork John Day River. The species is presumed to occur on the entire stretch of the river between these two locations, a great deal of which is inaccessible except by boat (Johnson 2008, *pers. comm.*). The species is also common at the Malheur and Owyhee Rivers (Johnson and Valley 2005). On the Owyhee River it has been found from Rome to Three Forks, and is presumed to occur on the entire stretch between these two locations but access is very difficult except by boat. It is unknown how far downstream from Rome, or upstream on the tributaries from Three Forks the species occurs, but it has been found at on Crooked Creek, a tributary of the Owyhee (Johnson 2008, *pers. comm.*).

Forest Service/BLM lands: Washington: No known occurrences on BLM or FS lands, although one of the two known Washington documentations was in close proximity (650m, 2100 ft.) to BLM land, just east of the Yakima River (Spokane District). Oregon: Documented on BLM land in the Prineville District (Central Oregon Resource Area, John Day River) and Vale District (Jordan and Malheur Resource Areas, Malheur and Owyhee Rivers). The species is likely to occur in the Malheur and Ochoco National Forests, since rivers running through these forests have records of the species at close proximity. The species is also suspected to occur on BLM land in the Burns District, Andrews Resource Area.

Habitat Associations:

The genus is generally known from lotic, depositional habitats with fine sediments (Merritt *et al.* 2008). The Washington collection records were in sandy streams and rivers (Paulson 2007b). This species inhabits desert

streams, creeks and irrigation ditches with wide sandy or rocky margins in the Southwest (Abbott 2007). Often seen perched on sandbars of streams, and in shady, more protected areas in the late afternoon (Abbott 2007). The larvae are burrowers (Merritt *et al.* 2008).

Threats:

Habitat disturbance and degradation are the main threats to this species. The larvae of this species require fine substrate for normal burrowing behavior. Road construction, building construction, and logging related activities in the watershed degrade aquatic substrate through increased erosion and sediment delivery (Rothrock *et al.* 1998). The loss of trees through timber harvest poses additional threats, since trees provide (1) shade that maintains lower water temperatures for larvae and (2) foraging and nighttime roosting areas for adults (Packauskas 2005).

In Oregon (where this species is not ranked), cattle grazing and agriculture activities in occupied watersheds pose the greatest threat to this species. Both the Malheur and Owyhee Basins support intense agricultural activities, including irrigated row crops, rangeland, and confined animal feeding operations (CAFOs) (Cude 2008). Degraded water quality, including high levels of total phosphates, biochemical oxygen demand, ammonia, nitrate nitrogen, and fecal coliform bacteria, has been reported in both of these rivers, and irrigation withdrawals, fertilizers and animal waste breakdown products have been identified as the major sources of contamination (Cude 2008). While the upper course of the John Day River has protection under two important river preservation programs (the National Wild and Scenic Rivers Act and the Oregon Scenic Waterways Act), the lower course, including stretches where this species has been found, is used for crop irrigation and ranching (BLM 2008). Dewatering of aquatic systems can have dramatic impact on habitat and communities by decreasing water depth, increasing sedimentation, and altering water temperature and chemistry (*reviewed in* Dewson *et al.* 2007). Grazing by livestock not only reduces the amount of vegetation available for perching and emerging, but also has deleterious impacts on water quality, including increases in nutrient levels due to introduction of livestock waste material into waters, and increases in temperature, sediment, and turbidity due to trampling and bank alteration (Agouridis *et al.* 2005, *reviewed in* Mazzacano and Black 2008). The soils in this species' habitat, including both the lower Malheur Basin and lower Owyhee Basin, are fine-grained flood plain deposits, prone to erosion, and aggravated in some areas by livestock and poor farming practices (Cude 2008). Chemical pollution has been recognized as a threat to members of this family (Paulson 2008, *pers. comm.*), and insecticides, herbicides, and other pollutants carried in agricultural run-off and wind drift may have serious consequences for the reproductive potential and long-term survival of this species.

Global climate change may further threaten the long-term survival of this species. Projected changes in this region include increased frequency and severity of seasonal flooding and droughts, reduced snowpack to feed river flow, increased siltation, and increased air and water temperatures (Field *et al.* 2007), all of which could impact this species' habitat unfavorably. Moreover, since many aspects of odonate survival (e.g. development, phenology, immune function, pigmentation, and behavior) are sensitive to changes in temperature, global climate change is predicted to have serious consequences on this taxon (Hassall and Thompson 2008).

