AQUATIC AMPHIBIANS AND REPTILES OF THE

LITTLE RIVER ADAPTIVE MANAGEMENT AREA, OREGON

by

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SUMMARY

We conducted surveys for aquatic amphibians and reptiles at 25 stream sites in the Little River Adaptive Management Area (AMA), Douglas Co., Oregon. Work was conducted from July to September 1995 with a focus on streams in or near forested stands (various management levels). We recorded key habitat variables at every site. We sampled 13 sites classified as headwaters (Stream Orders #1-2; sampled with three 5-m belts), and 12 larger streams (7 Stream Order #3, 2 Order #4, and 3 Order #5; sampled along one 500-m length each). All sites were visited more than once (e.g., three visual searches of each large water), increasing the total surveys to 72 (= 117 person-hrs of field work). An additional 6 sites were identified, but excluded becasue they were inaccesible or later became dry creek beds. We recorded 467 amphibians (8 species) and 33 reptiles (6 species), including the Pacific giant salamander (*Dicamptodon tenebrosus*), Dunn's salamander (*Plethodon dunni*), Tailed frog (*Ascaphus truei*), Red-legged frog (*Rana aurora*), Yellow-legged frog (*R. boylei*), Cascade frog (*R. cascadae*), Bullfrog (*R. catesbeiana*; an introduced species), Chorus frog (*Pseudacris regilla*), Common garter snake (*Thamnophis sirtalis*), Northwestern garter snake (*T. ordinoides*), Western terrestrial garter snake (*T. elegans*), Oregon garter snake (*T. atratus hydrophilus*), Northern alligator lizard (*Elgaria coerulea*), and Western pond turtle (*Clemmys marmorata*). These surveys provided a major increase in the number of locality records for all these species. Also, our evidence indicates that *Ascaphus truei* and *Dicamptodon tenebrosus* tend to occur in headwater habitats, but are present in moderate-sized streams (Stream Order 3). *Rana boylei*, *Thamnophis* species, and *Clemmys marmorata* frequent open, larger waters. In the Little River AMA, we found all three species of native ranid frogs, including one of the lowest elevation sites known for *Rana cascadae*.

INTRODUCTION

A primary objective with Adaptive Management Areas (AMAs) is to determine resource baseline conditions and to monitor change over time. Most AMAs are managed for timber and other values, and have important wildlife resources. One of high biological interest is the Little River AMA in the Mt. Scott Resource Area [Swiftwater Field Office] (BLM) and North Umpqua Ranger District (USFS) of eastern Douglas Co., Oregon. The Nongame Program of the Oregon Dept. Fish and Wildlife (ODFW) was also concerned with the status of the regional herpetofauna. The area is at the junction of four physiogaphic regions (Coast Range, West Cascade, Klamath and Western Interior Valleys), which complicates understanding of distributional information on animals. Habitat types are highly variable over short distances.

Our objective was to establish baseline data and habitat associations for stream-dependent amphibians and reptiles in this poorly known region. We sought information on the occurrence and relative abundance of aquatic-dependent species. We also attempt to assess the habitat characteristics and preferences of amphibians and reptiles in and near streams.

MATERIALS AND METHODS

Biologists with BLM, USFS and ODFW selected potential sites across the Little River AMA. Most of the streams were accessible by roads or walking. We generally worked upstream from roads or crossings to avoid the potential influence of road culverts or road sedimentation in the creek. We collected field data in a standardized method (from Bury and Corn 1991) and entered it on rainproof sheets (e.g., location, start/stop times, site characteristics, aspect, etc.).

During all searches the position of any animals we captured or observed was recorded on the section maps and data forms. Position designations included: TYPE (in riffle, pool, splash zone, seep, on the banks), SUBSTRATE (type and size), and LOCATION (on, under, or in substrate, or suspended in the water column). The data base is provided as Appendix A.

We kept captured animals in water in plastic bags or buckets to await processing. Processing involved measuring total length and snout-vent length (SVL) to the nearest mm by holding a ruler next to the animal in a plastic bag or in our hands, and weighing all animals to the nearest 1/10g using spring scales. We released all animals at the capture site.

Field surveys were conducted by Larry Gangle III, Sam Moyers, and Paul Levine, who were all trained in stream methodology and had experience with the regional herpetfauna.

