# Investigations of Giant Garter Snakes in the Natomas Basin: 1998-1999

## INTRODUCTION

In April 1998 the Dixon Field Station of the Western Ecological Research Center (U.S. Geological Survey) began a survey for giant garter snakes (*Thamnophis gigas*) in the San Joaquin Valley. The purpose of this survey was to determine if giant garter snakes were still extant in selected areas where they had previously been described, and, if so, to estimate their relative abundance and distribution. This work was done in cooperation with and on the lands of the Grasslands Water District, the California Department of Fish and Game, and the U.S. Fish and Wildlife Service.

## MEHODS

From April 6 to August 19 we sampled wetland habitats for giant garter snakes using modified floating minnow traps placed at the edges of canals, channels, and vegetation. Selected locations were trapped (100 traps each) for two to three weeks during this time period (Figures 1-4). Traps were checked daily for captures and technicians also searched for snakes by walking the edges of these habitats. Captured snakes were weighed, measured, and marked with passively induced transponder (PIT) tags using protocols established by the Dixon Field Station. Locations of the traps and captured snakes were determined with global positioning system (GPS) recievers with an accuracy of 5 meters.

## RESULTS

We captured seven female and four male giant garter snakes during our surveys for a total of eleven individuals. Eight additional captures were recaptures of some of these snakes. Males were smaller than females, in keeping with our results from the Sacramento Valley. Snout-vent length ranged from a 556 mm male to a 965 mm female and weights ranged from an 84 g male to a 790 g female (Table 1). These snakes had checkered scale patterns with light colors in comparison to the generally darker giant garter snakes we have captured in the Sacramento Valley.

Cover from aquatic vegetation was present at all capture loctions; terrestrial vegetation was also present at one location. Fourteen captures (including recaptures) were in natural channels or sloughs and four captures were in irrigation canals. Trapping was most successful in May with eleven captures; we caught five in June and three in August.

We found the majority of our giant garter snakes in the North Grasslands with seven caught in Los Banos Creek and three caught at the Volta State Wildlife Area (Figure 5). We caught one snake in the South Grasslands (Figure 6). Considering the areas searched and the time spent trapping, we caught relatively few giant garter snakes. Snake densities in areas where we found them seemed extremely low in comparison to our study areas in the Sacramento Valley. Unusually wet, cool weather during spring and extensive late flooding of the study areas may have interfered with our ability to find and trap snakes, and could account for these low number of giant garter snakes. Our observations may also reflect reality, and numbers of giant garter snakes are low in the sampled areas.

locations with an error of about 5 meters. We also recorded environmental characteristics of the sites of snake captures, such as vegetation and substrate types and ambient temperature.

**Measuring and Marking**

Each snake was processed as soon as possible after capture to determine weight, total length, snout to vent length, and sex. Taxonomic features were also quantified such as labial scale counts on the head and dorsal scale counts at mid-body, and stripe and background color. Individuals were implanted with passively induced transponder (PIT) tags for permanent identification. All snakes were released at the point of capture as soon as possible after they were processed except for those who were selected for telemetry.

**Telemetry and Habitat Use**

Larger individuals (generally over 200 grams) were chosen to be implanted with radio transmitters for telemetry study. Seven snakes were chosen for telemetry from the Elverta Site and five were chosen from the Fisherman's Lake Site. Signal pulse rates of radios indicated temperatures of snakes. Surgery to implant radios was done at the Wildlife Health Center, Institute of Toxicology and Environmental Health, University of California, Davis. After recovery of ten days to two weeks, radio-implanted snakes were returned to the study areas at their point of capture. Periodically over the course of this study these snakes were recaptured, weighed and measured, and checked for overall body condition. Snakes were retrieved from the field and their radios removed when radios were showing signs of failing or when the snakes were determined to be in poor health. After a period of recovery these snakes were returned to the location of their last capture.

Hand-held and vehicle-mounted telemetry systems were used to locate snakes. Coordinates of all verified snake locations were recorded with GPS units. When we could not access areas occupied by radio-implanted snakes, we estimated their locations by triangulation. Snakes were monitored daily with a goal of obtaining at least two locations each week in each of five time periods throughout the daylight hours. Where possible, we recorded surrounding environmental characteristics of each positively identified snake location. Home ranges were calculated from telemetry locations for individual snakes over the course of the study with the adaptive kernal method of Worton (1989).

Habitats were categorized as rice, ditch, slough/riparian, fallow field, and other (such as field roads). For habitat use analysis we divided time periods into spring and summer using calendar designations of these seasons. The period of overwintering for the snakes was the remainder of the year. We also separated our observations according to location of the snakes in either the Elverta site or the Fisherman's lake site. Data are only available from the Fisherman's Lake site for 1998 because of radio failure and mortality of the radio-marked snakes.

## Density Estimates

We estimated densities of giant garter snakes along trap lines in ditches where we had sufficient recaptures to make estimates. We used the methods of White and Garrott (1990) and the program CAPTURE. Population estimates are problematic because of the indeterminate nature of population boundaries in this situation. We felt it more appropriate to estimate the numbers of snakes per linear distance because of their tendency to use linear habitat such as ditches and field edges.

# RESULTS

## Demography

We caught a grand total of 277 individual giant garter snakes during this project: 104 in 1998 and 173 in 1999. Of these individuals 108 were males and 169 were females. We also recaptured about 25% of these individuals. Figure 2 shows the locations of snake captures. Access to a greater number of properties in 1999, such as land controlled by the Sacramento Airport, allowed us to catch more snakes than in 1998.

Female snakes grew larger in length and weight than males snakes (Figures 3 and 4) with a maximum snout/vent length of over 1100 mm and maximum weight of 900 g; male snakes were generally less than 800 mm snout/vent length and weighed less than 250 g. We caught more female than male snakes likely because the females' greater size made them more visible and vulnerable to capture. Unbiased passive sampling with traps from this and other study sites indicates the true sex ratio for giant garter snakes is 1:1 (Wylie et al. 1996, 1997). With more extensive use of trapping in 1999 we caught greater numbers of smaller snakes than in 1998, which reduces our concern about recruitment into the population in the Natomas Basin. Using categories of mass as surrogates for age classes, giant garter snakes in the Natomas Basin appear to have a reasonably healthy population age structure (Figure 4).

Estimates of linear densities of giant garter snakes ranged from 8-52 per kilometer for the four trap lines where we had sufficient recaptures to make estimates (Figure 5). The Elverta site yielded higher densities than areas west of Highway 99 (Figure 5), although this difference may not be statistically or biologically meaningful. For comparison, our density estimates for giant garter snakes in a canal at Colusa National Wildlife Refuge (Colusa County) were 50-60 snakes per kilometer (Wylie, unpublished data). Although we feel it is most appropriate to associate densities of giant garter snakes with linear distance, we do not imply that the remaining surface area of surrounding habitat has no influence on their well being.