It is not known if disease and predation are serious threats to this species, but stocking of non-native fish species for commercial or recreational purposes could negatively impact population survival, since the larvae may not be adapted to co-exist with such predators.

Conservation Considerations:

Inventory: Since this species is known from many areas in Oregon but only a few limited sites in Washington, Washington surveys are more pressing at this time. Surveys for new populations should be concentrated in southern Washington, since central Washington represents the extreme northwestern edge of this species' range. Since population size is important in evaluating the stability of a species at a given locality, abundance estimates for this species at new and recorded sites would assist future conservation efforts.

Management: Protect known sites and their associated watersheds from management practices that would adversely affect any aspect of the odonate life-cycle. Since the largest proportion of an odonate's life is spent as an aquatic larva, protecting the larval stage is most critical for the species' success (Packauskas 2005). Maintain water quality and water levels at known sites and in other potential habitat in Washington. Focus fish management on retention of the native species with which the insect community is adapted to co-exist; avoid or minimize non-native species stocking. Adaptive land management practices, such as conserving and restoring riparian buffers around known aquatic habitats and fencing to exclude livestock, may help protect this species from the impacts of grazing and agriculture (Packauskas 2005).

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ATTACHMENTS:

- (1) References**
- (2) List of pertinent or knowledgeable contacts**
- (3) Maps of Global Range/Conservation Status and Oregon/Washington Distribution**
- (4) Odonata (Anisoptera) Survey Protocol, including specifics for this species**
- (5) Photographs of Adult (lateral and dorsal view) and Larva (dorsal view)**

ATTACHMENT 1: References:

Abbott, J.C. 2007. "*Erpetogomphus compositus*." OdonataCentral: An online resource for the distribution and identification of Odonata. 2007. *Texas Natural Science Center, The University of Texas at Austin* 3 Oct. 2008
<<http://www.odonatacentral.org/index.php/FieldGuideAction.get/id/46076>>.

Agouridis, C.T., Workman, S.R., Warner, R.C., and Jennings, G.D. 2005. Livestock grazing management impacts on stream water quality: a review. *Journal of the American Water Resources Association*. 41 (3): 591-606.

BLM, 2008. "John Day River Study" 28 Oct. 2008
<<http://www.blm.gov/or/districts/prineville/plans/johndayriverstudy/>>.

Cude, C. 2008. "Oregon Water Quality Index Report for the Malheur and Owyhee Basins." *Oregon Department of Environmental Quality* 27 Oct. 2008
<<http://www.deq.state.or.us/lab/wqm/wqindex/malowy3.htm>>.

Dewson, Z.S., James, A.B.W., and R.G. Death. 2007. A review of the consequences of decreased flow for instream habitat and macroinvertebrates. *Journal of the North American Benthological Society* 26(3): 401-415.

Field, C.B., Mortsch, L.D., Brklacich, M., Forbes, D.L., Kovacs, P., Patz, J.A., Running, S.W. and M.J. Scott. 2007. Chapter 14: North America. *In: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J. and Hanson, C.E., eds.). Cambridge University Press, Cambridge, UK. Available at: www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter14.pdf.

Hassall, C. and D.J. Thompson. 2008. The effects of environmental warming on Odonata: a review. *International Journal of Odonatology* 11(2): 131-153.

Johnson, Jim. 2008. Personal communication with Sarah Foltz.

Johnson, J. and S. Valley. 2005. The Odonata of Oregon. *Bulletin of American Odonatology* 8(4): 101-122.

Mazzacano, C. and S.H. Black. 2008. Petition to emergency list Susan's Purse-making Caddisfly (*Ochrotrichia susanae*) as an endangered species under the U.S. Endangered Species Act. 8 July 2008. *Xerces Society for Invertebrate Conservation*. 28 Oct. 2008.

<http://www.xerces.org/Endangered/Xerces_Society_Susan%27s_caddisfly_petition_July_8_2008.pdf>

Merritt, R.W., Cummins, K.W., and M.B. Berg. 2008. An introduction to the aquatic insects of North America. Fourth Edition. Kendall/Hunt Publishing Co., Dubuque, Iowa. 1158pp.

NatureServe. 2008. "*Erpetogomphus compositus*." *NatureServe Explorer: An online encyclopedia of life [web application]*. Feb. 2008. Version 7.0.