HEADWATER SURVEYS (HW)

Headwater sites (n = 13) were 1st-2nd Order Streams (Table 1). In 1995, we employed sampling techniques and methods from Bury and Corn (1991) improved with a habitat-based method from Welsh et al. *(in press*), who identified up to 24 different mesohabitat types in flowing waters. The predominate types (>5% occurrence) they recorded were low-gradient riffle, high-gradient riffle, run, step run, step pool, and lateral scour pool)log. We used a reduced number of 12 common and 5 other habitat types (shown in Appendix A). The method of Welsh et al. *(in press*) was derived from techniques widely used for sampling and recoding data on fish populations (see Hankin 1986, Hankin and Reeves 1988). Thus, we employed proven methods.

Surveys are conducted in a 2-tiered sampling scheme. **Survey 1 (Habitat Typing)** delineates, measures, and marks habitats whereas **Survey 2 (Sampling)** incorporates both visual search of the entire stream length and intensive sampling of portions of the headwater for amphibians and reptiles. Herpetofauna sampling is usually conducted within 3 days of habitat typing to reduce the possible effects of climatological changes on habitat variables (e.g., major rainfall events effect stream width).

Survey sites are 100-m long sections of stream. We measured length to the nearest 1-m with a 50-m tape and marked the start/end with flagging and metal tags (attached to nearby objects on the bank). We walked along the section from the downstream end and categorized habitats using a habitat classification system (simplified from Welsh et al. *in press*). Also, we mapped the section to scale and recorded measurements of physical characteristics. We took compass bearings of stream direction at each bend, and recorded prominent stream features (bars, islands, large woody debris, boulders, etc.) to assist in future orientation.

We employed visual searches and 5-m long plot searches (Fig. 1). First, we conducted a visual survey of the entire 100-m stretch. One person walked each bank starting from the downstream end of the section. We looked for animals in the water, on the banks, and on protruding rocks and islands. We tried not to disturb the stream environment except to capture animals that fled into the water. They were measured and released at the site of capture.

Next, we returned to the start of the section and did an area-constrained search consisting of three 5-m long belts at approximately 0-5 m, 45-50 m and 95-100 m. We marked each 5-m section with flagging. Then, we categorized and measured stream features (aspect, slope, gradient) and key habitat variables (width, average depth, substrate type, pool:riffle ratio). We sampled each sq. meter by intensive hand-search (see Bury and Corn 1991): briefly searching the adjacent streambank (usually <0.5 m from water), turning over rocks or boulders (including looking for tadpoles of tailed frogs that may attach to the undersides of objects), and lifting objects out of the stream (all are returned at the conclusion of work). We set wire-screens (0.2 X 0.3 m) or commercial dip nets (0.3 m wide mouth) below objects to catch animals escaping in the flowing water. Our crew consisted of two people, who searched the belt at the same time with each holding their own net. We also noted any salmonids, sculpins or crayfish in the stream.

LARGE WATER (LW) SURVEY PROTOCOL

Large waters (n = 12) were 3rd-5th Order Streams (Table 1). As with the headwater surveys, we conducted surveys of large waters using a 2-tiered sampling scheme but over a larger area. Habitat type classification and intensive plot sampling were conducted 3-5 days apart.

Survey sites consisted of one 500-m section per stream or river, which was partitioned into five units of approximately 100 m each (depending on the length of habitats). On the first visit, we measured and marked habitat boundaries in each unit based on habitat classifications (modified from Oregon Dept. Fish and Wildlife Stream Protocol, provided in Appendix B).

We mapped the section to scale and recorded measurements of physical characteristics (e.g., depth, width) corresponding to each mapped habitat onto data sheets. We also recorded compass bearings of stream direction at each bend, and mapped prominent stream features (bars, islands, large woody debris, log jams, cliffs, boulders, etc.) for orientation.

At the starting point and the habitat break nearest to 100 m, we marked the survey unit with flagging and a metal tag (placed on nearby objects above water level). We repeated this procedure for each of the five units in the 500-m section. We employed 3 sampling methods on each 100-m unit and repeated this procedure for all five units in each 500-m section. (Fig. 2):

Area-Constrained Searches.---First, we conducted an intensive search along either the right or left bank. We avoided steep banks or cliffs that backed the shoreline. If both banks were similar, we used the bank we were currently on. We measured and marked one 1 X 5-m plot and then hand-searched it (visual scan, turn over large objects). We modified a standard method (Bury and Corn 1991) by using one 5-m band for each 100-m section rather than one 10-m belt per stream. We used two people to search the band at the same time, each holding their own hardware-cloth screen or dipnet.