## Habitat Use

At the Elverta site in spring, 80-90% of our observations of radio-marked snakes were in ditches with the remainder in rice fields (Figure 6). Rice fields are usually dry until mid May and become emergent habitat during late spring in most years. Snakes began to use rice fields shortly after vegetation emerged in late spring. In 1998 the weather was unseasonably cool and wet, and rice planting was delayed, which likely explains the reduced use of rice in spring 1998 (8% of observations) compared to spring 1999 ( 18% of observations). In summer, when rice fields were established as emergent habitat, snakes used them in approximately half of our observations; they used ditches in the other half of our observations (Figure 6). When snakes were in rice fields they primarily used the edges of the field perimeter or along the check dikes. Rice fields were used until early October when they were completely dewatered. Giant garter snakes then used ditches which retained water the longest after rice harvest and overwintered in burrows high in the ditch banks.

Habitats used by radio-marked snakes at the Fisherman's Lake Site was dominated by the Fisherman's Lake slough channel itself with use of adjacent rice fields making up most of the remaining summer observations (Figure 6). Irrigation canals branching off from the slough were seldom used. Again, snakes used the edges of the slough habitat near the banks. They also overwintered in burrows in the ditch banks.

Vegetative cover, either aquatic or terrestrial or both, was present at nearly all relocation sightings of radio-marked snakes at both sites (Figure 8). Vegetative cover was composed of emergent aquatic plants (tules and cattails), floating aquatic plants (marsh primrose) annual grasses (salt grass, water grass, foxtail, etc.) and annual weeds (thistles, lamsquarter, smartweed, etc.) Because snakes were often at the land-water interface, the vegetative cover surrounding them was often a mix of aquatic and terrestrial species (Figure 8).

Home range estimates for radio-marked snakes ranged from 13 to 87 ha with a median of 35 ha with no apparent difference between the Elverta and Fishermans Lake sites (Table 1). Examples of home range shapes are seen in Figures 9 and 10 and examples of movements are seen in Figures 11 and 12.. For comparison home ranges were 2-86 ha (median 16) at Gilsizer Slough (Sutter County) and 9-838 ha (median 53) at Colusa National Wildlife Refuge.

## DISCUSSION

In the marsh-like habitat of Fisherman's Lake, radio-marked snakes extensively used the slough habitat and seldom ventured into surrounding rice fields. Fisherman's Lake likely provides a stable habitat from which snakes were seldom forced to venture. This site is similar to our other study areas of Gilsizer Slough and Badger Creek, and provides an example of how created marshes could sustain populations of giant garter snakes. However, extensive excavation of bank edges and the channel bottom and removal of vegetation during 1998 may have significantly altered the habitat value of Fisherman's Lake for giant garter snakes.

At the Elverta Site, giant garter snakes used rice fields when they became emergent habitat. Associated ditches and canals were important habitat even when rice fields were available; they provided the only habitat at other times. We also captured significant numbers of giant garter snakes in rice fields and ditches near the Sacramento Metropolitan Airport. Although giant garter snakes primarily used the edges of rice fields, the overall importance of rice fields to giant garter snakes in the Natomas Basin should not be underestimated. Rice fields likely function to produce populations of food organisms to sustain snake populations and could be vital nursery areas for young snakes (George Hanson, personal communication). Emergent rice fields are also refuges for snakes when adjacent ditches are drained or are denuded by weed control.

At times in spring and fall the only habitats available to giant garter snakes in the Natomas Basin are canals and other ditches. Even these habitats are restricted if water is not being delivered or drained through them. At the time of year when snakes are active disturbance of ditch banks for maintenance or weed control can be ameliorated if the maintenance is done when snakes have refuges available in emergent rice fields or when water is prevalent in connecting ditches.

Regardless of the habitat value of individual rice fields, the combined effects of rice agriculture on the landscape, of keeping water in ditches, canals and sloughs (which in turn become linear marshes), is important in providing habitat for giant garter snakes. In the 1980s and early 1990s vegetative cover used to be markedly more abundant along ditch banks according to the long-term observations of George Hanson (personal communication). Management for giant garter snakes in the Natomas Basin can be improved in a strategy of benign neglect by allowing vegetative cover along ditches, canals and sloughs. More habitat could also be provided by maintaining water in drainage ditches for longer periods of time either by manipulating water control structures or by altering the morphometry of the ditches. Maintenance of water in ditches would be most important in spring, after snakes become active and before rice is planted, and in fall, after rice fields are drained and before snakes enter dormancy.

Our radio-marked snakes overwintered in burrows in ditch banks where they remained relatively inactive from mid-October to April. Physical disturbance of ditch banks should at least be avoided until the weather warms appreciably in spring when snakes will have likely left their burrows. Guidelines already exist to minimize earth work and other ditch maintenance impacts on giant garter snakes and our data reinforce the importance of these guidelines. Several snakes were killed by construction activity in the Natomas Basin when they were excavated from their burrows in ditch banks during the unusually cool spring of 1998.

Given the distribution of our snake captures within the Basin (Figure 2), giant garter snakes probably exist throughout the Basin where suitable habitat is available. Although giant garter snakes are relatively abundant in some areas of the Natomas Basin, their habitat has apparently degraded with time and the quality of habitat is less than at other geographic locations in which we have found this species (Wylie 1996, 1997). Given the possible 10-15 year life span of these snakes and their fecundity of 15-25 young per female per year, there is great potential to enhance populations of giant garter snakes in the Natomas Basin by appropriate habitat management and habitat creation. Because of the projected net loss of habitat in the Basin as development proceeds such habitat management and creation will be required to sustain (let alone increase) current numbers of giant garter snakes. Existing rice agriculture could become better habitat with the recommended low cost management recommendations found in existing guidelines (California Rice Industry Association, 1995). Experimental approaches to habitat creation will also be useful in assessing design criteria for giant garter snakes. Gilsizer Slough (Wylie 1996, 1997) is a good model for how inter-connected wetlands and appropriately managed rice fields would work together on the landscape to support healthy giant garter snake populations. Badger Creek (Wylie 1997) is another model of permanent emergent marsh habitat that supports giant garter snakes. A blend of permanent marshes and appropriately managed rice fields would be the most practical approach to maintaining giant garter snake numbers in the Natomas Basin.

