PETITION TO LIST
THE STRAIGHT SNOWFLY (*Capnia lineata* Hanson, 1943**)**
AND
THE IDAHO SNOWFLY (*Capnia zukeli* Hanson, 1943**)**

AS ENDANGERED SPECIES
UNDER THE U.S. ENDANGERED SPECIES ACT

Winter snowfly (unidentified).
Photograph by Dan White, used with permission.

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The Xerces Society for Invertebrate Conservation

Submitted by
The Xerces Society for Invertebrate Conservation and Friends of the Clearwater
June 9, 2010

The Honorable Kenneth Salazar
Secretary of the Interior
Office of the Secretary
Department of the Interior
1849 C Street N.W.
Washington D.C., 20240

Dear Mr. Salazar:

The Xerces Society for Invertebrate Conservation and Friends of the Clearwater National Forest hereby formally petition the U.S. Fish and Wildlife Service to list both the straight snowfly (*Capnia lineata*) and the Idaho snowfly (*Capnia zukeli*) as endangered pursuant to the Endangered Species Act, 16 U.S.C. §§ 1531 *et seq*. This petition is filed under 5 U.S.C. § 553(e) and 50 C.F.R. § 424.14 (1990), which grants interested parties the right to petition for issue of a rule from the Secretary of the Interior. Petitioners also request that critical habitat be designated concurrent with the listing, as required by 16 U.S.C. § 1533(b)(6)(C) and 50 C.F.R. § 424.12, and pursuant to the Administrative Procedure Act (5 U.S.C. § 553).

We are aware that this petition sets in motion a specific process placing definite response requirements on the U.S. Fish and Wildlife Service and very specific time constraints upon those responses. 16 U.S.C. § 1533(b).

Sincerely,

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The Xerces Society is a nonprofit organization that protects wildlife through the conservation of invertebrates and their habitat. Established in 1971, the Society is at the forefront of invertebrate protection worldwide, harnessing the knowledge of scientists and the enthusiasm of citizens to implement conservation programs.

Friends of the Clearwater defends the Idaho Clearwater Bioregion's wildlands and biodiversity through a Forest Watch program, litigation, grassroots public involvement, outreach, and education. The Wild Clearwater Country, the northern half of central Idaho's Big Wild, contains many unprotected roadless areas and wild rivers and provides crucial habitat for countless rare plant and animal species.

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I. EXECUTIVE SUMMARY

Both the straight snowfly (*Capnia lineata*) and the Idaho snowfly (*Capnia zukeli)* are in imminent danger of extinction. Known solely from a small network of streams and creeks in Latah County, Idaho, on private land and the Palouse Ranger District of the Clearwater National Forest, these endemic and highly sensitive animals are threatened by habitat loss and degradation as well as climate change. The threats include (1) increased stream sediment and high stream temperatures caused by timber operations, (2) increased sediment, fertilizer and pesticide pollution from agricultural crop production, (3) cattle grazing in an along the stream areas, (4) altered stream flow conditions from management of water levels at Spring Valley Reservoir, and (5) increased sedimentation, nutrients, and water temperature from development, including runoff from streets and discharges from Waste Water Treatment Plants. These stressors, in combination with the species' limited ranges, limited dispersal ability, the inherent instability of small populations, and observed and projected stream water temperature and flow changes due to global climate change, collectively threaten these rare species with extinction. The straight and Idaho snowflies should be given immediate protection under the Endangered Species Act ("ESA").

II. CANDIDATE BACKGROUND, STATUS, AND LISTING HISTORY

Neither the straight nor the Idaho snowfly currently receive any federal protection. Both species are rated by the Idaho Conservation Data Center (IDCDC) as S1 (Critically Imperiled; at high risk of range wide extinction or extirpation due to extreme rarity, rapidly declining numbers, or other factors) (IDCDC, n.d.). The Nature Serve global rankings for these species are G2 (Imperiled) for the Idaho snowfly and G3 (Vulnerable) for the straight snowfly (NatureServe, 2009a,b), but these rankings are expected to change to reflect both the IDCDC statewide rankings, and the recent information that the straight snowfly is endemic to Idaho and is not known from California (Cordeiro & Capuano, pers. comm., March 2010). The straight snowfly had been reported from a single site in California by Jewett (1960), but R. Baumann confirms that this record was erroneous and that the straight snowfly does not occur in California (Baumann, pers. comm., December 2009).

III. SPECIES DESCRIPTION

Stoneflies (order Plecoptera) are somewhat flattened, elongate, soft-bodied insects with filamentous antennae, large compound eyes, and two sensory tails (cerci) projecting from the end of the abdomen. Stonefly adults are generally characterized by having two pairs of membranous, heavily cross-veined wings, although adults of a few species (including the straight and Idaho stoneflies) have wings that are reduced (brachypterous) or absent (apterous), usually seen in males of the species (Nelson & Baumann, 1989; Stark *et al.*, 1998). Since stoneflies exhibit incomplete metamorphosis, the aquatic nymphs have many of the same features of the adult, including the paired cerci, and differ mainly in the lack of wings.

Both the straight and Idaho snowflies are small, dark-bodied stoneflies in the family Capniidae and genus *Capnia.* Members of the Capniidae family, commonly known as snowflies or small winter stoneflies, are separated from other families by the long, four-segmented cerci (tails) and unique characteristics of the mouthparts and tarsi (last segments of the legs) (Stewart & Stark, 2008). Adults of the *Capnia* genus are distinguished from other genera in the family by several characteristics, including the pattern of wing venation and the form of the male epiproct (intromittent organ) (Nelson & Baumann, 1989; Stark *et al.* 1998). *Capnia* nymphs are distinguished from other genera in the Capniidae family by the presence of notches halfway along the inner margins of the hind wingpads and the lack of deep serrations at the base of the ventral tooth of the right mandible (Stewart & Stark, 2002, Stewart & Stark, 2008). At the species level, nymphs in this genus are frequently undescribed, and no attempt has been made to describe the nymphs of either of these species (Nelson & Baumann, 1989).

A. *Capnia lineata* (the straight snowfly)
Capnia lineata belongs to the Vernalis species-group in the genus *Capnia* which includes two other species, *C. confusa* and *C. vernalis*. The males of *C. lineata* most closely resemble *C. confusa*, but are distinguished by the relatively long epiproct of *C. lineata* (0.70 mm (0.03 in.) in length) (Hanson, 1943; Nelson & Baumann, 1989). The females of *C. confusa* and *C. lineata* are separated by the presence of vestiges of a sclerotized bridge between sternites 7 and 8 in *C. lineata* (Nelson & Baumann, 1989). *Capnia lineata* males are 5 mm (0.2 in.) in length, with forewings that are 0.5 mm (0.02 in.) in length (Hanson, 1943). The larger females are 7 to 8 mm (0.28 to 0.31 in.) in length, with forewings that are also 7 to 8 mm (0.28 to 0.31 in.) in length (Hanson, 1943). All examined males of this species have reduced, unveined forewings, about the size of the wing pads of normal immature *Capnia* (Hanson, 1943; Nelson & Baumann, 1989). The wings of males of the other two species in the Vernalis group are longer (Nelson & Baumann, 1989).

B. *Capnia zukeli* (the Idaho snowfly)
Capnia zukeli is unplaced in regard to a species group. Adults are similar in general morphological details to other *Capnia* species (Hanson, 1943), but are distinguished by the lack of knobs or processes on the dorsal (top) surface of abdominal segments, the extremely reduced wings (brachyptery) in males, and the extremely long male epiproct, which is sharply recurved over the abdomen, has a length of 1.35 mm (0.05 in.), and is almost 30 times as long as it is wide (Nelson & Baumann 1989; Stark *et al.*, 1998). Males of this species are 7 mm (0.28 in.) in length, with forewings that are 2 mm (0.08 in.) in length (Hanson, 1943). The larger females are 9 mm (0.35 in.) in length, with forewings that are 7.8 mm (0.31 in.) in length (Nelson & Baumann, 1989). The females lack a medial bridge between abdominal segments 7 and 8, a characteristic that can be used to distinguish them from females of some other closely related species in this genus (Nelson & Baumann, 1989). In addition, the female subgenital plate has a straight and recessed hind margin, and the muscle insertions lateral to the posterior margin are darkly colored (Nelson & Baumann, 1989).

IV. TAXONOMY

Capnia zukeli and *C. lineata* were both originally described by John F. Hanson in the same paper in 1943. Baumann *et al.* (1977) considered *C. zukeli* a synonym of *C. lineata*, however, examination of the type specimens and definite association of the male and female of both species clearly indicated the occurrence of two distinct taxa in Latah County (Nelson & Baumann 1989). The specific statuses of *C. lineata* and *C. zukeli* are valid and uncontested (Nelson & Baumann, 1989; Stark *et al.*, 2009).

V. POPULATION DISTRIBUTION AND STATUS

A. Historic Distribution (APPENDIX I: Table 1; Figures 1, 2, 3).

i. *Capnia lineata*
The range and abundance of the straight snowfly (*Capnia lineata*) is not known prior to 1911 when the first known specimens (1 male, 27 females) were collected at “Troy, Idaho,” the type locality for this species (Hanson, 1943). This species is endemic to Latah County, northern Idaho, where it has been collected from

eight waterbodies in the Potlatch watershed: Big Bear Creek, Little Bear Creek, West Fork Little Bear Creek, Little Boulder Creek, Hog Meadow Creek, Potlatch River, Spring Valley Creek, Spring Valley Reservoir) and three waterbodies in the Palouse watershed (Lost Creek, Robinson Lake, and South Fork Palouse River). More generally, this species is also recorded from "Troy," "Moscow," and a few vague localities east and northeast of Moscow. Since these species are lotic (flowing water), not lentic (still water), it is worth noting that the Spring Valley Reservoir sighting was in the immediate area of where the Reservoir flows into Spring Valley Creek, and the Robinson Lake sighting was very near where the lake (now drained) flowed into the South Fork Palouse River (Biggam, pers. comm., Feb. 2010). *Capnia lineata* has also been reported from a single site in California (Jewett, 1960), but further work has revealed that this was a misidentification and the species does not occur in California and is endemic to Idaho (Baumann, pers. comm., Dec. 2009). Although abundance estimates are not known to have been made at any site, collections of this species range from as few as one adult to as many as 87 adults at a single location and date (Baumann, pers. comm., Dec. 2009). Based only on the number of individuals collected, the most abundant populations appear to have been from Spring Valley Creek (1985), Little Boulder Creek (1989), and West Fork Little Bear Creek (1969).

ii. *Capnia zukeli*

The range and abundance of the Idaho snowfly (*Capnia zukeli*) is not known prior to 1938 when the first known specimens (1 male, 1 female) were collected at "Moscow, Idaho," the type locality for this species (Hanson, 1943). *Capnia zukeli* is endemic to Latah County, where it has been found at three rivers in the Potlatch watershed (Little Boulder Creek, Potlatch River, and Spring Valley Creek, at the same sites as *Capnia lineata*) and one river in the Palouse watershed (Palouse River). More generally, this species is also recorded from "Moscow," "Moscow Mountain," and "Troy Creek"; the latter may refer to a creek in the Troy area, as Troy Creek isn't known to exist (Stephens, pers. comm., Jan. 2010). Although abundance estimates are not known to have been made at any site, collections of this species range from as few as one to as many as 89 adults at a single location and date (Baumann, pers. comm., Dec. 2009). Based only on the number of individuals collected, the most abundant populations appear to have been from the Potlach River at Hog Meadows Creek (1985) and Little Boulder Creek (1985).