Time-Constrained Searches.---Immediately upon finishing the area-constrained search, we conducted a time-constrained search in the remaining part of the first 5-m belt of the unit. The area of coverage was variable (5-m belt X stream width). We searched this area visually, and turned over large cover objects up to a maximum of 0.5 person hrs (2 biologists X 15 min each) or until the entire area was covered.

Visual Searches.---Next, we visually searched the remaining 95 m of the unit by walking and wading the shoreline or shallows. We did not search water >0.5 m deep. We attempted to cover both banks of the creek, even in deep water by swimming slowly along the shore (where banks were steep or cliffs).

RESULTS and DISCUSSION

SAMPLING DESIGN

Headwater Surveys.---The visual search along the length of the 100-m stretch required <1 hr per site. The method added only 23 captures (23.5%) and this was the only method that yielded Red-legged frogs (n = 6 at two sites), Cascades frogs (n = 2 at one site), and Pacific treefrog (n = 1). It revealed giant salamanders at 5 sites.

The intensive searches using three 5-m belts per site took 22.1 person-hrs (mean = 1.7 hrs per site; Table 2). The method yielded 75 (76.5%) of the detections (Table 3A). This was the only method that revealed the occurrence of tailed frogs (n = 22 individuals) and at 4 sites, and Dunn's salamander (n = 1) at one site. However, but no other frog species were detected. There were giant salamanders (n = 40) at 10 sites. Most of the giant salamander (74.1%) were caught in the intensive searches, and this species would be undersampled using just walking transects.

Overall, the searches of 5-m belts are necessary to detect tailed frogs (a sensitive species to management practices) and giant salamanders. The walking searches added few animals, but flushed out a few ranid frogs that would have otherwise been missed. Because of the little time required, we recommend use of the 100-m visual search to supplement the intensive belts.

Large Water Searches.---These surveys required considerable time (74.5 person-hrs; Table 2). Walking visual searches along 500-m stretches required the most effort (67.8% of the time), followed by time-constrained searches (32.4%) and area-constrained searches (26.6%).

We conducted three replicates of the visual searches along the 500-m stretches with the most captures/observations (n = 121) on the first visit, then only 50 detections, and an increase to 99 detections on the last visit. The second search added 6 species (2 Dunn's salamanders at 2 sites, 2 Cascade frogs at 2 sites, and at one site each: 1 Red-legged frog, 1 common garter snake and 1 aquatic garter snake). The third search added 5 species but no new ones (15 Cascades frogs at 4 sites, 2 Pacific treefrogs at two sites, and at one site each: 1 Red-legged frog, 1 common garter snake and 1 aquatic garter snake). The additional search times added few species, and none that were not found elsewhere during the surveys of the 12 largewater streams. We recommend employment of only 1 or 2 visual searches on future surveys of large waters.

Area-constrained searches (1 X 5-m bands) yielded 69 animals, mostly giant salamanders (87% of the records) at 6 sites (Table 3B). This method also revealed tailed frogs (n = 8) at 3 sites. All giant salamander and tailed frog detections were waters in Stream Order 3. Only one Yellow-legged frog was added (in Stream Order 4-5). Time-constrained searches added 44 records, the fewest of any method (Table 3B). It revealed giant salamanders (n =37) at 6 sites and tailed frogs (n = 7) at one site. All were Stream Order 3. This method added little to the results and we suggest that it be eliminated in future surveys.

COMPARISON OF HEADWATERS AND LARGE WATERS

We found no reptiles, two species of salamanders, and four species frogs in headwaters (Table 4). Large waters had six species of reptiles, two salamanders, and six species of frogs, including the only detections for Yellow-legged frogs and bullfrogs (an introduced species). This division appears to be a poor predictor of species occurrence, except for reptiles.