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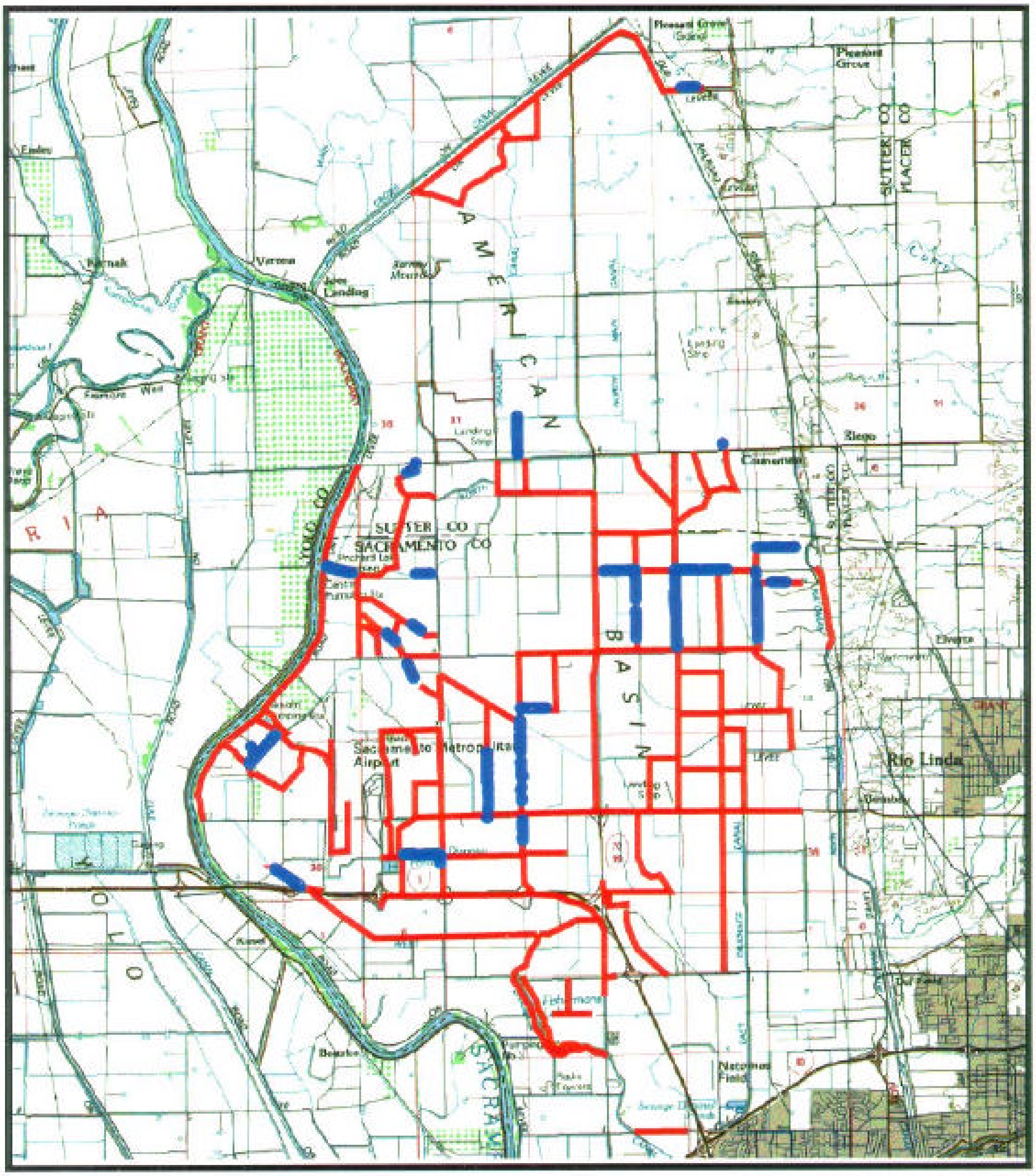
Figure 1. Search locations for giant garter snakes in the Natomas Basin.




0 1 2 3 4 5 Kilometers

Trap Locations
Transects

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Figure 2. Capture locations of giant garter snakes in the Natomas Basin.

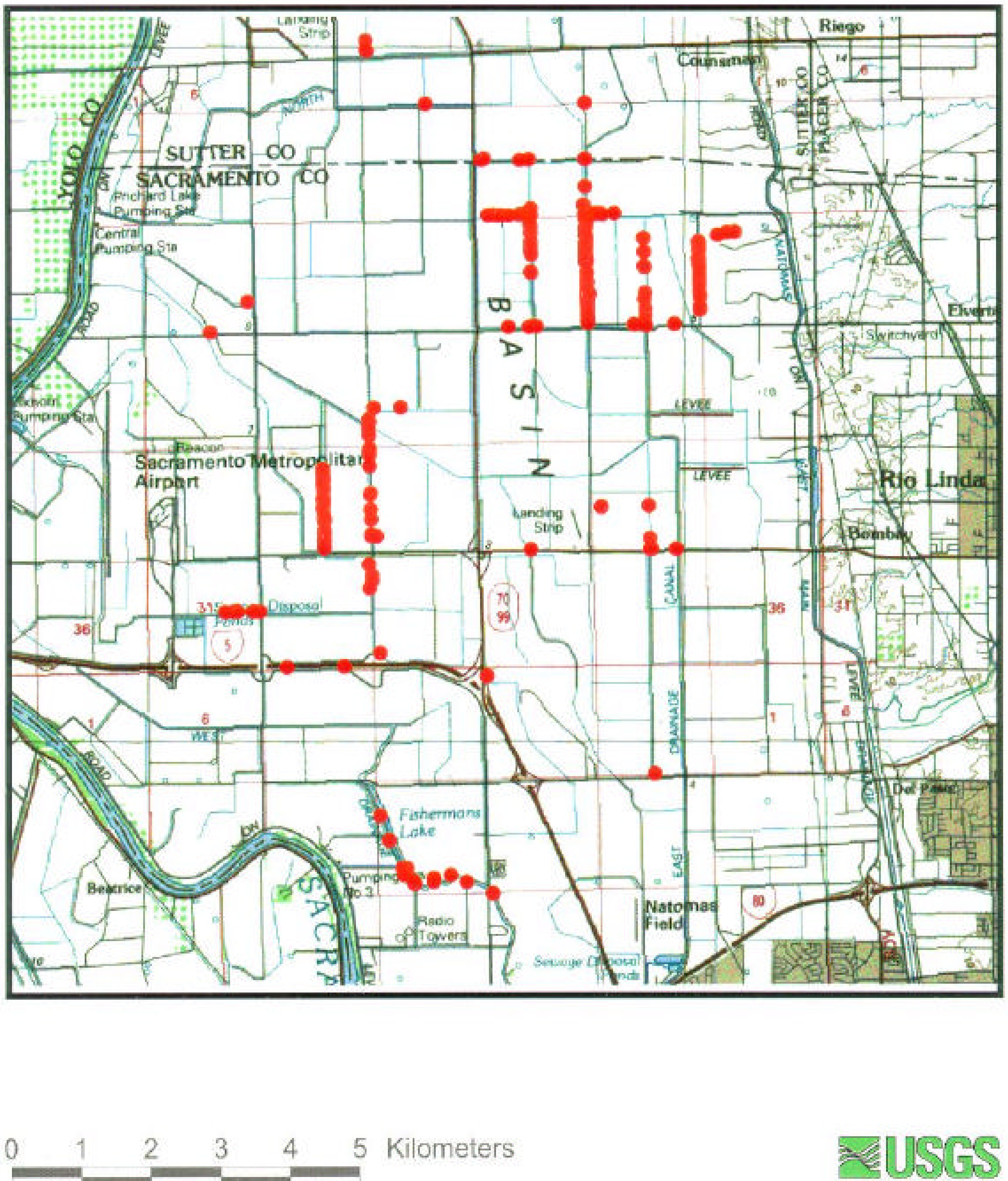


Figure 3. Snout-vent length classes for giant garter snakes from the Natomas Basin.