B. Current Distribution

Although no known targeted surveys for these species have been conducted in recent years, neither species has been observed or collected since the 1980's (Baumann, pers. comm. Feb 2010; Biggam, pers. comm. Feb. 2010; Nelson, pers. comm. Feb 2010; Zack, pers. comm. Feb 2010). Due to heavy land use in the watersheds and well-documented water-quality impairment in the streams within the historic ranges of these species, both the number and abundance of populations of these species are likely to have declined.

VI. HABITAT REQUIREMENTS

A. Overview

Capnia lineata and *C. zukeli* belong to the winter stonefly family (Capniidae), which differs from other stonefly families in that the adult emergence period is from late winter to early spring. Although related *Capnia* species have been found in lower elevational warmer lotic (running) water and cold lentic (still) water, most winter stoneflies, including *C. lineata* and *C. zukeli,* are typically found in montane cold, clean, well-oxygenated, running water habitats (Baumann, 1979; Stewart & Stark, 2002; Stewart & Stark, 2008). Stoneflies are considered to be one of the most sensitive indicators of water quality in streams and are frequently used as sentinel organisms in biomonitoring, as they are among the first macroinvertebrates to disappear from systems impacted by physical habitat degradation and thermal and chemical pollution (Gaufin, 1973; Baumann, 1979; Rosenberg & Resh, 1993; Stark *et al*., 1998; Barbour *et al*., 1999). The larvae in particular have very narrow dissolved oxygen, substrate, stream-size, and temperature requirements, making them especially vulnerable to sedimentation, nutrient loading, increases in ambient water temperature, and other anthropogenic impacts on water quality (Baumann 1979; Williams & Feltmate, 1992; Stewart & Stark, 2008).

The water temperature and dissolved oxygen requirements for *C. lineata* and *C. zukeli* have not been specifically documented, but other lotic, cold water species in this family are known to require dissolved oxygen saturations of 80 to 100%, and typically inhabit streams, creeks, and rivers with mean temperatures below 16° C (Hynes, 1976; Baumann, 1979; Lillehammer *et al*., 1989; McNutt, 2003). The substrate in the natal streams where *C. lineata* and *C. zukeli* occur is described as small, pebble-gravel in the riffle areas, with siltation only in the pools (Biggam, pers. comm., Feb. 2010). Stream bed gravels affect instream dissolved oxygen and temperature (IDEQ, 2007), and also provide the needed habitat for larval aestivation. A detailed study of habitat use by a related winter snowfly found the highest densities of larvae were associated with average particle sizes between 3 and 4 mm, with pore space between 20 and 25%, and sample layers without larvae had a smaller average particle size and pore space (3.07 mm and 14 % pore space) than sample layers with larvae (3.79 mm and 16.3 % pore space) (McNutt, 2003).

B. Diet
Specific feeding behaviors of *C. lineata* or *C. zukeli* nymphs have not been observed, but active nymphs of most species in this family are generally found in leaf packs or woody debris in riffle areas, where they shred detritus and feed on interstitial, detrital material (Stewart & Stark, 2008; McNutt, 2003). Adult stoneflies generally hide on branches or vegetation during the day, and crawl about at night to feed (Hynes, 1976). Female stoneflies must eat to acquire nutrients for their eggs, but males in some families consume only water (Hynes, 1976). The adult feeding behavior of these species has not been documented, but capniid adults are known to feed on epiphytic algae or the buds and pollen of riparian vegetation (Hynes, 1976; Stewart & Stark, 2008).

C. Life Cycle
Species in the family Capniidae require cool temperatures for development and have a “fast” univoltine life cycle, producing only one generation per year, with nymphs undergoing diapause and then growing rapidly over a short period before emerging as adults (Lillehammer *et al.*, 1989; Stark *et al*., 1998; Stewart & Stark, 2002). Capniidae eggs are generally laid in the early spring and usually hatch after three to four weeks. As the water temperatures rise, the young nymphs move into the hyporheic zone (a zone of loose, rocky, water-saturated substrate below the stream) and undergo diapause, becoming inactive until the water cools in late fall and winter, at which time they return to the benthos to feed and grow rapidly to maturity (Hynes, 1976; Pugsley & Hynes, 1985; Stewart & Stark, 2002; McNutt, 2003). Mature nymphs climb out of the water onto rocks, leaf packs, or pieces of wood that extend above the water-line and emerge as adults. Adults in the *Capnia* genus generally emerge in late winter or early spring, but the emergence period varies with species and elevation (Stewart & Stark, 2002). *Capnia lineata* emerges relatively late compared to other *Capnia* species, and adults have been collected from late February to June (Nelson & Baumann, 1989). *Capnia zukeli* adults emerge over a shorter window of time, and have been collected from April 1st to May 5th. Male stoneflies attract females by drumming, i.e. tapping specialized structures on their terminal abdominal segments on the substrate (Hynes, 1976; Stark *et al*., 1998; Sandberg & Stewart, 2006). The frequencies are transmitted through the substrate (not through the air), and females feel, rather than hear, the vibrations.

Virgin females will drum in reply, followed by continued communication and migration towards each other until the two meet and mate. Shortly after mating, females extrude their egg mass over the stream surface or in the water (Hynes, 1976; Stark *et al*., 1998). Most adults are winged, although a few species are wingless (apterous) or have shortened wings (brachypterous or micropterous). In *Capnia lineata* and *C. zukeli*, the females are winged and the males are brachypterous. Adult *Capnia* are weak fliers with limited airborne dispersal ranges, and rely primarily on stream corridor connections to colonize new habitats (Hynes, 1976; Stewart and Stark, 2002). Like other winter stoneflies, these species are generally collected near streams, walking on snow, bridges, rocks, or streamside vegetation (Stark *et al*., 1998).

VI. Habitat Status and Condition

A. Geographic, Ecological and Hydrological Characteristics

Both the Palouse and Potlatch watersheds are part of the Palouse Prairie ecosystem of northern Idaho and eastern Washington. This area is comprised of loess-covered basalt plains and undulating plateaus, with deeply incised river canyons running off the upland regions (Black *et al.*, 2003). This region has undergone extensive changes over the past century since European-American settlement, including large-scale agriculture and residential development (Black *et al.,* 2003). While historically prairie grasslands, shrubs, and ponderosa forests dominated the landscape, the dominant land uses in these watersheds today are dry land agriculture and associated agribusinesses, timber production, livestock grazing, suburban residences and homesteads, light industry, hiking and motor trails, and the urban areas of the city of Moscow and the University of Idaho (IDEQ, 2007, 2008). In the Potlatch watershed, large tracts of grasslands have been converted to dry land agriculture (IDEQ, 2008), and most of the forests in this watershed are second- and third-growth stands, with very little original forest remaining (Latah Soil and Water Conservation District, 2007). In the Palouse bioregion, over 94% percent of the original grasslands and 97% of the wetlands have been converted to crop, hay, or pasture lands, and 21% of the forested lands have been converted to agriculture or urban areas (Black *et al.,* 2003). Most of the vegetated riparian zones along the existing rivers and streams have been dramatically reduced due to conversion to agricultural fields and pastures. In the Viola area of Latah County, for example, 61% of riparian areas existing in 1940 were gone by 1989 (Black *et al.,* 2003). Several species that were once common in this area, including the ferruginous hawk, white-tailed jack rabbit, and sharp-tailed grouse, are now rare and survive only as small relict populations in isolated fragments of habitat (Black *et al.,* 2003).

The streams and rivers inhabited by *C. lineata* and *C. zukeli* are cold-water drainages originating in the Palouse Range and Rocky Mountains. Stream flow patterns reflect seasonal weather patterns of cool, moist winters and warm, relatively dry summers with precipitation falling primarily during the spring, fall, and winter (Black *et al.,* 2003; Latah Soil and Water Conservation District, 2007; IDEQ, 2008). The precipitation and temperature patterns tend to cause high peak flows in early spring which subside rapidly by early summer. Extremely low flows are typical throughout the summer, and increase again with the onset of the fall and winter rainy seasons (IDEQ, 2008). Although the streams where these species occur were historically perennial (year-round flow), the hydrographs of many have been altered by livestock grazing, timber harvest, and upland agriculture, resulting in massive spring runoff events and no surface flow late in the summer (IDFG, 2006).

B. Land Ownership

Land ownership in the Palouse and Potlatch watersheds varies greatly from tributary to tributary and among ecosystem types. Records for these species occur on private, federal, and state-owned land (Appendix A, Figures 1, 2, and 3). Private ownership dominates the lower elevation drainages and agricultural plateaus in the Palouse and lower Potlatch watersheds, while public lands are more abundant in the higher elevation drainages and forested land. Federally owned habitat for these species consists of a cluster of sites in the Clearwater National Forest (Palouse Ranger District), which falls under the jurisdiction and management of the U.S. Forest Service. Spring Valley Reservoir, a recreation site where these species are known from, is state-owned and falls under the management of the Idaho Department of Lands.

VII. CURRENT AND POTENTIAL THREATS—SUMMARY OF FACTORS FOR CONSIDERATION

A. The Present or Threatened Modification, or Curtailment of its Habitat or Range.

Like most capniid stoneflies, both *C. lineata* and *C. zukeli* require a narrow set of environmental conditions to survive, including clean, cold, well-oxygenated water with areas of pebble-gravel substrate free from heavy siltation (Baumann, 1979; Stark *et al*., 1998; Stewart & Stark, 2002). Impaired water quality and habitat conditions have already been documented in the majority of the streams where these species occur. In fact, each of the streams within these species' ranges that were recently investigated by the IDEQ[1] are recognized as failing to meet Idaho's water quality standards as established by Idaho state law, based on low dissolved oxygen levels, elevated temperature, nutrient, and sediment levels, and other pollutants (IDEQ, 2007, 2008). Each of these creeks also failed the IDEQ's multimetric assessment (Beneficial Use Reconnaissance Program (BURP), which, based on both biological and physical characteristics (*e.g.* percent Plecoptera (stoneflies) and bank stability), concluded that that these creeks do not support their designated beneficial uses, including the ability to support cold-water aquatic organisms (IDEQ, 2007, 2008). Two of these waterbodies[2] are listed on the Clean Water Act 303(d) list of impaired waters (EPA, 2008). The primary causes of stream impairment are identified as timber harvest operations, agriculture, livestock grazing, recreational use, and development, each of which leads to widespread habitat degradation that threatens the survival of these species. Dispersal limitations, the inherent vulnerability of small populations to stochastic events, and the effects of global climate change in this region pose additional threats to the continued existence of these stoneflies.

