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Cover photo: Tagging a 45 mm stonefly presents somewhat different problems than tagging a white-tailed deer. The whitish patch on the upper shoulder of the stonefly in the cover photo shows abrasion of the original tag. Better placement of the second tag (#1487) solved the recapture identification problem. The stonefly story is on page 3. The deer article begins on page 4.

Superglue-tagged Stoneflies Aid Aquatic Food Web Research

By Jerry Freilich

Wildlife biologists and resource managers today routinely tag many kinds of animals to study home range, dispersal, and interactions among individuals. We read of tagging studies on bird species, wolves, bears, and even fish. My research adds a new and perhaps surprising creature to the list of tagged animals. I've been tagging individual stonefly nymphs (*Pteronarcys californica*) in Pacific Creek, Grand Teton National Park, Wyo.

Stoneflies (insect order Plecoptera) are important in the life of a stream. Most are predators feeding on mayflies and other aquatic insects. As such, they are vital components of aquatic food webs. The species I am studying, commonly called the Salmonfly, is the largest North American stonefly (reaching > 50 mm). It is a leaf-shredder and detritivore rather than a predator. These insects are especially important because their leaf-shredding activity creates fine particulate organic matter (FPOM) eaten by other insects. They're also important because they're large and thus too big for all but large fish to eat. *Pteronarcys* has a prolonged life-cycle, spending 3 years as an aquatic nymph. Their emergence as winged adults in early summer is as much anticipated by the flyfishing public as by the ravenous fish.

Tagging aquatic insects proved to be difficult (see general references in Walker and Wineriter 1981,

Wineriter and Walker 1984, and Emery and Wydoski 1987). Very few existing studies have done it, and most of those were conducted in either "lab streams" or slow water. I devised a method that worked on insects living in turbulent riffles and burrowing under rocks. The procedure that finally evolved uses plastic paper tags attached with gel-type Duro Super Glue™ (Loctite Inc., Newington, CT). Each tag is 2 x 3 mm and carries a 4 digit number. I learned that the tag's location on the insect is critical. Tags in the wrong location were badly abraded by the rocks and gravel in the streambed. I would be happy to provide other workers a detailed protocol for creating the tags, sealing them with clear epoxy, and attaching them.

Why Tag Aquatic Insects?

Most terrestrial ecologists could probably answer the question "what controls animal populations?" at least in general terms. In aquatic ecosystems, however, this question still is controversial (Hart 1983). Even such questions as whether predators control prey, or whether food is limiting in streams are largely unresolved.

My Ph.D. project involves resource limitation and intraspecific competition in *Pteronarcys*. I am trying to learn which factors influence the movement of individual insects in a stream. To do this I tagged 1500



Adult stonefly can reach 50 mm from stern to stern.

individuals in 2 seasons of field work. In 1987, I tagged 1008 and released them at the same place where they were caught. In 1988, I performed an experiment where I modified food and stonefly density in 36, 4m² quadrats.

Results from 1987

Head capsule widths showed that *Pteronarcys* has a 3 year life cycle in Pacific Creek. Females were larger than males (maximum 56 mm body length, 6.0 mm head width). Males reached 47 mm (5.1 mm head width). Only 2nd and 3rd year males and females were tagged. I recaptured 249 of the 1008 tagged (25%) between August and November.