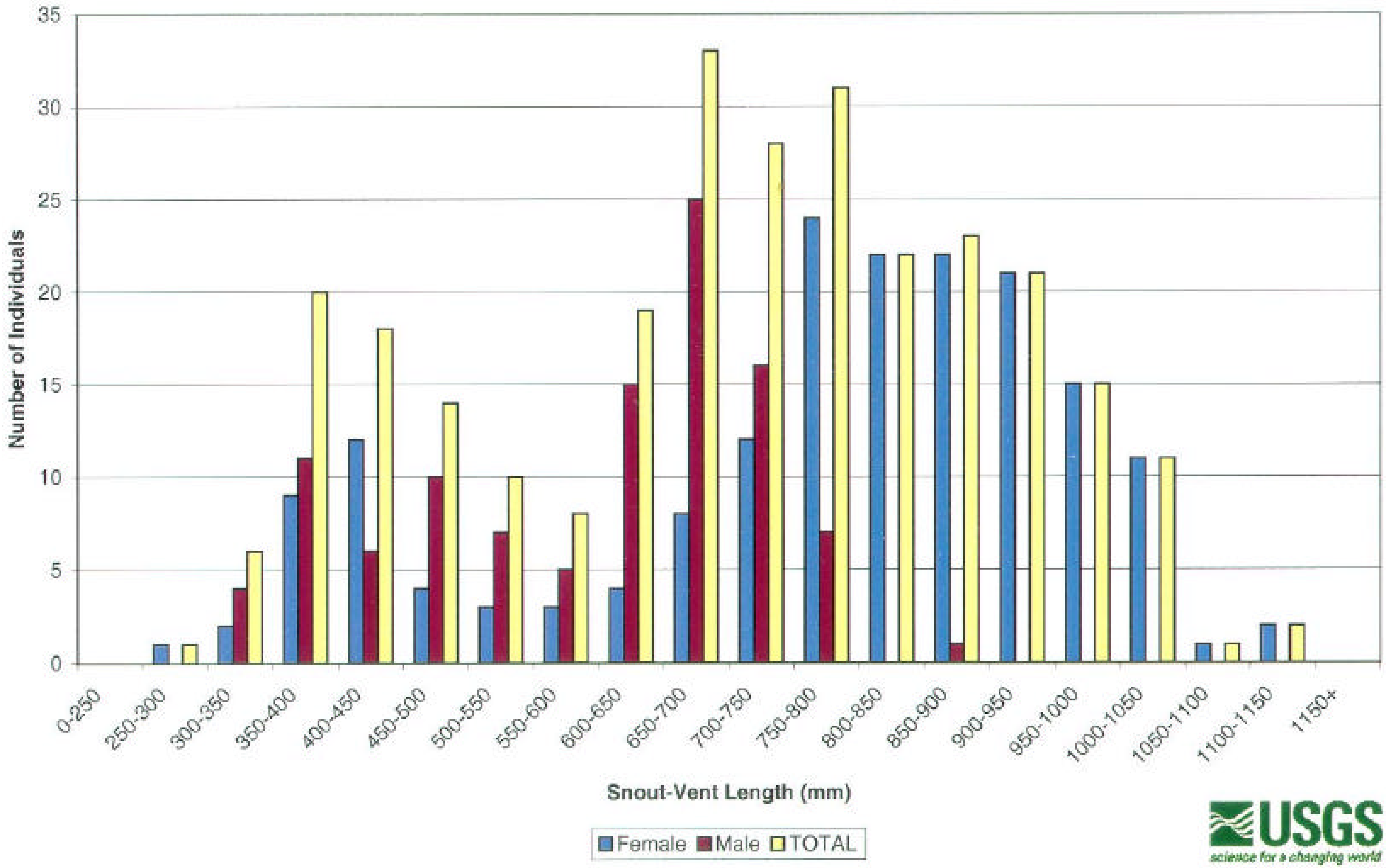
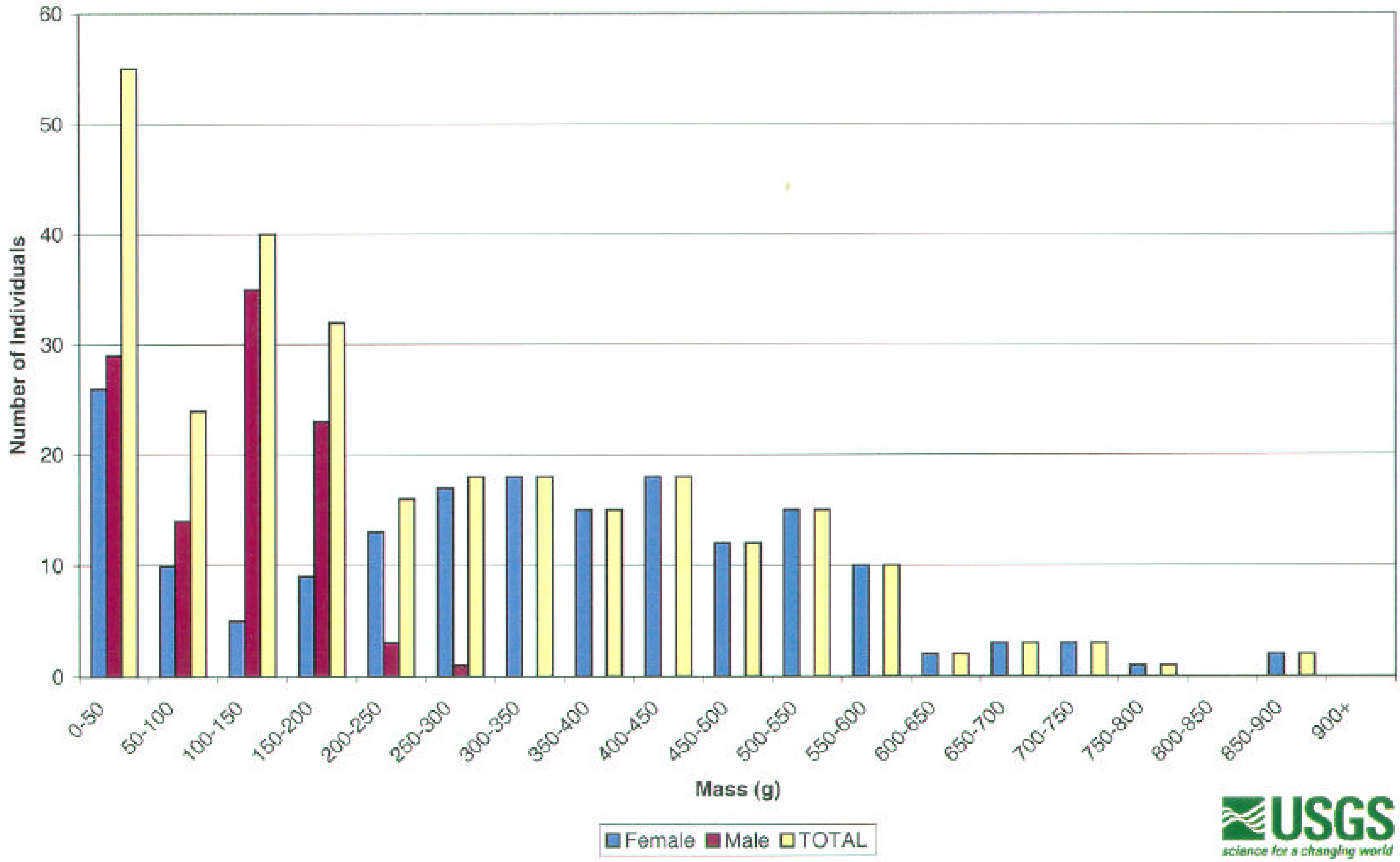