HERPETOFAUNA BY STREAM ORDER

Combined Date.---Species composition markedly differed by stream order (Table 5). We found three species of salamanders, two species frogs and no reptiles in headwaters. Third order streams had the most salamanders and moderate numbers of frogs, and few reptiles. Although representing only few sites (n = 5 sites total), Stream Order 4 and 5 had no salamanders, moderate to high numbers to frogs, and most of the reptile records.

Watershed Differences.---In the Little River basin (no class 4 streams sampled; Table 6), Giant salamanders were frequent or common in 2nd and 3rd order streams, but they were not present in larger waters. Tailed frogs had low to moderate occurrence in 2nd and 3rd order streams, but they also were not present in larger waters. A few ranid frogs (*Rana aurora* and *R. cascadae*) were also found. There were Pacific treefrogs (*Pseudacris regilla*), *Rana aurora* and *R. cascadae* at all 3 of the 5th Order streams. This basin had high frequency of occurrence for *R. boylei*, garter snakes (both *Thamnophis elegans* and *T. ordinoides*), and alligator lizards (*Elgaria coerulea*).

The Cavitt Creek basin only had 2nd and 4th Order Streams (Table 7). Again, giant salamanders and Tailed frogs were only detected in the headwaters, whereas ranid frogs (*Rana cascadae*, *R. catesbeiana*), Pacific treefrogs (*Pseudacris regilla*), Northwestern garter snake (*Thamnophis ordinoides*), and Western pond turtle (*Clemmys marmorata*) were in the 4th Order Stream. Red-legged frogs (*Rana aurora*) were found in both stream orders.

Combining the two basins (Table 8), it is apparent that there are two ecological groups:

Cool-water Species.---Species often associated with rocky, flowing, and cold waters are *Ascaphus truei* and *Dicamptodon tenebrosus* (although the later species can live in larger, warmer waters). These species and some ranid frogs frequent 1st to 3rd Order Streams.

Warm-water Species.---There was occurrence of garter snakes (genus *Thamnophis*) and western pond turtle (*Clemmys marmorata*) only in the quieter, warmer waters (Stream Order 3 but mostly 4-5th order). The larger streams also had all three species of native ranid frogs, where they apparently also reached their highest occurrence.

BIOGEOGRAPHY

The Little River AMA received some historical collecting and more recent surveys by St. Johns (1985), who concentrated on reptiles. We found 67 new localities of amphibians and reptiles, surpassing the prior data base of 52+ records (Table 9). Our efforts added substantially to aquatic amphibians such as the giant salamander (*Dicamptodon tenebrosus*)) 17 new locales; Dunn's salamander (*Plethodon dunni*)) 4; Tailed frogs (*Ascaphus truei*)) 9 sites, all new for the watershed; and three species of ranid frogs: *Rana aurora*) 8 new sites, *R. boyle*i) 2, and *R. cascadae*) 7. The region is rich in species because of its location at the confluence of two major elements of North America's herpetofaunas: northern amphibians (e.g., *Ascaphus truei*), and southern or Mediterranean groups of reptiles (e.g., *Thamnophis hydrophila*).

The Little River AMA is at the junction of four physiographic regions (Coast Range, West Cascade, Klamath and Western Interior Valleys), but we found no patterns based on these criteria. In part, this to no occurrence of endemic species in these provinces that also range into the Little River AMA. For example, the Siskiyou Mountain salamander (*Plethodon stormi*) only occurs in the Klamath Province, but it is not known in the Little River AMA. There were some broad differences in the herpetofauna related to biogeographic affinities. Fore example, Tailed frogs and giant salamanders are associated with mountainous waters (e.g., Coast Range, West Cascade, Klamath) and are not found in lowland valleys.

Sympatry (overlapping ranges) of three species of ranid frogs was unexpected. *Rana aurora* occurs over many habitats locally, but this species mostly ranges west of the Little River AMA. *Rana boylei* frequents lower portions of the Little River AMA where habitats are open and warmer, which is typical conditions for this "southern" species. *Rana cascadae* may occur because of its abundance in adjacent higher elevations habitats (Cascade Mountains). The presence of *R. cascadae* may represent dispersal of animals downstream during high runoffs.

However, we lack sufficient distributional and ecological information on adjacent lands in the region to better clarify biogeographic patterns. For example, there are no studies on the biology of ranid frogs in the region that describes preferred selection of habitat for egg laying or year-round use. We need specific, intensive studies to define habitat preferences of the native species, and attention to distribution) abundance patterns to better track their long-term survival.