NatureServe, Arlington, Virginia. 6 Oct. 2008

<<http://www.natureserve.org/explorer/>>

Packauskas, R.J. "Hudsonian Emerald Dragonfly (*Somatochlora hudsonica*): a technical conservation assessment." 24 Aug. 2007. *USDA Forest Service, Rocky Mountain Region*. 16 Oct. 2008

<<http://www.fs.fed.us/r2/projects/scp/assessments/hudsonianemeralddragonfly.pdf>>

Paulson, D. 1999. Dragonflies of Washington. Seattle Audubon Society, Seattle 31pp.

Paulson, D. 2007a. "Washington Odonata." *Slater Museum of Natural History*. Oct. 2007. University of Puget Sound. 6 Oct. 2008

<<http://www.ups.edu/x7041.xml>>.

Paulson, D. 2007b. "Field Key to Adult Washington Dragonflies (Odonata)." *Slater Museum of Natural History*. Jan. 2007. University of Puget Sound. 2 Oct. 2008

<<http://www.ups.edu/x6518.xml>>.

Paulson, Dennis. 2008. Personal communication: E-mail exchange with Sarah Foltz regarding Pacific Northwest odonates.

NatureServe. 2008. "*Erpetogomphus compositus*." *NatureServe Explorer: An online encyclopedia of life [web application]*. Feb. 2008. Version 7.0.

NatureServe, Arlington, Virginia. 6 Oct. 2008
<<http://www.natureserve.org/explorer/>>.

Rothrock, J. A., Barten P. K., and Ingman, G. L. 1998. Land use and aquatic biointegrity in the Blackfoot River watershed, Montana. *Journal of the American Water Resources Association* 34 (3): 565-581.

Tennessen, K. 2007. Odonata Larvae of the Pacific Northwest: An Identification Manual. Created for use in a taxonomic workshop sponsored by the Xerces Society and held at Evergreen State College, Olympia, Washington, March 16-18, 2007.

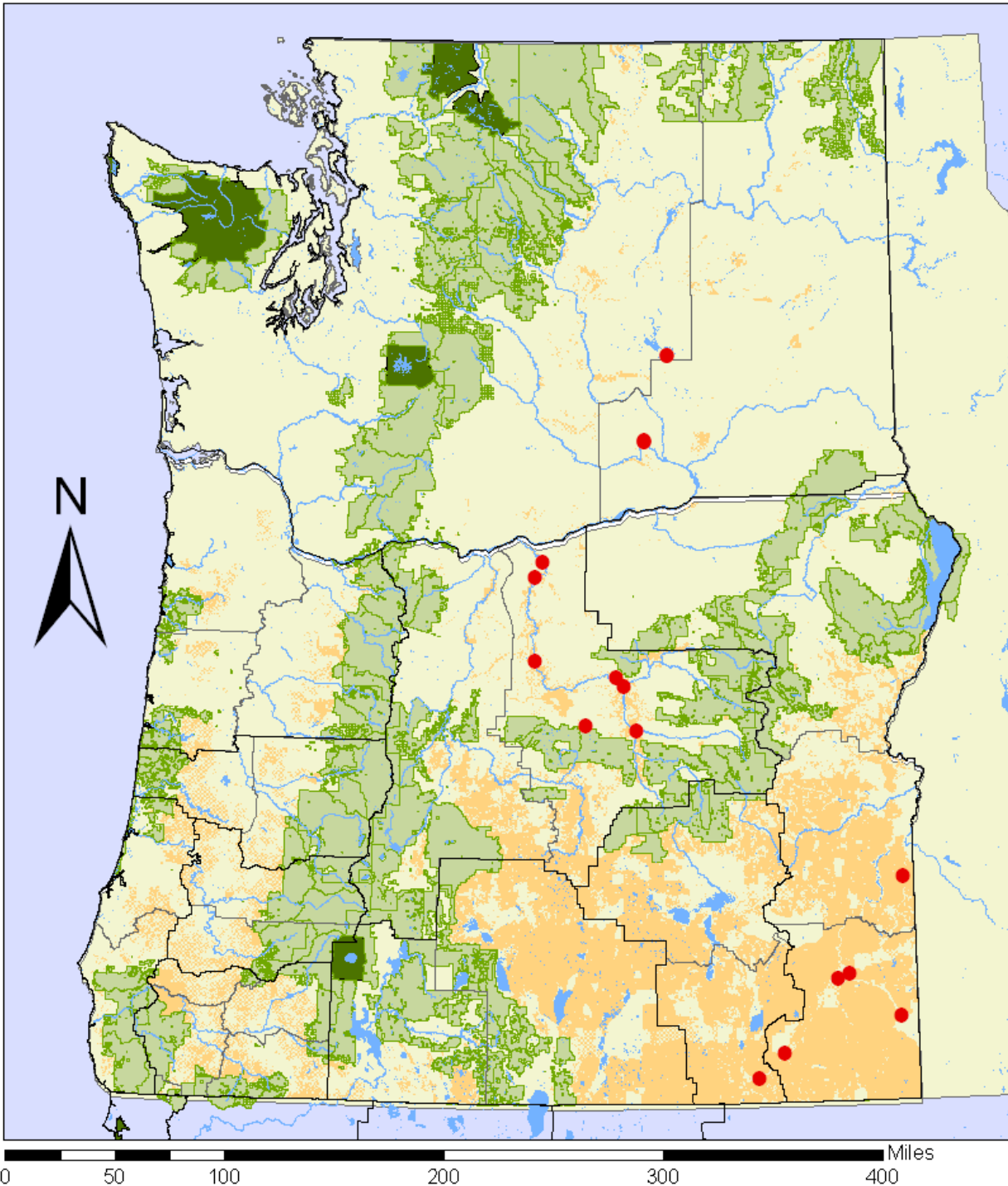
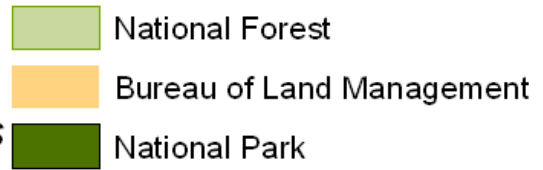
ATTACHMENT 2: List of pertinent, knowledgeable contacts:

Dennis Paulson
Steve Valley
Ken Tennessen
John Abbott
Jim Johnson

ATTACHMENT 3: Maps of Global Range/Conservation Status and Oregon/Washington Distribution:

Odonata

• *Erpetogomphus compositus*



Records of *Erpetogomphus compositus* in Washington and Oregon, relative to Forest Service and BLM lands. BLM District boundaries are shown in black, and Resource Area boundaries are shown in grey.

ATTACHMENT 4: Photographs of Adult (dorsal and lateral views) and larva (dorsal view):



Erpetogomphus compositus adult, lateral view. Photograph by Dennis Paulson.



Erpetogomphus compositus male, dorsal view. Female coloration is nearly identical to the male. Photograph (digital scan in life) by Dennis Paulson.



Erpetogomphus compositus larval exuvia (the exoskeleton shed by the final-instar as it emerged as an adult), dorsal view. The larvae of this species look very similar to the exuviae. Photograph (digital scan) by Dennis Paulson.

ATTACHMENT 5: Odonata (Anisoptera) Survey Protocol, including specifics for this species:

Survey Protocol

Taxonomic group:

Odonata

Species:

Erpetogomphus compositus

Where:

Adult odonates can be found feeding in range of terrestrial habitats, but are most effectively sampled at the aquatic habitat where they mate and oviposit. Ponds, streams, rivers, lake shores, marshes, bogs, and fens support a range of odonate diversity. Some species (e.g. *Gomphus kurilis*) frequent a variety of habitats, while others (e.g. *Leucorrhinia borealis*) have highly specific preferences with regard to substrate, vegetation, and water quality. For species-specific habitat information, see the section at the end of this protocol.

When:

Adults are surveyed in summer, during the often-short window of their documented flight period. Adult odonates are most active in warm temperatures, and usually begin to fly at the aquatic habitat with the morning sun. Depending on the species, males arrive as early as 9 am and leave as late as 6 pm. Females tend to arrive several hours later, after the males have established their mating territories (Campanella 1975). In the high temperatures of the late afternoon, some species seek shade in trees and vegetation.

Although larvae are present all summer, it is preferable to sample later in the season (i.e. just prior to and during the early part of adult emergence), when a higher proportion of the more easily identified late larval instars will be found.

Adult Surveys:

Use a long-handled, open-mesh aerial net, light enough to be swung rapidly. Triplehorn and Johnson (2005) recommend a 300-380 mm diameter net with a handle at least 1 m long.