**Figure 4. Weight classes for giant garter snakes from the Natomas Basin.**

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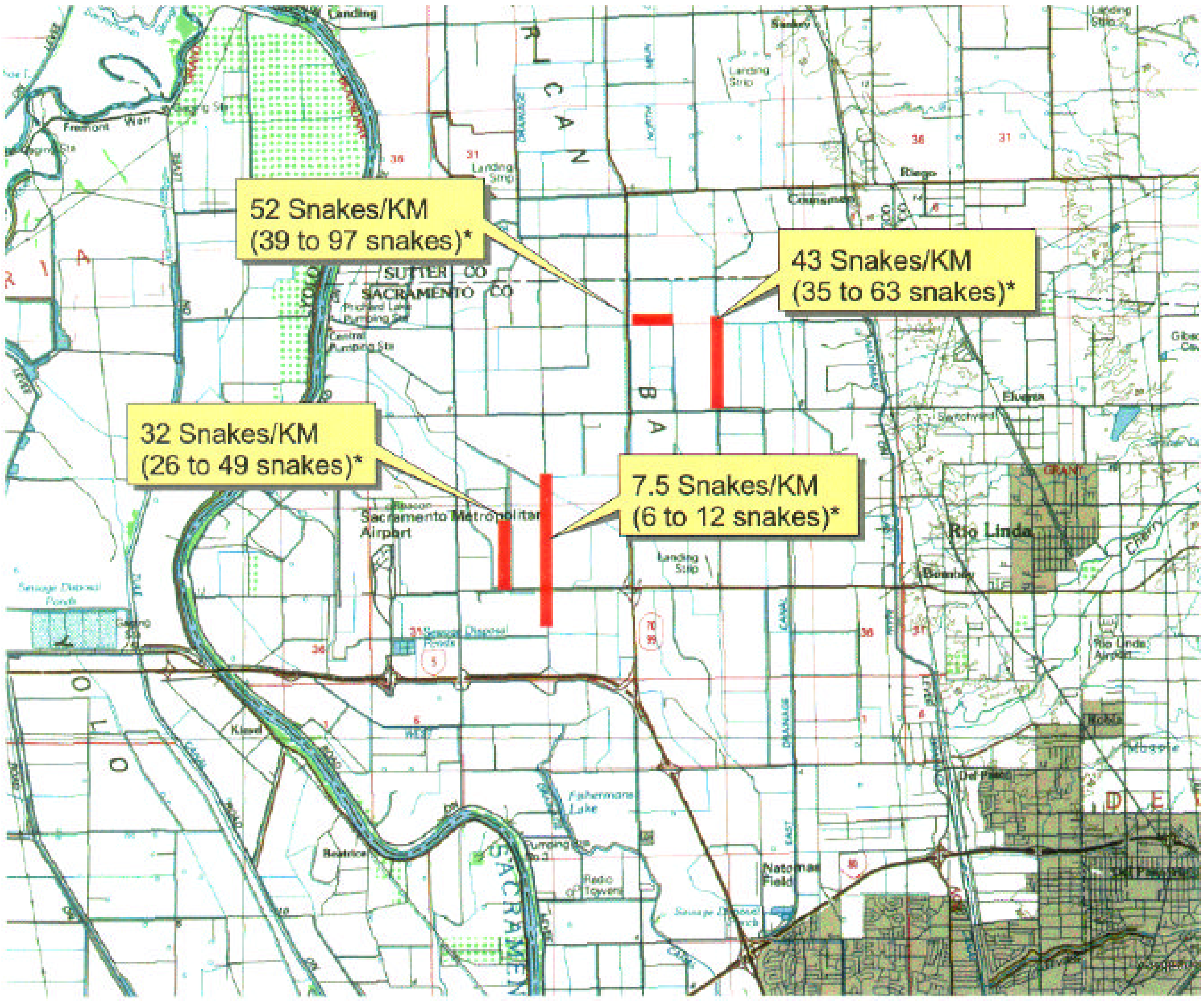
# Figure 5. Giant garter snake population densities along linear ditches in the Natomas Basin, 1999.