1. <u>Timber Harvest</u>

The Palouse Ranger District of the Clearwater National Forest is home to the largest site cluster for these species: Little Boulder Creek at Little Boulder Creek Campground, Hog Meadows Creek, and three Potlatch River sites (2 miles south of Helmer, 3-4 miles south of Helmer, and near the junction with Hog Meadows Creek) (Figure 2). The forest around these sites has been heavily logged and roaded, and there are numerous old railroad grades along the creeks, most of which are now roads (Macfarlane, pers. comm. Feb. 2010). Timber harvest in the past 30 - 40 years has been mainly even-aged (clear-cut to leave a few seed trees in the stand), and yarding (hauling felled timber) has been mainly done by tractor as the terrain is generally not too steep to preclude vehicle use (Macfarlane, pers. comm. Feb. 2010). The Cherry Dinner Timber Sale is an ongoing project in this area, impacting both the Hog Meadow Creek and Little Boulder Creek drainages (USDA Forest Service, 2006, 2008a). The Proposed Action, approved in 2006, includes understory slashing and burning of 310 acres, logging of ~2,210 acres, construction of 8.1 miles of permanent road and 1.5 miles of temporary road, and reconstruction of 9.4 miles of existing roads (USDA Forest Service, 2006). Although this project does not log within 300 feet of permanent fish-bearing streams,

[1] Streams within the ranges of *C. lineata* and *C. zukeli* that failed to meet Idaho's water quality standards include: West Fork Little Bear Creek, Big Bear Creek, Little Bear Creek, South Fork Palouse River, and Potlatch River.
[2] Big Bear Creek and Potlatch River.

there are numerous logging roads, including new road construction projects, crossing streams and draws in the area (Macfarlane, pers. comm. Feb. 2010).

The Potlatch watershed in this area is further jeopardized by the Upper Lochsa Land Exchange, a pending agreement between the U.S. Forest Service and a private timber company (Western Pacific Timber) which may result in the loss of ~4,300 acres of National Forest land in Latah County in exchange for land elsewhere (USDA Forest Service, 2010a, 2010b). Four of the exchange parcels in the proposed swap (UC-LA-22, 23, 24, and 25) are on the Potlatch River, approximately one mile downstream from the cluster of sites at which both *Capnia lineata* and *C. zukeli* have been collected (Figure 4). Although the fate of these parcels has not been disclosed, both timber harvest and real estate development are likely possibilities (C. Halverson, pers. comm. Feb. 2010). Several small towns, private landowners, and environmental groups have expressed strong opposition to the land trade, largely due to recognition that the activities related to industrial logging, real estate development, and road construction will be detrimental to the already compromised Potlatch watershed (Friends of the Clearwater National Forest, 2009; Halverson, pers. comm. Jan. 2010). Recent water quality assessments of the Potlatch River found that the stretch where these species are known from (Moose Creek to Corral Creek) is already impaired and on the 303(d) list due to elevated temperature (IDEQ, 2008).

Another site, located on a small patch of private land within the Clearwater National Forest, three miles north of Bovill near where Nat Brown Creek enters the Potlatch River, is also heavily impacted by timber operations. Similar to the other sites in the Clearwater National Forest, this area has been heavily logged and roaded in the past, and there are numerous old railroad grades along the creeks, most of which are now roads (G. Macfarlane, pers. comm. Feb. 2010). In recent years, the West Fork Potlatch Timber Sale EIS and Record of Decision have made several decisions resulting in considerable logging (mostly even-aged clear-cutting) of the National Forest land in the watershed above this site (G. Macfarlane, pers. comm. Feb. 2010). Additionally, the Idaho Department of Lands Fiscal Year 2010 Timber Sales Plan includes the upcoming auction of 500 acres of timber parcels in this area, including units 1.5 miles west of Bovill in the Moose Creek drainage, and 0.5 mile east of Bovill in the East Fork Potlatch Creek drainage (Idaho Department of Lands, 2010). The planned harvest methods include ground-based harvesting, overstory removal, seed tree methods (removing most of the overstory and leaving only a few scattered residual trees to serve as a source of seeds), and clear-cutting. Additionally, approximately 2.5 miles of spur road will be constructed in order to harvest this sale (Idaho Department of Lands, 2010).

The habitat suitability and long-term survival of *C. lineata* and *C. zukeli* at these sites is threatened by logging-related sedimentation, altered hydrological patterns, and warmer water temperatures. Forestry operations are well-known to cause increased sediment delivery to streams. A variety of forestry-associated activities contribute to this increased sedimentation, including yarding (hauling felled timber to a temporary storage site prior to offsite transport), skidding (a yarding process that involves dragging timber across the ground), site preparation for replanting, and the construction, use, and maintenance of permanent or temporary roads (Waters, 1995; Anderson, 1996). Timber harvest operations also have considerable influences on stream temperatures, typically by the removal of riparian vegetation, which results in increased stream heating due to greater solar radiation in the riparian zone (Moore *et al.*, 2005). Although leaving riparian buffers can decrease the magnitude of stream temperature increases and changes to riparian microclimate, substantial warming has been observed for streams within both un-thinned and partial retention buffers (Moore *et al.*, 2005).

Although it is difficult to separate the effects of logging from the effects of logging-associated roads on aquatic habitats, disturbance associated with logging road construction and operation is thought to have the greatest influence on increasing sediment load in streams (Cederholm *et al*., 1981; Furniss *et al*., 1991). By increasing the amount of compacted and/or impervious surfaces, reducing water infiltration, and removing surface vegetation, logging roads result in increased runoff of surface water to streams, which in turn increased erosion, turbidity, and sedimentation. Roads associated with a logging unit in the Payette National Forest in Idaho resulted in a 750-fold increase in sediment production over the natural rate for six years following their construction (Megahan & Kidd, 1972). Similarly, the presence of roads has been found to cause erosion rates and turbidity levels three orders of magnitude greater than in undisturbed forest areas (Grace, 2002). Even the use of temporary roads can have a long-term effect on soil compaction, as studies conducted in California indicated that soil in logging skid trails that had not been used in forty years remained 20% more compacted than soil in nearby areas that were not used as skid trails (Vora, 1988). Additionally, logging roads and associated run-off can increase flooding, alter the stream channel, spread invasive plant species, and facilitate the delivery of contaminants to streams, including heavy metals and organic pollutants (Anderson, 1996; Forman & Alexander, 1998; Jones *et al.*, 1999; Trombulak & Frissell, 2000; Gucinski *et al.*, 2001; Grace, 2002; Angermeier *et al.*, 2004). Forest roads also frequently reduce shade in riparian areas, and the enhanced solar radiation input caused by logging roads is considered to be similar to the influence of clear-cut areas (Moore *et al.*, 2005). In Oregon, for example, downstream warming of up to 7°C was observed in a 46 m stream reach which was completely cleared of vegetation during road construction (Brown *et al.,* 1971).

Timber harvesting activities impact numerous stream-dwelling insects and other aquatic macroinvertebrates, and can change aquatic macroinvertebrate community composition, structure, and function (Rothrock *et al.*, 1998; Banks *et al*., 2007). An assessment of seven stream sites in the Blackfoot River watershed in Montana showed that sites in areas where silviculture activities occurred had increased soil erosion and sediment delivery and decreased benthic macroinvertebrates when compared with a reference-quality restored wilderness site (Rothrock *et al*., 1998).

2. Agriculture

Agricultural activities pose significant threats to the long-term survival of *Capnia lineata* and *C. zukeli* in the southwestern portions of their ranges. The Palouse region is one of the world's most productive grain-growing areas, and wheat is the major cash crop in Latah County (Black *et al*., 2003). Five streams where these species are known from (Big Bear Creek, Little Bear Creek, West Fork Little Bear Creek, Palouse River, and South Fork Palouse River) are situated directly below upland agriculture for the majority of their lengths. The uplands in this region were historically bunchgrass prairie, but are now predominately agricultural lands producing wheat, dry-pea, and lentil crops (IDFG, 2006). This replacement of native grasses with annual crops has left the soil susceptible to erosion by precipitation runoff and wind, which results in increased overland surface flow and decreased infiltration of water into the soil. This in turn causes (1) high sediment loads in streams and rivers, and (2) an altered stream hydrograph with high peak-flows following precipitation events, and extremely low base-flows in summer (IDFG, 2006). Although the hydrological patterns of the streams in this area are naturally controlled by snowmelt and precipitation events, it is likely that stream hydrology has changed due to changes in land use. For example, in the Palouse region, several creeks that were known historically to be perennial streams are now classified as intermittent (IDEQ, 2005a). At least three of the agricultural streams mentioned above (Big Bear Creek, Little Bear Creek, and West Fork Little Bear Creek) are now characterized by low gradients, incised channels, limited riparian vegetation, small substrate composition, and altered hydrographs (IDFG, 2006).