Approach the site quietly, observing the environment and natural behaviors occurring prior to sampling. Note the number of different species present, and what their flight patterns are. This will help in predicting the movement of target species, and in evaluating whether the site has been surveyed “exhaustively” (i.e. all species observed at the site have been collected or photodocumented). Since dragonflies are wary of humans and readily leave an area when disturbed, it is important to be as discreet in your movements as possible, at all times.

Watch vegetation, logs, tree-trunks, and large, flat rocks for perched individuals, particularly those in the Gomphidae and Libellulidae families. Since dragonflies are powerful fliers and notoriously challenging to catch, try to quietly photo-document specimens prior to attempting to capture. Use a camera with good zoom or macrolens, and focus on the aspects of the body that are the most critical to species determination (i.e. dorsum of abdomen, abdominal terminalia (genitalia), pleural thoracic markings, wing markings, eyes and face). For helpful tips, see the article “Photographing Dragonflies”

(Nikula 1997) available at: <http://www.odenews.org/PhotoArticle.htm> (last accessed: 25 Oct. 2008).

When stalking perched individuals, approach slowly from behind, covering your legs and feet with vegetation, if possible (dragonflies see movement below them better than movement at their level). When chasing, swing from behind, and be prepared to pursue the insect. A good method is to stand to the side of a dragonfly's flight path, and swing out as it passes. After capture, quickly flip the top of the net bag over to close the mouth and prevent the insect from escaping. Once netted, most insects tend to fly upward, so hold the mouth of the net downward and reach in from below when retrieving the specimen. Collected specimens should be placed on ice in a cooler long enough to slow their movement (a few minutes), and then set on a log or stone and comprehensively photographed until the subject starts to stir. Specimens to be preserved should be placed alive, wings folded together, in glassine or paper envelopes, as they lose color rapidly once killed. Record the eye color and locality/collection data on the envelope, including longitude and latitude if possible.

Acetone, which helps retain bright colors, is recommended for killing odonates. Glassine envelopes with the lower corner clipped and the specimen inside should be soaked in acetone for 24 hours (2 to 4 hours for damselflies) and then removed, drained, and air-dried. The resulting specimens are extremely brittle, and can be stored in envelopes, pinned with wings spread, or pinned sideways to conserve space. Mating pairs in tandem or copula should be indicated and stored together, if possible. Collection labels should include the following information: date, time of day, collector, detailed locality (including water-body, geographical coordinates, mileage from named location, elevation, etc.), and detailed habitat/behavior (e.g. "perched on log near sandy lake shore"). Complete determination labels include the species name, sex (if known), determiner name, and date determined.

Relative abundance surveys can be achieved by timed watches at designated stations around a site. We recommend between 5 and 10 stations per site, each covering one square meter of habitat, and each monitored for 10 to 15 minutes. Stations should be selected in areas with the highest odonate usage, and spread out as evenly as possible throughout the site. During and one minute prior to the monitoring period, observers should remain very still, moving only their eyes and writing hand. Recorded information should include start and end times, weather, species, sex, and behavior (e.g. male-male interaction, pair in tandem). Observations occurring near, but outside of, the designated station should be included but noted as such.

Catch and marked-release methods can help evaluate population sizes, species life-span, and migration between sites. This strategy (most appropriate if

several sites are being surveyed repeatedly throughout a season) involves gently numbering the wing with a fine-tip permanent marker before release.

Larval Surveys:

When surveying for larvae, wear waders, and use care to avoid disrupting the stream banks, vegetation, and habitat. Depending on the habitat, a variety of nets can be useful. D-frame nets are the most versatile, as they can be used in both lotic and lentic habitats. Kick-nets are only useful when sampling stream riffles, and small aquarium nets are most effective in small pools. If desired, relative abundance between sites or years can be estimated by standardizing sampling area or sampling time. When the use of a D-frame net is not feasible (e.g. in areas that have very dense vegetation, little standing water, and/or deep sediment), an alternative sampling device, such as a stovepipe sampler, can be used. This cylindrical enclosure trap (~34 cm in diameter and 60 cm in height) is quickly forced down through the water/vegetation and firmly positioned in the bottom substrate. Material and organisms are then removed by hand using small dip nets (Turner and Trexler 1997).