* denotes 95% Confidence Interval for population estimate

trap line used for density estimate

**Figure 6. Habitat use of giant garter snakes in the Natomas Basin.**

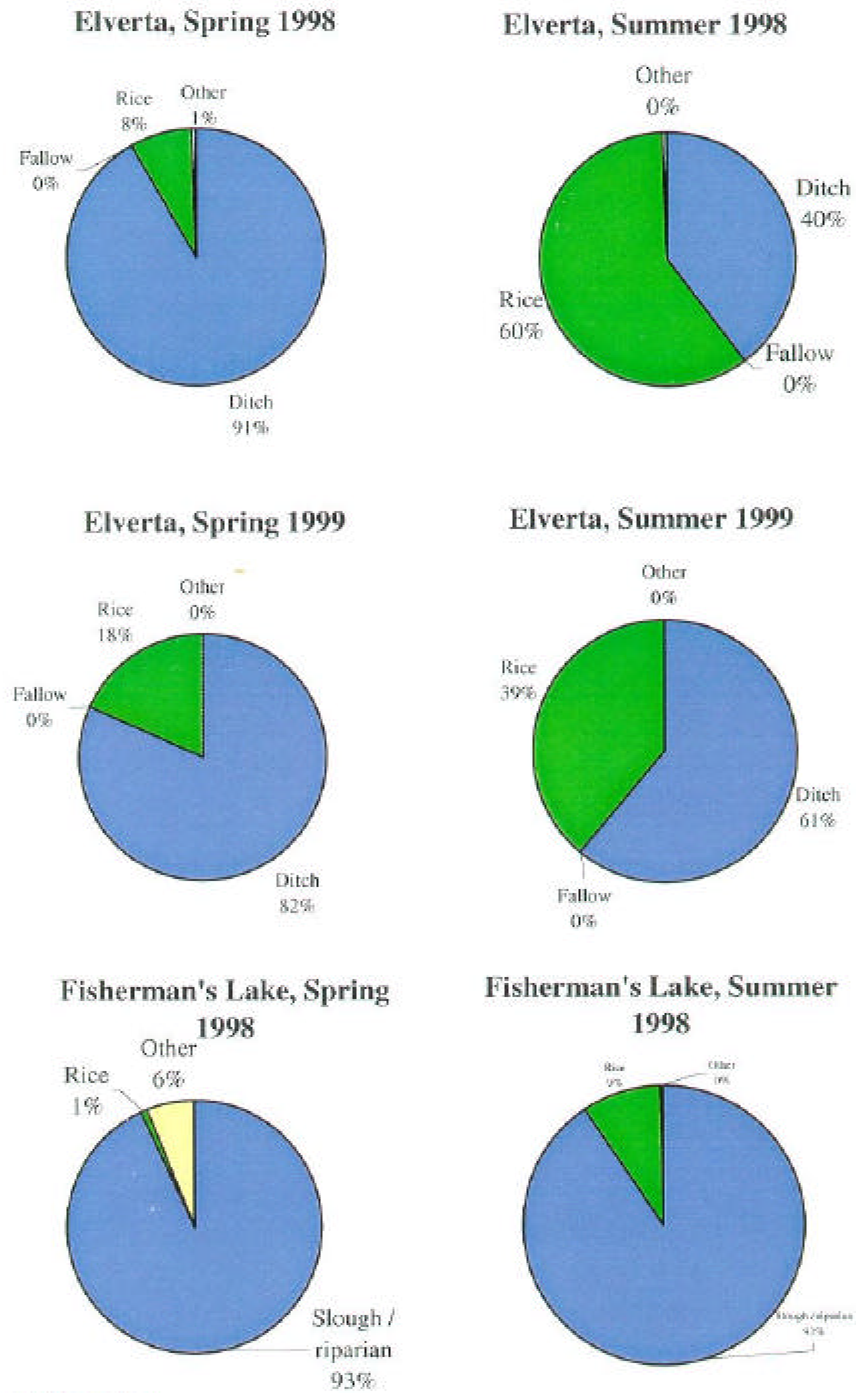



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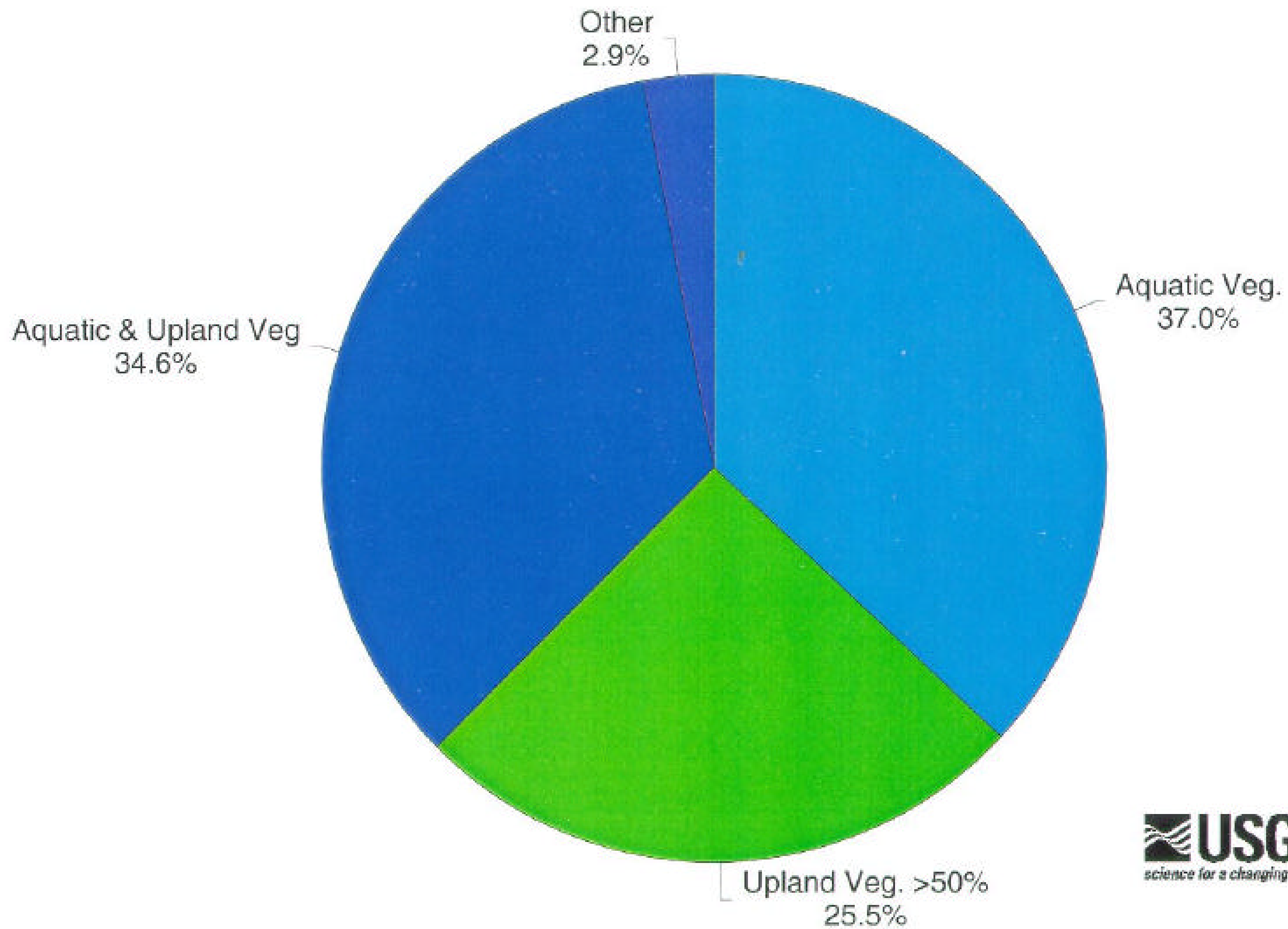
**Figure 7. Cover classes for habitats used by giant garter snakes at the Elverta site.**




Cover class corresponds to the area within a .5m radius of the snakes location.
Data from summer 1998 and 1999.