In addition to degrading the physical habitat of streams in the Palouse and Potlatch watersheds, commercial agriculture also negatively impacts water chemistry, further threatening the long-term survival of the Idaho and straight stoneflies. While virtually every water body in the United States contains anthropogenic chemicals (Gilliom *et al.*, 2006), streams and rivers that are situated immediately in the drainage system of commercial agriculture are especially vulnerable to ground and surface water pollutants, including high nutrient loads, herbicides, and insecticides, particularly in areas with runoff-prone soils (Blanchard & Lerch, 2000), such as those found in this region (IDEQ, 2007). Triallate, a pre-emergent, selective, thiocarbamate herbicide, is the most commonly used pesticide in the Palouse region (Roberts & Wagner, 1996), and is regionally registered for use on barley, lentils, dry-peas, and wheat (EPA, 1998). Depending on the crop, various formulations of this chemical are applied at application rates of 1.0-1.5 pounds of active ingredient per acre (EPA, 1998), with a total of ~236,800 pounds applied in the Palouse region per year (Roberts & Wagner, 1996). In a USGS National Water-Quality Assessment (NAWQA) study investigating pesticide concentrations in surface water of the Palouse River and surrounding area, this chemical, along with three other pesticides (Diazinon, Carbaryl, and *gamma*-HCH), was found at concentrations exceeding the freshwater-chronic criteria for the protection of aquatic life, as established by the EPA (Roberts & Wagner, 1996). Although its specific toxicity to stoneflies has not been investigated, triallate is highly toxic to other aquatic insects, and both lethal (mortality) and sub-lethal (intoxication and immobility) effects have been reported (Kegley *et al.,* 2009a). Trifluralin, another herbicide frequently formulated with triallate and also detected in streams in the Palouse region but at lower concentrations (Roberts & Wagner, 1996), has been found to cause mortality in stoneflies (Stavola & Patterson, 2004; Kegley *et al.*, 2009b). Likewise, the insecticides diazinon and carbaryl, both found at concentrations exceeding EPA freshwater-chronic criteria in the Palouse region (Roberts & Wagner, 1996), are very highly toxic to stoneflies, inflicting mortality at low concentrations and (in the case of carbaryl) impacting overall stonefly diversity in stream ecosystems (Kegley *et al.*, 2009c). High usage levels of these chemicals in dry-land agriculture, combined with their high detections/concentrations in Palouse region streams and acute toxicity to aquatic insects, render these chemicals, along with many other agricultural chemicals, a serious threat to *C. lineata* and *C. zukeli.*

Apart from generic statements on the packaging labels, there are no specific protective measures for rare or at-risk species inadvertently exposed to these chemicals. In the recent IDEQ Potlatch River Subbasin Assessment (IDEQ, 2008), no TMDL's were developed for pesticides, based on an Idaho State Department of Agriculture study in the Clearwater Basin which detected numerous pesticides in streams, but concluded that "all pesticide concentrations detected during this study were below any chronic or acute levels that may cause ill effects for aquatic species" (Campbell, 2004). This study points out, however, that the restricted scope of the sampling effort did not allow for sample collection during certain peak rain and discharge events, and that, despite low concentrations, the fact that these pesticides were still detected in the environment should be of concern (Campbell, 2004). Even at low concentrations, agricultural chemicals can have profound sublethal effects on the behavior, physiology, and reproduction of aquatic organisms (*e.g.* Tessier *et al.*, 2000), as well as the structure and function of aquatic communities (Fleeger *et al.*, 2003; Rohr & Crumrine, 2005; Relyea & Hoverman, 2009).

High application rates of ammonium-based nitrogen fertilizer in agricultural operations in this region pose additional concerns. The acres on which fertilizer was used (as a percentage of total acres farmed in Latah County, Palouse bioregion) increased from 0-20% in 1949 to 20-40% in 1992 (Black *et al.*, 2003). High ammonia concentrations and other nutrient inputs can lead to excess algae growth (algal blooms), which cause oxygen depletion due to the growth and decomposition cycle of algae feeding on the nutrients and the biochemical oxygen demand as ammonia is transformed to nitrate-nitrogen. Reduction in dissolved oxygen levels is deleterious to stoneflies and poses a significant threat to these species.

3. Grazing

Grazing-related impairment of water quality impacts the habitat for these species at most sites. Livestock grazing is a common nonpoint source of pollution in the Palouse region watersheds and numerous locations where these species occur on private land are threatened by livestock grazing (IDEQ, 2007). Additionally, all of the sites where the species have been collected on the Clearwater National Forest (Palouse Ranger District) are within an active grazing allotment (Figure 5; USDA Forest Service, 2007). The Potlatch Creek Allotment encompasses a number of sites for these species clustered around the Potlatch River, Hog Meadows Creek, and Little Boulder Creek. Permitted animals within this allotment total 218 cow/calf pairs, including 161 cow/calf pairs on National Forest Systems Land (USDA Forest Service, 2009a, G. Chislett, pers. comm. 2010). This allotment uses a three pasture rotation grazing system and is active annually from June 8th through November 7th (USDA Forest Service, 2009a). Recent IDEQ water quality assessments of the Potlatch River found that the stretch where these species occur (Moose Creek to Corral Creek) fails to meet Idaho's water quality standards as established by Idaho law and the Clean Water Act, due to elevated temperature levels (IDEQ, 2008; EPA, 2008). An additional site for the straight snowfly (3 miles north of Bovill, near where Nat Brown Creek enters the Potlatch River) is considerably impacted by livestock grazing in the Purdue Allotment and West Fork Potlatch-Moose Creek Allotment (USDA Forest Service, 2007; G. Macfarlane, pers. comm. Feb. 2010). 435 cow/calf pairs are permitted to graze at the West Fork Potlatch-Moose Creek Allotment, including 188 cow/calf pairs on National Forest Systems Land (USDA Forest Service, 2009b, G. Chislett, pers. comm. 2010). This allotment uses a three pasture rotation grazing system and is active annually from late spring through early fall (June 1 through October 31st) (USDA Forest Service, 2009b). Cattle-related riparian degradation at Nat Brown Creek, including destabilized bank conditions and lack of riparian shade, has been noted by the Forest Service and targeted for improvement projects (USDA Forest Service, 2008b), although the degree of habitat recovery at the site is not known.

Livestock grazing can degrade water quality and negatively impact aquatic macroinvertebrate communities in several ways: trampling riparian vegetation; consuming streamside vegetation and downcutting the riparian buffer; defecating and urinating on stream banks or in the channel; and increasing sedimentation due to removal of riparian vegetation and direct damage to banks and channel from trampling and wallowing. In places where cattle are not excluded from the stream bed, eutrophication and erosion are especially significant threats. Intensive livestock grazing has been shown to result in loss of biodiversity, disruption of biological communities, and dramatic alteration of terrestrial and aquatic communities (Fleischner, 1994; Agouridis *et al.*, 2005). The negative effects of livestock grazing are frequently magnified in riparian ecosystems, as cattle tend to congregate in these areas for the abundant forage, shade, and water (Kennedy, 1977; Roath & Krueger, 1982; Gillen *et al.*, 1984; Chaney *et al.*, 1993; Belsky *et al.*, 1999). The preference of livestock to loiter near streams results in increased defecation and urination in or near the water source, which can degrade water quality and alter both nutrient levels and the trophic status of streams (Strand & Merritt, 1999). Nitrogen, phosphorus, and potassium levels have been shown to increase in close proximity to livestock forage and watering sites (Mathews *et al.*, 1994). The tendency of livestock to be attracted to riparian zones is considered to be higher during the summer and fall (Clary & Webster, 1989; Leonard *et al.*, 1997), which overlaps with the annual grazing season on the West Fork Potlatch-Moose Creek and Corral Creek allotments (G. Chislett, pers. comm. Feb. 2010), and increases the potential for livestock waste to have a serious, adverse effect on the straight and Idaho snowflies.

Additionally, livestock grazing creates greater erosion potential due to removal of riparian and upland vegetation, removal of soil litter, increased soil compaction via trampling, and increased area of bare ground (Schultz & Leininger, 1990; Fleishner, 1994). Increased erosion leads to higher sediment loads in nearby waters, degrading habitat and increasing water turbidity. These problems are exacerbated by the livestock removal of riparian vegetation, as a riparian buffer helps filter overland runoff, slow flooding, and stabilize stream banks. A four-year study of a western mountain stream found a dramatic decline in macroinvertebrate abundance when just ten cow-calf pairs were allowed to graze in units along the stream from July through September, including significant reductions in species richness and total abundance of the sensitive Ephemeroptera, Plecoptera, and Trichoptera taxa (mayflies, stoneflies, and caddisflies) in grazed units versus ungrazed controls (McIver & McInnis, 2007). Likewise, a variety of aquatic macroinvertebrate community attributes relating to taxa diversity, community balance, trophic status, and pollution tolerance were strongly negatively impacted by moderate or heavy grazing in small mountain streams in Virginia, compared to lightly grazed or ungrazed controls (Braccia & Voshell, 2007). Livestock grazing has been shown to remove riparian zone vegetation and disrupt riparian plant communities (Kennedy, 1977; Kovalchik & Elmore, 1992; Fleishner, 1994), which in turn reduces the shading canopy, leading to rising water temperatures and lower dissolved oxygen levels, as well as decreased emergence substrates (*e.g.* woody debris) and food supply (leaf detritus) for active foraging nymphs. All of these factors, combined with increased sediment loads discussed previously, further imperil *Capnia lineata* and *C. zukeli* at grazed sites.

4. <u>Recreation</u>

The habitat conditions and water quality requirements of *Capnia lineata* and *C. zukeli* are threatened by intense recreational use at both state (Spring Valley Reservoir) and federally owned (Clearwater National Forest) sites. The Palouse Ranger District is the most heavily visited district in the entire Clearwater National Forest, as it is closest to the population centers in Moscow and Lewiston (Friends of the Clearwater National Forest, 2009). Over 90 miles of hiking trails and three developed campgrounds are maintained within the Palouse Ranger District, including Little Boulder Campground, where both species were found in 1985. Common recreational activities include hiking, biking, camping, fishing, hunting, and driving, and each year more people in the Clearwater National Forest are involved in Off Highway Vehicle (OHV) recreation, including all terrain vehicles (ATVs), trail motorcycles, four wheel drive vehicles, and snowmobiles (USDA Forest Service, 2009c). The growth in use of OHVs and their increasing ability to travel in rougher terrain has outraced the development of management strategies for them, and the damage from increasing cross-country travel and user-created trails in the Clearwater National Forest is obvious (USDA Forest Service, 2009c). Vegetation loss, unsightly scars, soil erosion, and stream degradation (*e.g.* de-vegetation, destruction of fragile banks, and increased siltation) are issues associated with OHV use in this forest (USDA Forest Service, 2009c).

Little Boulder Creek Campground, originally a logging camp for the Potlatch Lumber Company, is an increasingly popular developed campground and recreation area. The site has paved roads and parking areas; tent, RV, and group camp sites; drinking water and restrooms; and roads open to ATVs, motorbikes and 4-wheel drive vehicles. Increasing recreational use of this campground and the surrounding area has recently prompted the Clearwater National Forest to keep the campground open for over a month longer in the fall, starting in 2009 (Public Lands Information Center, 1997-2010, USDA Forest Service, 2009d). According to Palouse Ranger District Recreation Staff Officer Adam McClory, “We have received a number of requests from the public, hoping to use our developed campgrounds as a base for recreation into the fall season… Keeping these facilities available for use will allow visitors to spend even more time on the Clearwater" (USDA Forest Service, 2009d). Recreational activities at these sites may adversely affect stonefly habitat in numerous ways, including increased erosion and sedimentation from foot, bike, car, and OHV traffic; runoff of pollutants from roads and OHV trails; introduction of bacteria and excess nutrients from dog waste; trampling of streamside riparian habitat by campers, hikers, and fishermen; and the construction and maintenance of stream crossings and culverts which can interrupt stream flow, generate additional sedimentation and siltation of waterways, and pose barriers to species dipersal.