Net contents are usually dumped or rinsed into shallow white trays to search for larvae more easily, as they are quite cryptic and can be difficult to see if they are not moving. White ice-cube trays may also aid in field sorting. Voucher collection should be limited to late instar larvae, which can be most readily identified. If necessary, early instars can be reared to later stages or adulthood in screened buckets/aquaria with tall grasses added for emergence material. However, since the rearing process often takes many trials to perfect, it is only recommended if knowledge of species' presence-absence status at a particular site is critical, and few-to-no late instars or adults are found.

Voucher specimens can be either (1) preserved on-site in sample vials filled with 80% ethanol, or (2) brought back from the field in wet moss/paper-towels, killed in boiling water, cooled to room temperature, and transferred to 80% ethanol. Although the latter method is more time intensive, it is recommended for maximum preservation of internal anatomy (Triplehorn and Johnson 2005). Live specimens should be separated by size during sorting to reduce cannibalism/predation.

Although easily overlooked, larval exuviae left on rocks, sticks, or vegetation on which the adult emerged are valuable for species documentation. These cast-off exoskeletons of the final larval instar can be identified to species using larval traits, and offer a unique, conservation-sensitive sampling method for odonates (Foster and Soluk 2004). Since exuviae indicate the presence of successful breeding populations at a particular locale, their habitat data can be very informative, and should be documented with as much care as that of larvae and adults.

Species-specific survey details:

Erpetogomphus compositus

Since this species appears relatively well-established in Oregon, surveys in Washington are more pressing at this time. The known Washington records are from sandy streams and rivers, but the species is recorded elsewhere from creeks and irrigation ditches with wide sandy or rocky margins (Abbott 2007a).

Sites should be surveyed at midday, between June and August, and approached quietly in search of perched adults. Members of this family are frequently found sitting in the open on sandy beaches, rocks, or shoreline leaves, but tend to be quite skittish and, when disturbed, rarely return to the same perch (Nikula 1997). This species is often seen perched on sandbars of streams, and in shady, more protected areas in the late afternoon (Abbott 2007a). The larvae burrow in fine substrate (Merritt *et al.* 2008).

While researchers are visiting sites and collecting adults and exuviae, detailed habitat data should also be acquired, including substrate type, water source, water velocity, and presence/use of canopy cover (Packauskas 2007).

References (Survey Protocol Only):

Abbott, J.C. 2007a. "*Erpetogomphus compositus*." OdonataCentral: An online resource for the distribution and identification of Odonata. 2007. *Texas Natural Science Center, The University of Texas at Austin* 3 Oct. 2008 <<http://www.odonatacentral.org/index.php/FieldGuideAction.get/id/46076>>.

Campanella, P.J. 1975. The evolution of mating systems in temperate zone dragonflies (Odonata: Anisoptera) II: *Libellula luctuosa* (Burmeister). *Behaviour* 54: 278-310.

Foster, S.E. and D.S. Soluk. 2004. Evaluating exuvia collection as a management tool for the federally endangered Hine's emerald dragonfly, *Somatochlora hineana* Willaimson (Odonata: Cordulidae). *Biological Conservation* 118: 15-20.

Merritt, R.W., Cummins, K.W., and M.B. Berg. 2008. An introduction to the aquatic insects of North America. Fourth Edition. Kendall/Hunt Publishing Co., Dubuque, Iowa. 1158pp.

Nikula, B. 1997. "Photographing Dragonflies" 13 September 1997 *Ode News*. 22 Oct. 2006 <<http://www.odenews.org/PhotoArticle.htm>>.

Packauskas, R.J. "Hudsonian Emerald Dragonfly (*Somatochlora hudsonica*): a technical conservation assessment." 24 Aug. 2007. *USDA Forest Service, Rocky Mountain Region*. 16 Oct. 2008

<http://www.fs.fed.us/r2/projects/scp/assessments/hudsonianemeralddragonfly.pdf> >

Paulson, D. 2008. Personal communication. E-mail exchange with Sarah Foltz regarding Pacific Northwest odonates.

Triplehorn, C. and N. Johnson. 2005. Introduction to the Study of Insects. Thomson Brooks/Cole, Belmont, CA. 864pp.

Turner, A.M. and J.C. Trexler. 1997. Sampling Aquatic Invertebrates from Marshes: Evaluating the Options. Journal of the North American Benthological Society 16(3): 694-709.