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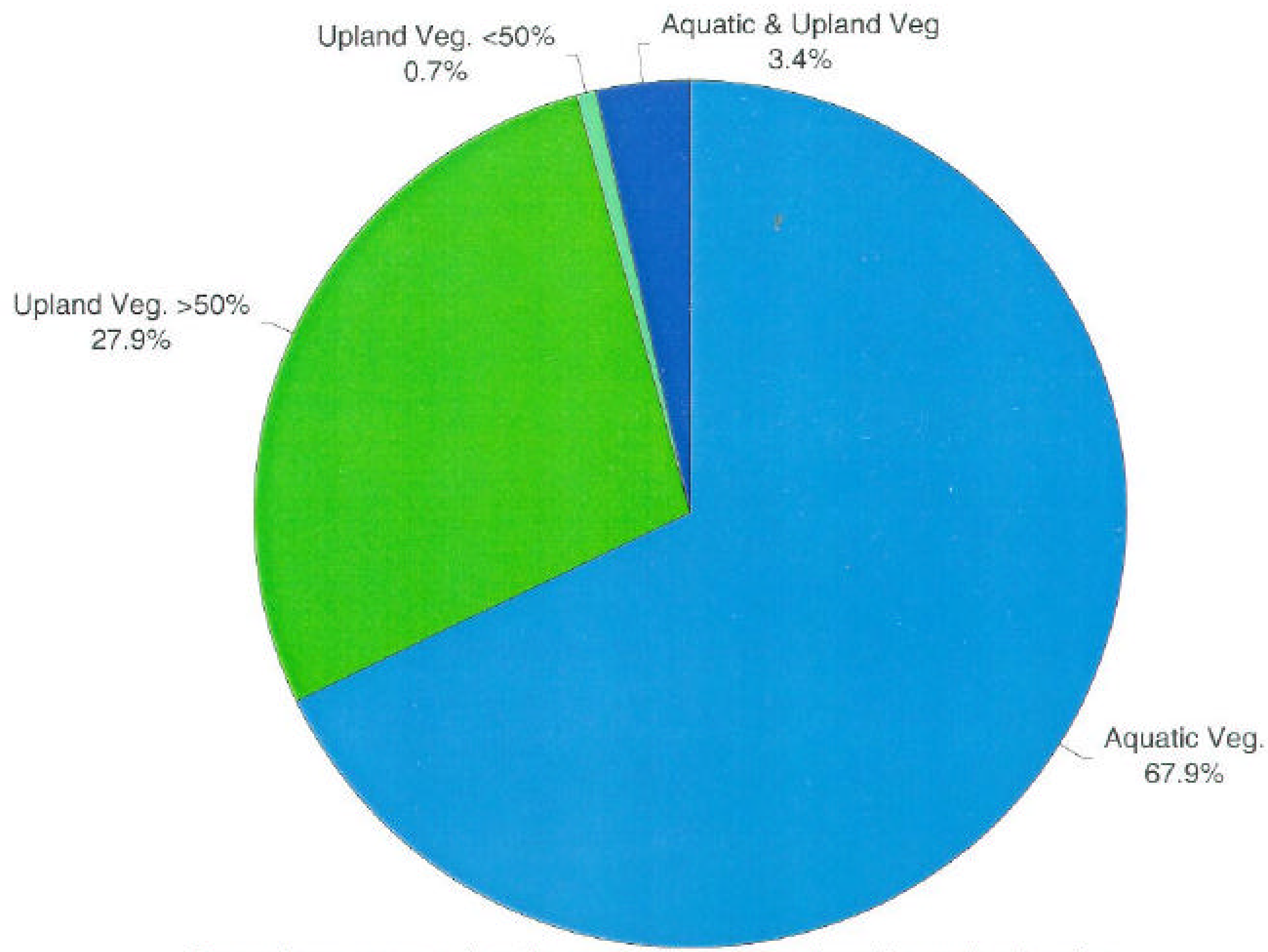
**Figure 8. Cover classes for habitats used by giant garter snakes at Fisherman's Lake.**




Cover class corresponds to the area within a .5m radius of the snakes location.

Summer 1998 data only.

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Figure 9. Examples of home ranges for two giant garter snakes at the Elverta site.

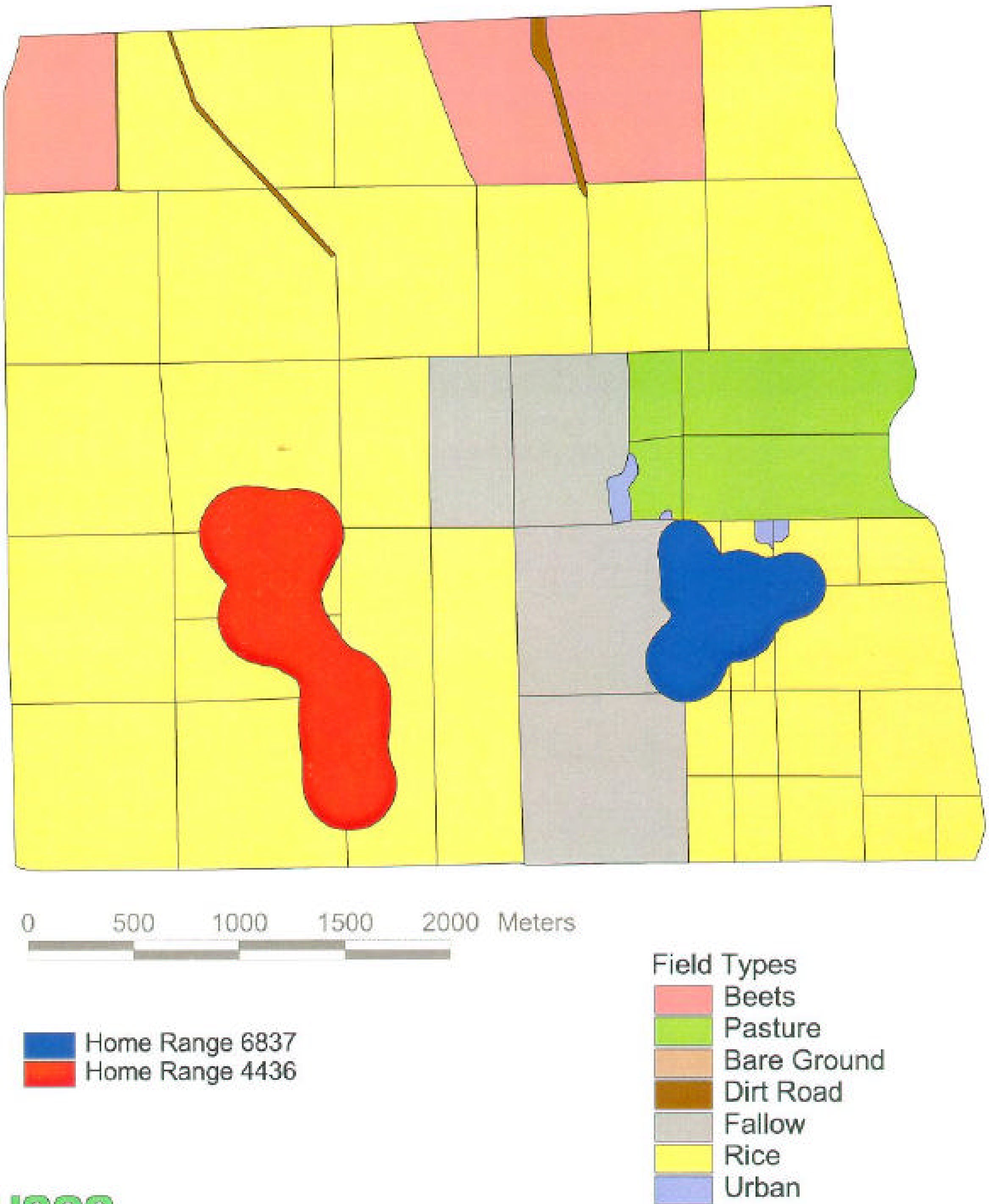


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Figure 10. Examples of home ranges for two giant garter snakes at the Fisherman's Lake site.