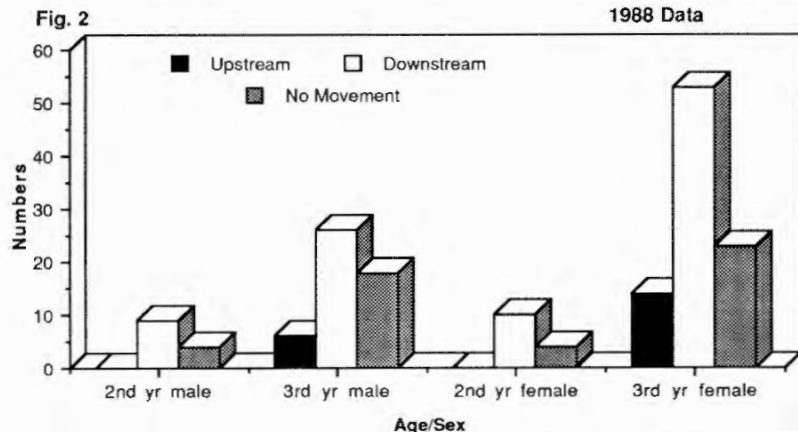
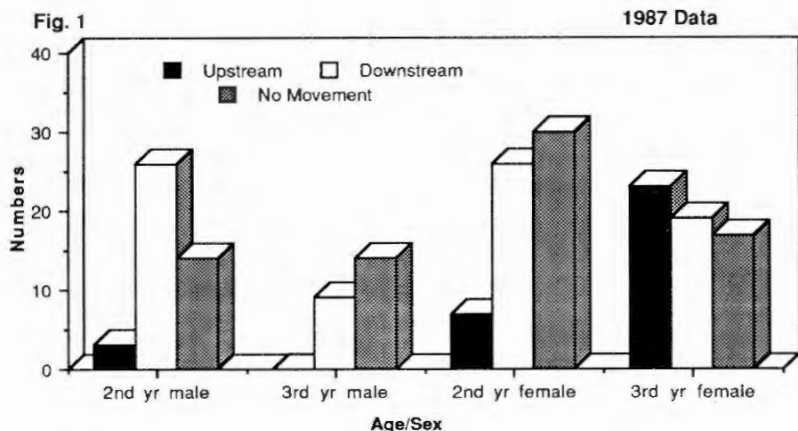
Pteronarcys were found in areas of fast, deep water with large, loosely bedded cobbles. None was ever found in a pool nor in an area with silty or fine gravel bottom. No tagged stonefly ever crossed a pool. Individuals of the same sex and size frequently were found together, a previously reported phenomenon (Elder and Gaufin 1973).

Results show that upstream movement largely balanced downstream movement. But all movements averaged -2.71 (i.e., downstream 2.71 m) if zero movements are removed. The absolute value of all movements averaged 9.05 m, with zero movements deleted.

A large percentage (43%) of the stoneflies recaptured were found at the same spot as their previous capture. Forty percent moved downstream and 17 percent moved upstream. Forty-two *Pteronarcys* were recaptured twice, 10 were recaptured 3 times, and 2 were recaptured 4 times. Multiple recaptures showed that an individual may move long distances in a short time and then sit in the same place for weeks before moving again.

A very few individuals were notable for extremely rapid upstream movements. These movements ranged from 6-22 m/d upstream (mean 10.6 m/d, n=8). The farthest upstream traveler was a large female that moved 40 m upstream in 4 days. The fastest was another large female that covered 22 m upstream in a single day. Upstream movement is clear evidence of self-propelled activity. Corresponding downstream movement could be attributed to drift, although not necessarily. ("Drift" is the well-known phenomenon of insects moving downstream with the current. *Pteronarcys* drifted little if at all).

One way ANOVA (analysis of variance) comparing the distances moved by males and females shows significant difference between the sexes. Figure 1 (based on a subset of the *Pteronarcys* that were



Graphs showing numbers of recaptured *Pteronarcys* stoneflies in 1987 (Fig. 1) and 1988 (Fig. 2) by sex and age class. In 1987, N = 188 that were reliably sexed. In 1988, N = 214 recaptures.

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clearly identifiable to age class, $n=188$) shows a breakdown of movements by size and sex.

Results from 1988

Conditions were somewhat different in 1988. Fewer *Pteronarcys* were found so only 486 were tagged. Recapture success was greater however (44%). Movements were smaller and there were few long or fast upstream travelers. Average total moved was -5.7 m showing increased downstream travel and fewer active upstream movements. Absolute value of all movements with zeros deleted was 8.1 m. Fifty-eight percent went downstream, 30 percent showed no movement, and 12 percent moved upstream. Figure 2 shows movements by size and sex in 1988.

I am still analyzing the data from 1988, and don't yet know if the addition of food or stoneflies was significant. Even without the manipulation results, it is obvious that great detail is obtainable using tagged individual insects.

Experiments about resource limitation will provide important information about the quality of aquatic habitats. Each animal species perceives its world on a different spatial scale. Does the "fine grain" important to a stonefly occur over 2-3 rocks in a riffle, or over 2-3 km along the stream? When we learn the fineness of scale important to aquatic invertebrates, we will then

know how to manage stream habitat for biotic diversity. We will also have better understanding of effects caused by natural floods and man-caused flow regime alteration.

Freilich is a graduate student in the UGA Dept. of Entomology.

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