HABITAT PREFERENCES

We found marked differences in the use of general habitats by the herpetofauna (Table 10). In headwaters (Steam Order 2), there were only amphibians and their numbers were low. Giant salamanders (*Dicamptodon tenebrosus*) were mostly in pools, whereas Red-legged frogs (*Rana aurora*) mostly occurred on stream banks. There were increased numbers of amphibians in intermediate-sized waters (Stream Order 3). Tailed frogs (*Ascaphus truei*) preferred riffle habitats, whereas giant salamanders were mostly in pools but some were also in riffles. A few Red-legged frogs (*Rana aurora*), Cascades frogs (*R. cascadae*), and garter snakes (genus *Thamnophis*) were on banks.

A different pattern emerged in larger waters (Stream Order 4-5; Table 10). Red-legged frogs (*Rana aurora*) and the introduced bullforg (*Rana catesbeiana*) were on banks. Cascade frogs (*R. cascadae*) and Yellow-legged frogs (*Rana boylei*) were mostly on stream banks, but some were also in splash zones. Garter snakes (genus *Thamnophis*) and Northern alligator lizards (*Elgaria coerulea*) were all along banks. Western pond turtles (*Clemmys marmorata*) were in pools or lateral pools; however, one was in a splash zone.

The use of habitats was fairly consistent over stream order (e.g., garter snakes of the genus *Thamnophis* occur on banks). There seems to be differentiation of habitat use by giant salamanders (*Dicamptodon tenebrosus*) that were mostly in pools and Tailed frogs (*Ascaphus truei*) that were mostly in riffles, which is a pattern observed elsewhere (Corn and Bury 1991, Welsh et al. *in press*). Larvae of the tailed frog have suctorial mouths and they attach to rocky substrates in riffles, where they might have better odds of avoiding the giant salamander) a known predator on the frog (Nussbaum et al. 1983).

DISCUSSION

To our knowledge, this is the first study to quantify the occurrence and relative abundance of amphibians and reptiles by stream order for any region in Oregon. There were differences in species occurrences in headwaters (Stream Order 1-2), intermediate waters (3rd order) and larger waters (4-5th order). For example, Tailed frogs (*Ascaphus truei*) were present in headwaters and intermediate-sized streams. They generally only occur in cold, fast-flowing streams (Stream Orders 1-3), which was a pattern present in the Little River AMA. Similarly, giant salamanders (*Dicamptodon tenebrosus*) were common in headwaters and intermediate-sized waters, but not in larger waters. Two species of ranid frogs occurred on occasion in 2nd-3rd Order Streams.

Larger waters were home to all three native ranid frogs (genus *Rana*), garter snakes (genus *Thamnophis*), alligator lizards (*Elgaria coerulea*), bullfrogs (*R. catesbeiana*; an introduced species), Pacific treefrogs (*Pseudacris regilla*), and western pond turtles (*Clemmys marmorata*). Apparently, the open aspect and warmer waters on large streams (4-5th order) favors reptiles, and several species of frogs. The Yellow-legged frog (*Rana boylei*) occurs in warm conditions as long as standing water is nearby. They frequent large streams and riverine habitats throughout its range from southern Oregon to Central California. We found few *R. boylei* in the Little River AMA and cannot explain why they have low abundance. This species is of regional concern and a separate study of its status is underway (M. Hayes, pers. comm.).

Stream Order is often determined from examination of topographic or other maps. When one permanent creek joins another, they are termed a second order site. However, many seeps, underground waters, intermittent streams and small waters are not recognized on topo maps.

In our study, we found three of the 3rd order streams (43%) to have less width than some categorized as Stream Order 2. The reverse also happened. Three of the Stream Order 2s were wider than those identified as #3. These discrepancies raises the question of what is more important to stream amphibians: stream size (width or volume) versus Stream Order (number of branches). There is a general relationship that cold-adapted species tend to only occur in small streams or headwaters, but it vital to define what size streams no longer support these species. Many of these species are most sensitive to habitat perturbations (e.g., timber harvest), and are State protected or of concern to land-use agencies.