Spring Valley Reservoir, managed by the Idaho Department of Fish and Game, is another heavily used recreation site and developed campground in the immediate vicinity of sites for both *Capnia lineata* and *C. zukeli*. With tent sites, picnic areas, docks, boat ramps, and restrooms, the Reservoir is open year round and, located just 13 miles east of Moscow, is one of the most popular recreational waterways in the county (Latah County Comprehensive Plan, 2004). Although occasional clean-up events are hosted at the reservoir (IDFG, 2009), public opinion of the reservoir has suffered in recent years. Lorene Middleton, a contributor to GoingOutside.com, states "Spring Valley Reservoir has been a place I have visited since I was a young child and now I have introduced it to my children. Unfortunately the past few times I have visited the reservoir it has increasingly become more and more of a disappointment…The swim beach, restrooms, trails are littered and vandalized… I think this [situation] should be reviewed by the State, especially if our tax dollars are going towards the upkeep and care of this valuable and beautiful reservoir" (GoingOutside.com, n.d.). Although data on camping and other non-fishing recreational activity are currently not available, fishing is thought to account for at least 80-85% of reservoir use (R. Hand, pers. comm., Feb. 2010). The most recent fishing activity data is from 2005, when the reservoir received 28,997 hours of fishing effort, including bank (23,590 hours), boat (3,257 hours), and ice (2,150 hours) fishing. Spring Valley Creek, immediately below the reservoir, is a site at which both *Capnia lineata* and *C. zukeli* have been collected in the past. The water flow in this creek is managed by a dam at the southeast end of the reservoir, which controls the water levels in the reservoir using a series of dam boards placed across the top of a spillway (R. Hand, pers. comm., Feb. 2010). Since the primary management goal of the dam is to raise the water level of the reservoir for summer recreation, boards are placed in the spillway in late spring after the height of the spring runoff has occurred, and removed in the fall to let some of the water run out. The result of this is that much of the spring run-off that would otherwise be directed to the creek each spring is withheld until fall (R. Hand, pers. comm., Feb. 2010). Although these manipulations only cause the creek below the dam to dry up in very dry summers (R. Hand, pers. comm., Feb. 2010), the water levels and presumably thermal trends in the creek are dramatically affected by these management practices. In particular, warmer water temperatures in summer due to unnaturally shallower water are likely. Additionally, the riparian areas in this section of Spring Valley Creek are compromised by the dam rip rap and the road (G. Macfarlane, pers. comm. Feb. 2010), which could further elevate water temperatures via loss of shading vegetation.

5. <u>Development</u>

i. Waste Water Treatment Plants and other discharges

The population of Latah County increased by 24.9% between 1980 and 2008, with the 2008 population at 35,906 (Latah County Comprehensive Plan, 2004; US Census Bureau, 2009). Moscow, with a population of 22,000, is the largest city in the county, and home to the University of Idaho. Both the straight and Idaho stoneflies were known historically from Moscow, although their continued survival in streams within the city limits is doubtful due to habitat degradation. Troy, Deary, and Bovill are additional incorporated cities in these species' ranges that are growing in population. Moreover, each of these cities operates a Waste Water Treatment Plant (WWTP) which discharges waste-water effluent to a river or associated tributary where one or both of these species are known from (IDEQ, 2008). The city of Troy WWTP discharges effluent directly into the West Fork Little Bear Creek, where the straight snowfly has been collected. This creek has excessive plant growth due to nutrient overloading, as well as elevated temperature and bacteria levels (IDEQ, 2008). Comparisons between 2001/2002 and 2006/2007 data indicate that dissolved oxygen concentrations are declining in this creek (IDEQ, 2008); only one sample taken in the 2001/2002 period had a measured dissolved oxygen concentration below the critical level of 6.0 mg/l (a violation of Idaho state criterion IDAPA 58.01.02.250.02.a), while over 50% (13 of 20) of the samples taken during the 2006/2007 period had measured concentrations below the critical level, presumably due to excessive inorganic nitrogen loading from sewage effluent (IDEQ, 2008). The city of Deary operates a WWTP which discharges to Mount Deary Creek, a tributary to the thermal- and bacterial- polluted, 303(d)-listed Big Bear Creek (IDEQ, 2008; EPA, 2008), where the straight snowfly has been collected. The city of Bovill operates a WWTP which discharges directly into the Potlatch River, upstream of a cluster of sites for both *Capnia lineata* and *Capnia zukeli*. Like Big Bear Creek, the Potlatch River also suffers from thermal pollution and is 303(d)-listed in this stretch (IDEQ, 2008; EPA, 2008). In the Palouse watershed, Syringa Mobile Home Park discharges waste into the South Fork Palouse River, in the vicinity of at least one known site for *Capnia lineata* on this river. This stretch of the River fails to meet its designated beneficial uses, including the ability to support aquatic life, based on elevated sediment, nutrients, temperature, and bacteria (IDEQ, 2007). Although TMDLs and waste load allocations have been developed to help control pollutant loads in these waterbodies (IDEQ, 2007, 2008), it is unlikely that the required reductions will be sufficient to meet the habitat requirements of these highly sensitive species, and their long-term survival at these sites is questionable.

ii. Roads and impervious surfaces

Most of the natural land cover in this bioregion, including wetlands and floodplains, has been eliminated by agricultural land use, urbanization, and transportation infrastructure. As stated by Arnold and Gibbons (1996), "Impervious surfaces not only indicate urbanization, but also are major contributors to the environmental impacts of urbanization. As the natural landscape is paved over, a chain of events is initiated that typically ends in degraded water resources." Roads contribute substantially to sedimentation in aquatic systems; the increase in impervious surface area contributes to large quantities of overland flow, and both traffic and road maintenance activities generate large amounts of sediment (Anderson, 1996; Forman & Alexander, 1998; Jones *et al.*, 2000; Trombulak & Frissell, 2000; Gucinski *et al.*, 2001; Ziegler *et al.*, 2001; Grace, 2002), particularly in the Palouse region where the topography, soils, and climate make the watersheds very susceptible to erosion (IDEQ, 2007). In addition to increasing sedimentation, roads accumulate a variety of contaminants including brake dust, heavy metals, and organic pollutants, which are carried directly into streams by overland runoff (Forman & Alexander, 1998; Jones *et al.*, 2000; Trombulak & Frissell, 2000). Forest roads and smaller access roads often must receive periodic maintenance, including grading, which can increase the rate of erosion and deliver increased silt loads to streams (Gucinski *et al.*, 2001; Ziegler *et al.*, 2001; Grace, 2002). Road networks can also create a barrier to dispersal, especially for insects such as adult stoneflies, which are weak fliers and rely on an intact stream corridor for movement (Peterson *et al.*, 1999, 2004; MacNeale *et al.*, 2005).

In the cold climate of the Rocky Mountain West, de-icing and anti-icing road salts are gaining increasing attention for their movement into streams and rivers, and their detrimental effects on the aquatic organisms (Jackson & Jobbagy, 2005). Magnesium chloride ($MgCl_2$) is the primary component in the liquid anti-icers used by the Idaho Transportation Department (ITD), which, although touted on the ITD website as being "less toxic than baking soda or salt" (ITD, 2006), has been shown to have lethal and sublethal effects on a wide variety of organisms, including aquatic insects (Kegley *et al.*, 2009d). A study conducted for the

Colorado Department of Transportation showed that the aquatic invertebrate cladoceran *Ceriodaphnia* exhibited mortality and reduced reproductive capacity when exposed to 0.1% $MgCl_2$ de-icer (Lewis, 2000), a concentration considered to be close to the expected median concentration of deicer run-off from highways. While sodium chloride has well-known negative impacts on aquatic life (Hart *et al.*, 1991; Forman & Alexander, 1998; Kaushal *et al.*, 2005; Karraker *et al.*, 2008; Silver *et al.*, 2009), some studies have shown that magnesium-based salts have even higher invertebrate toxicity than sodium or calcium-based salts (Environment Canada, 1999). District 2 (which includes Latah County) has expanded its magnesium chloride anti-icing program more rapidly than any other Idaho district, and in the winter of 1999/2000 (most recent available data), applied 567,000 gallons of liquid magnesium chloride throughout the district (ITD, 2004). Chloride-based de-icers have been shown to increase the salinity of nearby rivers and streams (Jackson & Jobbagy, 2005), and may also contribute to mobilizing trace metals from the soil into groundwater and surface water (Fischel, 2001). Increased salinity has been reported in groundwater at a distance of more than 300 feet from roadways, and damage to vegetation from de-icing salts has been reported at a distance of up to 100-650 feet (Center for Environmental Excellence, 2009). Liquid magnesium chloride is believed to adversely affect riparian vegetation, stunting overall growth and decreasing the leaf cover (shade) that vegetation provides (Trains Not Lanes, n.d.). This is particularly problematic for stoneflies during the later parts of the summer, when flows are generally down but daytime temperatures are still high, heating the water. In addition, the dissolved oxygen requirements of these species may be compromised by de-icers, since rust inhibitors (included in deicer composition to offset the corrosive effects of the salts) can cause stream eutrophication (Fischel, 2001).

6. <u>Barriers to Dispersal</u>
The *Capnia* genus contains many narrowly endemic species (Stark *et al*., 1998), probably due to both their narrow habitat tolerances, which restrict them to pristine, cold-water streams (Baumann 1979; Williams & Feltmate, 1992), and the frequency of wing-reductions in the group, which limits their airborne dispersal ranges (Nelson, 1996). In *Capnia lineata* and *C. zukeli*, neither the brachypterous males nor the females fly well, and must rely on water courses to colonize new habitat (Nelson & Baumann, 1989, Hanson, 1943; Stewart & Stark, 2008). The majority of the streams in these species' range are tributaries of the Potlatch River, suggesting that historic dispersal from inhabited tributaries into new catchments was by means of larval drift down-stream to a confluence, followed by upstream migration of adults into the adjacent headwater (Griffith *et al.*, 1998). The current impaired habitat conditions (including elevated temperature, sediment, and nutrient levels (IDEQ, 2008)) on the stretches of the Potlatch River between the known range tributaries of these species may limit their capacity to use the Potlatch as a vehicle to colonize or re-colonize other apparently suitable tributaries. These snowflies may thus be confined to a smaller set of creeks than historically, all of which are becoming increasingly impaired (IDEQ, 2005b, 2007, 2008). Dispersal potential is of particular importance for these species, since dispersal is likely associated with the long-term persistence of freshwater taxa, and may be a predictor of a species' ability to withstand global climate change (*reviewed in* Bilton *et al.*, 2001).

B. Overutilization for Commercial Purposes
Neither of these snowfly species is used commercially, or is at risk of over-collection.

C. Disease or Predation
Neither disease nor predation is known to threaten either the straight or Idaho snowflies at this time. However, little is known about the specific life history and ecology of these species and threats from disease or predation have never been assessed. As discussed below, the rarity of these species and their confined

ranges makes them more vulnerable to extinction as a result of normal population fluctuations resulting from predation or disease.

D. The Inadequacy of Existing Regulatory Mechanisms

Neither the Idaho nor straight snowfly currently receive recognition or protection under federal or state law. Both species are recognized as Critically Imperiled by Idaho's Conservation Data Center, but this designation does not provide any protection for the species or their habitat. Likewise, these species are both recognized by the US Forest Service as Species-of-Concern, known to occur and potentially be affected by land management activities within the Clearwater National Forest administrative boundary, although this designation has not resulted in the species being taken into consideration in the assessment of the environmental impacts of management actions including timber management and grazing decisions.

E. Other natural or manmade factors affecting its continued existence

1. Small population size and stochastic events

As described above, the Idaho and straight snowflies are weak fliers, with a limited dispersal potential that is decreased even further by habitat disturbance. The population sizes of each of these species is unknown but presumably small, as no more than 89 individuals have ever been reported from a single site, and most collections were of many fewer individuals. Small and fragmented populations are generally at greater risk of extinction from normal population fluctuations due to predation, disease, and changing food supply, as well as from natural disasters such as floods or droughts (*reviewed in* Shaffer, 1981). Small populations are also threatened with extinction from a loss of genetic variability and reduced fitness due to the unavoidable inbreeding that occurs in such small populations (*reviewed in* Shaffer, 1981).

2. Global Climate Change

Assessment of climate change trends in North America has already revealed changes in precipitation patterns, stream hydrology, and plant bloom time. Overall, annual mean air temperature increased in North America from 1955-2005, and total annual flow has decreased in many streams in the central Rocky Mountain region throughout the past century at an average rate of 0.2% per year (Rood *et al.*, 2005). A temperature rise since the 1950's has shifted snowmelt more than 20 days earlier in the Latah County area of Idaho, and decreased snow pack 30 to 45 % in the ranges of the Idahoan Rockies where the Potlatch River originates (Service, 2004). Recent studies indicate that if even the most moderate regional warming predictions over the next 50 years come true, snow-packs will be reduced by up to 60% in some regions of Western North America, which, in turn, is expected to reduce summertime stream flows by 20% to 50% (Service, 2004).

It has been calculated that up to 60% of the climate-related trends of river flow, winter air temperature and snow pack from 1950 to 1999 are human-induced, and threaten an approaching crisis in water supply for the western United States (Barnett *et al.*, 2005). Climatologists agree that growing aridity in the West will be most severe in the Rocky Mountain West (Saunders *et al.*, 2008). These changing conditions may lead to increased flooding early in the spring and drier summer conditions, particularly in arid western areas where snowmelt sustains stream flows. As noted above, spring and summer snow cover has already been documented as decreasing in the western United States, and drought has become more frequent and intense (Intergovernmental Panel on Climate Change, 2007; Saunders *et al.*, 2008). Floods and droughts are projected to increase in frequency and intensity; erosion is also projected to increase due to decreased soil stability from higher temperatures and reduced soil moisture, and increases in winds and high intensity storms.

Stream flows in tributaries in the lower Potlatch river basin (*e.g.* West Fork Little Bear) are regulated largely by local precipitation, while rivers originating in the upper basin (*e.g.* the Potlatch River) are regulated largely by snow pack. Increases in surface temperatures have important consequences for the hydrological cycle in both situations, but particularly in rivers where water supply is currently dominated by melting snow or ice. Less winter precipitation falling as snow and the melting of winter snow earlier in the spring will lead to a shift in peak river runoff to winter and early spring, away from summer and autumn when the demand for water is highest (Barnett *et al.*, 2005). In contrast to many aquatic organisms, the snowfly life cycle is more constrained by warm water temperatures than cold. The nymphs of *Capnia lineata* and *C. zukeli* escape the warm summer water temperatures by entering diapause in the hyporheic zone below the stream bed, and return to the substrate surface in the fall to feed and grow when water temperatures are cooler (Pugsley & Hynes, 1985; Stark *et al*., 1998). Although diapause entry and exit may be triggered by changing stream temperatures, the cues for this behavior are not known definitively (McNutt, 2003). Possible negative implications of climate change, therefore, include (1) nymphs remaining in diapause longer to avoid warm stream temperatures, reducing their period of active feeding and growth, and (2) nymphs exiting diapause into water temperatures that are too warm for their survival. A detailed, long-term, study of diapause habitat-use by a related *Allocapnia* snowfly found that in extended periods of warm weather, the hyporheic zone showed no decrease in temperature with depth, indicating that burrowing into deeper layers in the hyporheos does not appear to provide a suitable refuge from higher summer stream temperatures (McNutt, 2003). The adult stonefly stage is also expected to suffer as a result of warmer climate, due to (1) untimely emergences, which could occur at times that are not appropriate for mating and egg maturation (Lillehammer *et al.*, 1989), and (2) impaired physiological conditions resulting in reduced fertility and fecundity. Species-specific temperature ranges for successful stonefly egg and nymph development have been documented (Lillehammer *et al*., 1989), and gravid *Capnia* females have been shown to be unable to survive to lay eggs above certain temperature limits (Elliot, 1986). All of these factors suggest that intensifying climactic shifts in this region pose serious threats to the straight and Idaho stoneflies, largely via reductions in the availability and suitability of their thermal habitat.

IX. CRITICAL HABITAT

Petitioners request the designation of critical habitat for the straight and Idaho stoneflies concurrent with their listing. 16 U.S.C. § 1533(b)(6)(C) and 50 C.F.R. § 424.12. Critical habitat should include areas of both the Potlatch and Palouse watersheds, at sites where this species currently and/or historically occurred.

X. CONCLUSION

For the above reasons, the Idaho and straight snowflies each meet three criteria under the Endangered Species Act for consideration as an endangered species: 16 U.S.C. § 1533 (a)(1)(A,D,E) (Section 4) including: (A) The present or threatened destruction, modification, or curtailment of its habitat or range, (D) The inadequacy of existing regulatory mechanisms, and (E) Other natural or manmade factors affecting its continued existence.

Due to the multiple different threats faced by these species, their small population sizes, restricted distribution, isolation, and the likelihood that they will be driven to extinction, the Xerces Society for Invertebrate Conservation and the Friends of the Clearwater formally petition the U.S. Fish and Wildlife Service to list the straight snowfly (*Capnia lineata*) and the Idaho snowfly (*Capnia zukeli*) as endangered species. Furthermore, we request the Service use its authority to establish Critical Habitat based on the facts presented to prevent the extinction of these rare and vulnerable snowflies.

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XII. PERSONAL COMMUNICATIONS

Dr. Richard Baumann, Brigham Young University
Russel Biggam, Private researcher/consultant
Nicole Capuano, NatureServe
Guy Chislett, USDA Forest Service
Jay Cordeiro, NatureServe
Cheryl Halverson, Friends of the Palouse Ranger District.
Robert Hand, Idaho Department of Fish and Game
Dr. Boris Kondratieff, Colorado State University
Gary Macfarlane, Friends of the Clearwater
Dr. C. Riley Nelson, Brigham Young University
George Stephens, Idaho Department of Fish and Game
Dr. Richard Zack, Washington State University

APPENDIX I. Table and Maps of the straight and Idaho snowfly collection localities.

Table 1. Known records of *Capnia lineata* and *C. zukeli*, Latah County, Idaho. Additional information (*e.g.* collector, determiner, repository, reference) is available from the Xerces Society. M = male; F = female; H = holotype; A = allotype; P = paratypes.

Species	**Watershed**	**Locality**	**Date**	**Number**
Capnia lineata	Palouse	2 mi NE Laird Park	11 Nov 1985	7 M, 2 F
Capnia lineata	Palouse	Lost Creek, 4 miles NNE of Harvard	1 June 1981	3 specimens
Capnia lineata	Palouse	Moscow	5 Apr 1930	1 F
Capnia lineata	Palouse	Robinson Lake	27 Feb 1969	3 M, 3 F
Capnia lineata	Palouse	South Fork Palouse River, 6 mi ENE of Moscow [SW of Robinson Lake]	24 Feb 1984	15 M, 4 F
Capnia lineata	Potlatch	7 miles east of Moscow	10 May 1975	5 specimens
Capnia lineata	Potlatch	7.4 mi E Moscow	24 Feb 1984	6 M, 8 F
Capnia lineata	Potlatch	Big Bear Creek, Hwy 8, near Deary.	25 March 1967	2 M
Capnia lineata	Potlatch	Hog Meadow Creek, 2 miles south of Helmer.	26 April 1985	2 M
Capnia lineata	Potlatch	Little Bear Creek.	6 March 1984	15 M
Capnia lineata	Potlatch	Little Boulder Creek, 3 miles south of Helmer.	7 April 1989	67 M, 20 F
Capnia lineata	Potlatch	Little Boulder Creek, Little Boulder Creek Campground.	26 April 1985	3 M, 5 F
Capnia lineata	Potlatch	Potlatch [River], 3 miles north of Bovill	7 May 1965	7 F
Capnia lineata	Potlatch	Potlatch River, junction Hog Meadow Creek.	26 April 1985	5 M
Capnia lineata	Potlatch	Spring Valley Creek near reservoir	14 Apr 1984	3 M, 10 F
Capnia lineata	Potlatch	Spring Valley Creek, below Spring Valley Reservoir, 5 miles NE Troy.	25/26 April 1985	45 M, 40 F
Capnia lineata	Potlatch	Spring Valley Reservoir (on snow, near creek)	27 Feb 1979	1 M
Capnia lineata	Potlatch	Troy	22 April 1911	1 M (H), 27 F (A & P)
Capnia lineata	Potlatch	West Fork Little Bear Creek, near Troy	6 March 1984	16 M
Capnia lineata	Potlatch	West Fork Little Bear Creek.	26 March 1969	24 M, 4 F
Capnia lineata	unclear	7 mi NE Moscow, on the wing	16 May 1986	9 F
Capnia zukeli	Palouse	Moscow	2 April 1938	1 M (H), 1 F (A)
Capnia zukeli	Palouse	Moscow Mt.	1 April 1980	1 M
Capnia zukeli	Palouse	Palouse River.	5 May 1962	1 F
Capnia zukeli	Potlatch	Little Boulder Creek at Little Boulder Creek Campground.	26 April 1985	12 M, 62 F
Capnia zukeli	Potlatch	Potlach River 2 mi SE Helmer	30 April 1985	unknown
Capnia zukeli	Potlatch	Potlach River, jct Hog Meadows Creek	26 April 1985	42 M, 47 F
Capnia zukeli	Potlatch	Potlatch River ca 3-4 miles SE of Helmer	2 May 1985	5 M, 7 F
Capnia zukeli	Potlatch	Potlatch River ca 3-4 miles SE of Helmer	12 May 1985	1 M, I F
Capnia zukeli	Potlatch	Spring Valley Creek near reservoir.	14 April 1984	3 M, 11 F
Capnia zukeli	Potlatch	Spring Valley Creek, below Spring Valley Reservoir, 5 mi NE Troy	26 April 1985	7 M
Capnia zukeli	Potlatch	Troy Creek [creek in the Troy area?]	17 April 1977	1 F