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LITERATURE CITED

Bury, R. B. 1994. Vertebrates in the Pacific Northwest: species richness, endemism and dependency on old-growth forests. Pp. 392-404. *In* Majumdar, S. K., D. J. Brenner, J. E. Lovich, J. F. Schalles, and W. E. Miller (eds.). Biological Diversity: Problems and Challenges. Penna. Acad. Sci., Easton, Penna. 461 pp.

Bury, R. B., and P. S. Corn. 1988. Douglas-fir forests in the Oregon and Washington Cascades: relation of the herpetofauna to stand age and moisture. Pp. 11-22. *In* Szaro, R. C., K. E. Severson, and D. R. Patton (tech. coord.). Management of amphibians, reptiles, and small mammals in North America. USDA Forest Serv., Genl. Tech. Rep. RM-166. 458 pp.

Bury, R. B., and P. S. Corn. 1991. Sampling methods for amphibians in streams in the Pacific Northwest. *In* Carey, A. B., and L. F. Ruggiero (eds.). Wildlife-habitat relationships: sampling procedures for Pacific Northwest vertebrates. USDA Forest Serv., Genl. Tech. Rep. PNW-GTR-275. 29 pp.

Corn, P. S., and R. B. Bury. 1989. Logging in western Oregon: responses of headwater habitats and stream amphibians. Forest Ecology and Management 29(3):1-19.

Corn, P. S., and R. B. Bury. 1990. Sampling methods for terrestrial amphibians and reptiles. *In* Carey, A. B., and L. F. Ruggiero (eds.). Wildlife-habitat relationships: sampling procedures for Pacific Northwest vertebrates. USDA Forest Serv., Genl. Tech. Rep. PNW-GTR-256. 34 pp.

Corn, P. S., and R. B. Bury. 1991. Terrestrial amphibian communities in the Oregon Coast Range. Pp. 304-317. *In* Ruggiero, L. F., K. B. Aubry, A. B. Carey, and M. H. Huff (tech. coord.). Wildlife and vegetation of unmanaged Douglas-fir forests. USDA Forest Serv., Genl. Tech. Rep. PNW-GTR-285. 533 pp.

Gilbert, F. F., and R. Alwine. 1991. Terrestrial amphibian communities in the Oregon Cascade Range. Pp. 318-324. *In* Ruggiero, L. F., K. B. Aubry, A. B. Carey, and M. H. Huff (tech. coord.). Wildlife and vegetation of unmanaged Douglas-fir forests. USDA Forest Serv., Genl. Tech. Rep. PNW-GTR-285. 533 pp.

Good, D. A., and D. B. Wake. 1992. Geographic variation and speciation in the torrent salamanders of the genus Rhyacotriton (Caudata: Rhyacotritonidae). Univ. Calif. Publ. Zool. 126:1-91.

Hankin, D. G. 1986. Sampling designs for estimating the total number of fish in small streams. USDA For. Serv. Res. Pap. PNW-360. 33 pp.

Hankin, D. G., and G. H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Can. J. Fish. Aquat. Sci. 45:834-844.

Maser, C. , and J. Trappe. 1984. The seen and unseen world of the fallen tree. USDA Forest Service, Gen. Tech. Rep. PNW-164. 56 pp.

Nussbaum, R. A., E. D. Brodie, Jr., and R. M. Storm. 1983. Amphibians and reptiles of the Pacific Northwest. University Press of Idaho, Moscow. 332 pp..

St. Johns, A. 1985. The herpetology of the interior Umpqua River drainage, Douglas County, Oregon. To Oregon Dept. Fish and Wildlife, Contract 85-2-02. Unpub. Report. 80 pp.

Welsh, H. H., Jr., and A. J. Lind. 1991. The structure of the herpetofaunal assemblage in the Douglas-fir/hardwood forests of northwestern California and southwestern Oregon. Pp. 394-411. *In* Ruggiero, L. F., K. B. Aubry, A. B. Carey, and M. H. Huff (tech. coord.). Wildlife and vegetation of unmanaged Douglas-fir forests. USDA Forest Serv., Genl. Tech. Rep. PNW-GTR-285. 533 pp.

Welsh, H. H., Jr., L. Ollivier, and D. G. Hanken. *In press*. A habitat-based design to sample aquatic amphibians. Northwestern Naturalist.

Fig. 1. Schematic drawing of stream survey method in headwater habitat.