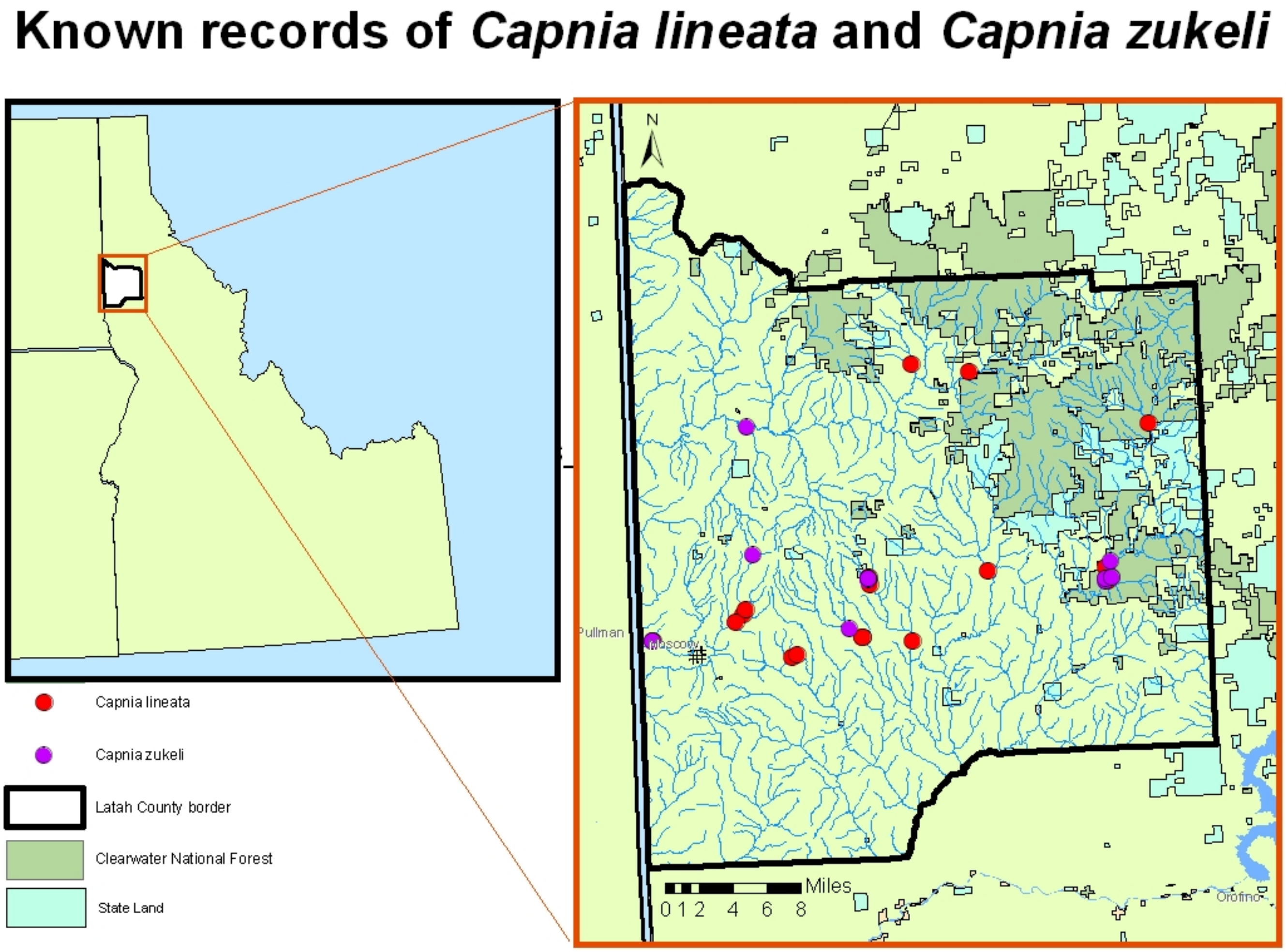

Figure 1. Known localities of *Capnia lineata* and *C. zukeli* in Latah County, Idaho (Palouse and Potlatch watersheds), relative to federal and state-owned land.

Records of *Capnia lineata* and *Capnia zukeli* in the Clearwater National Forest (Palouse Ranger District)

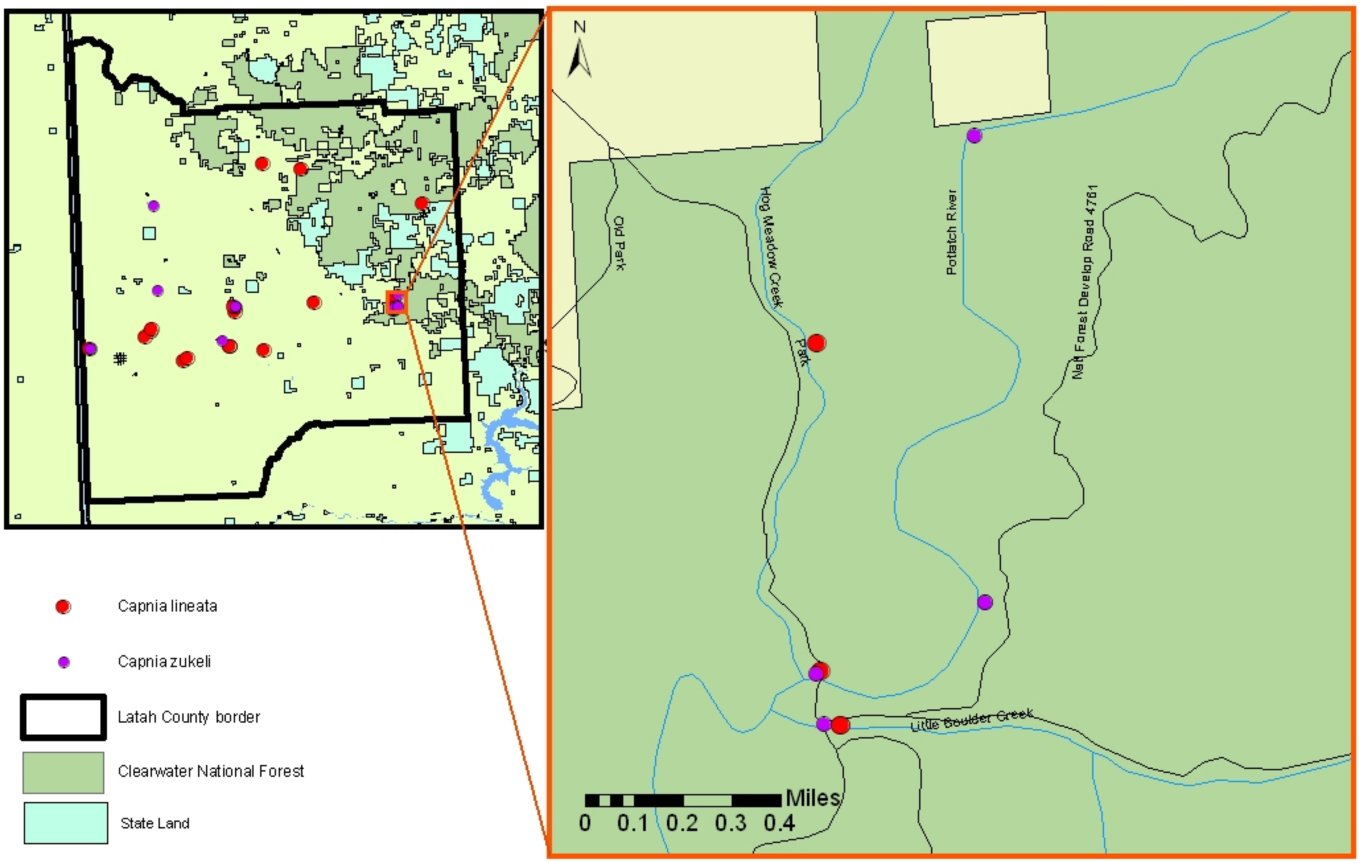

Figure 2. Known localities of *Capnia lineata* and *C. zukeli* in the Clearwater National Forest, Palouse Ranger District (Little Boulder Creek at Little Boulder Creek Campground, Hog Meadows Creek, and Potlatch River (2 miles south of Helmer, 3-4 miles south of Helmer, and near the junction with Hog Meadows Creek)). Each of these sites falls within an active grazing allotment, and the water quality and habitat integrity is heavily influenced by cattle, timber harvest, and recreation at these sites.

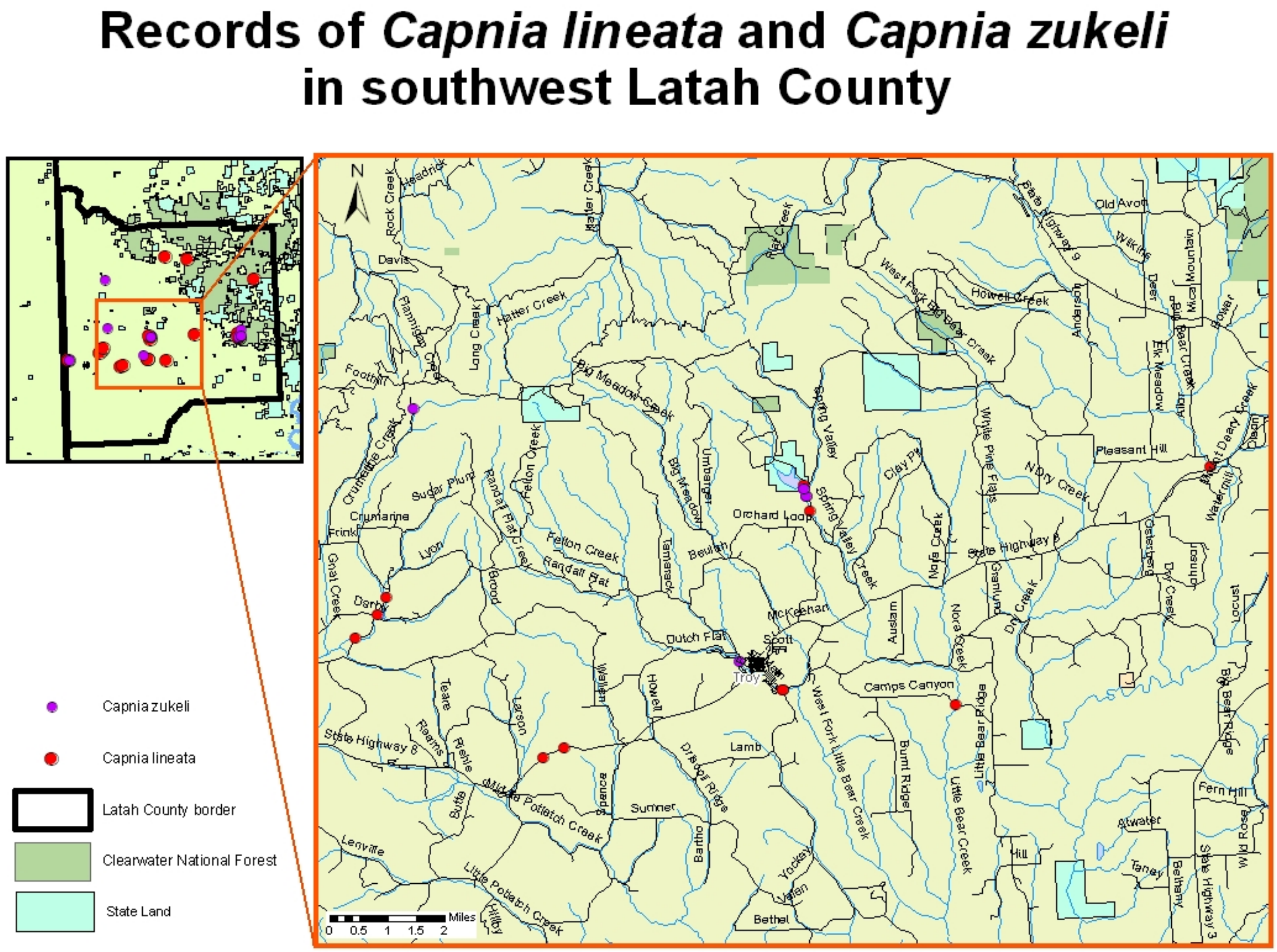

Figure 3. Additional localities of *Capnia lineata* and *C. zukeli* in Latah County, Idaho, including Big Bear Creek, Little Bear Creek, West Fork Little Bear Creek, Spring Valley Creek, South Fork Palouse River, and Robinson Lake. The majority of these sites occur on private land, and the water quality and habitat integrity are threatened by upland agriculture, waste water treatment plant discharges, grazing, and recreation.

APPENDIX II. USDA Forest Service Maps.

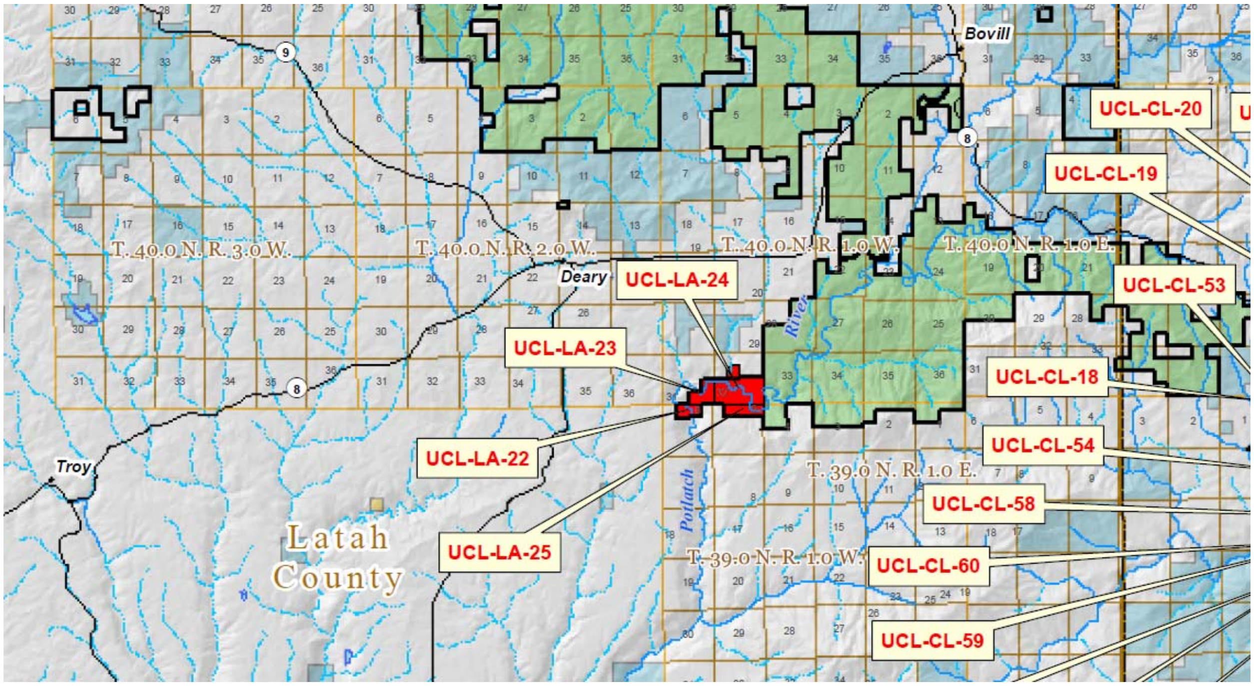

Figure 4. Selected section of USDA Forest Service Map of Clearwater National Forest Lochsa Land Exchange Parcels. Parcels in red (UCL-LA-22, 23, 24, and 25) are located about a mile downstream of the site cluster for these species (Potlatch River and tributaries near Little Boulder Creek, shown in Figure 2). Entire map available at: http://www.fs.fed.us/r1/clearwater/Projects/Upper_Lochsa_LEX/Low_res_maps/Clw_043008_lores.pdf.

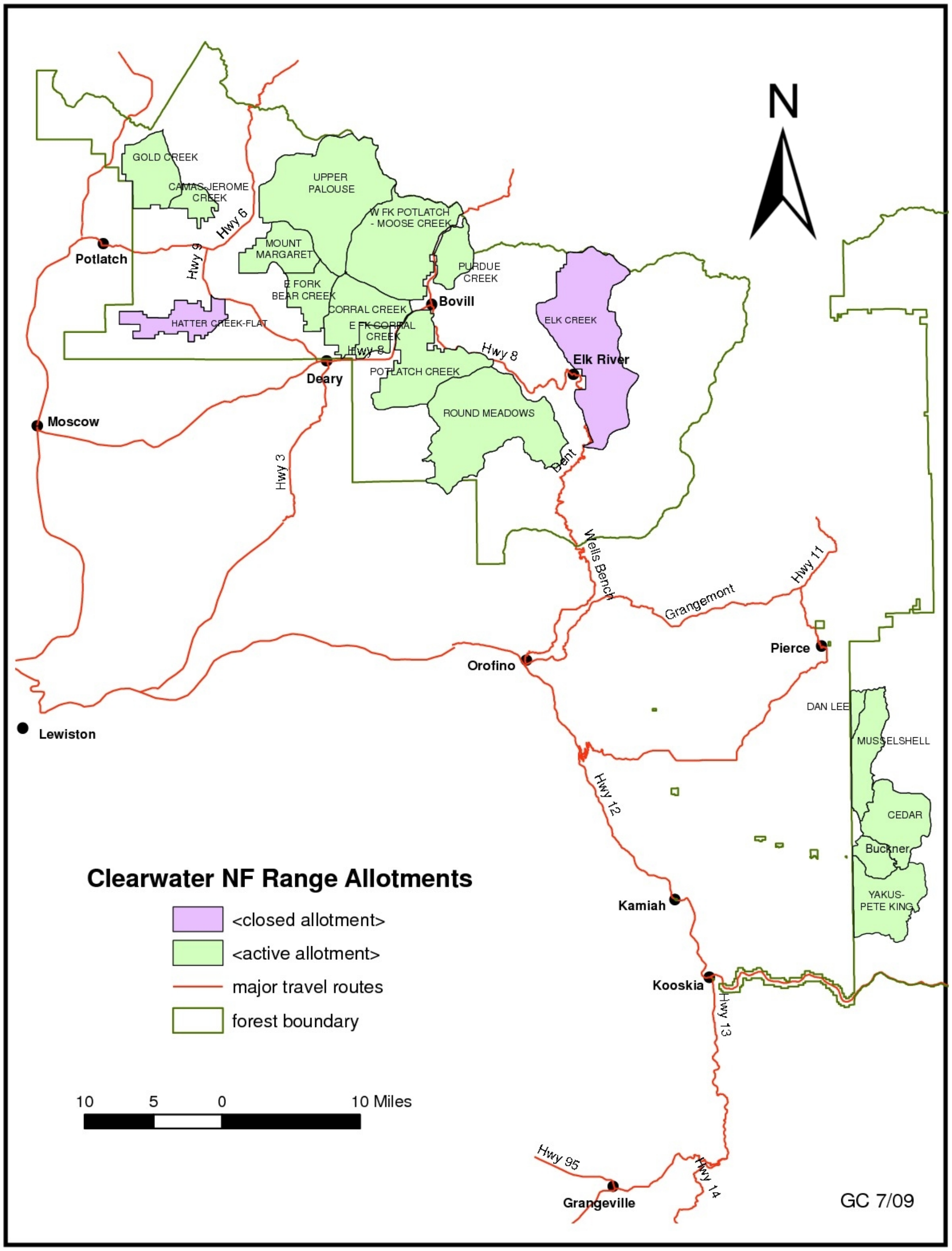

Figure 5. USDA Forest Service Map of active grazing allotments in the Clearwater National Forest. All known sites for *Capnia lineata* and *C. zukeli* in the Clearwater National Forest are within the Potlatch Creek Allotment. Another private-land site for *C. lineata* (3 miles North of Bovill on the Potlatch River) is impacted by grazing on private land and on the West Fork Potlatch-Moose Creek and Purdue Allotments. Map provided by Guy Chislett, USDA Forest Service, 2010.