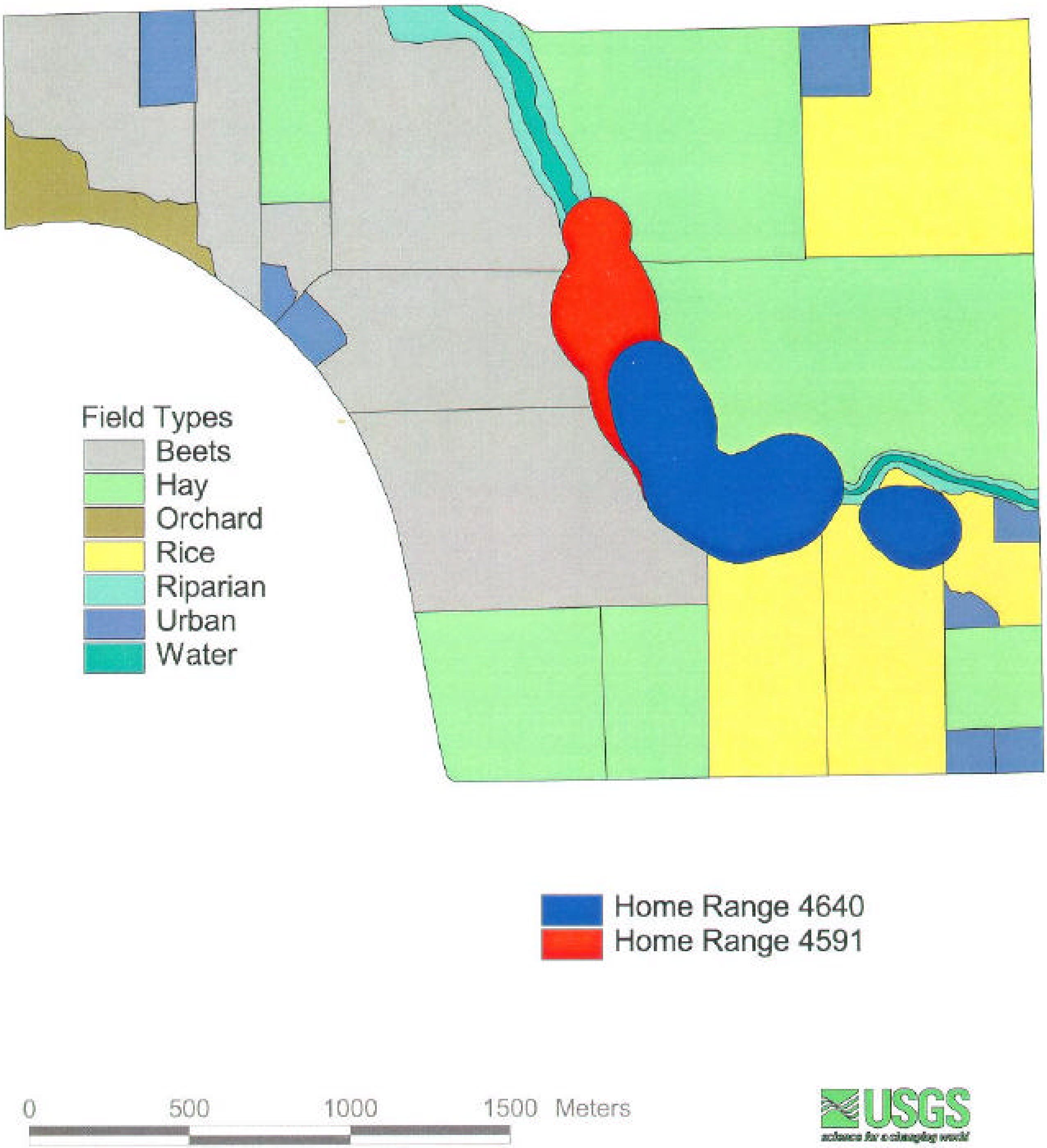

Figure 11. Movement patterns of individual radio-marked giant garter snakes at the Elverta site.

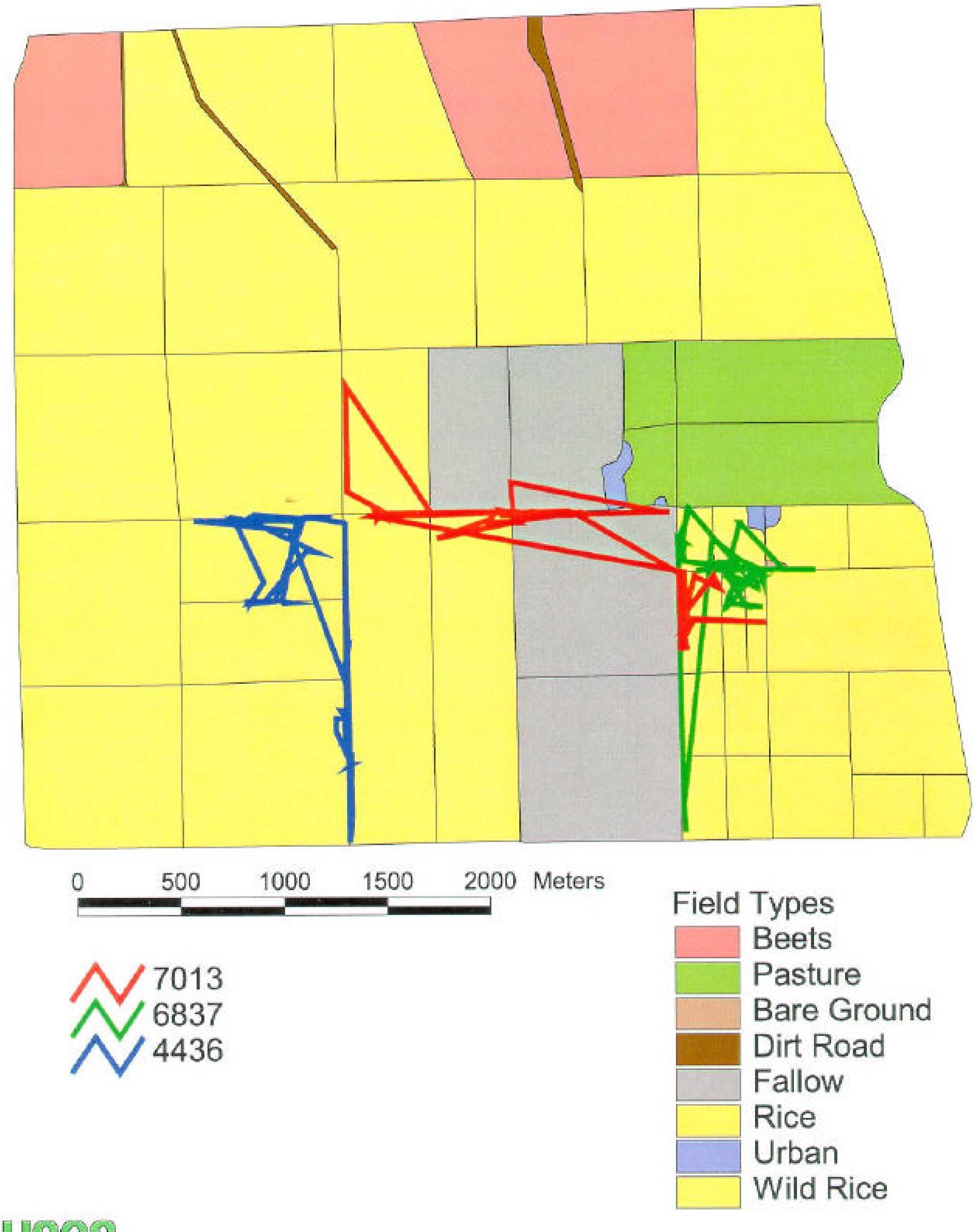


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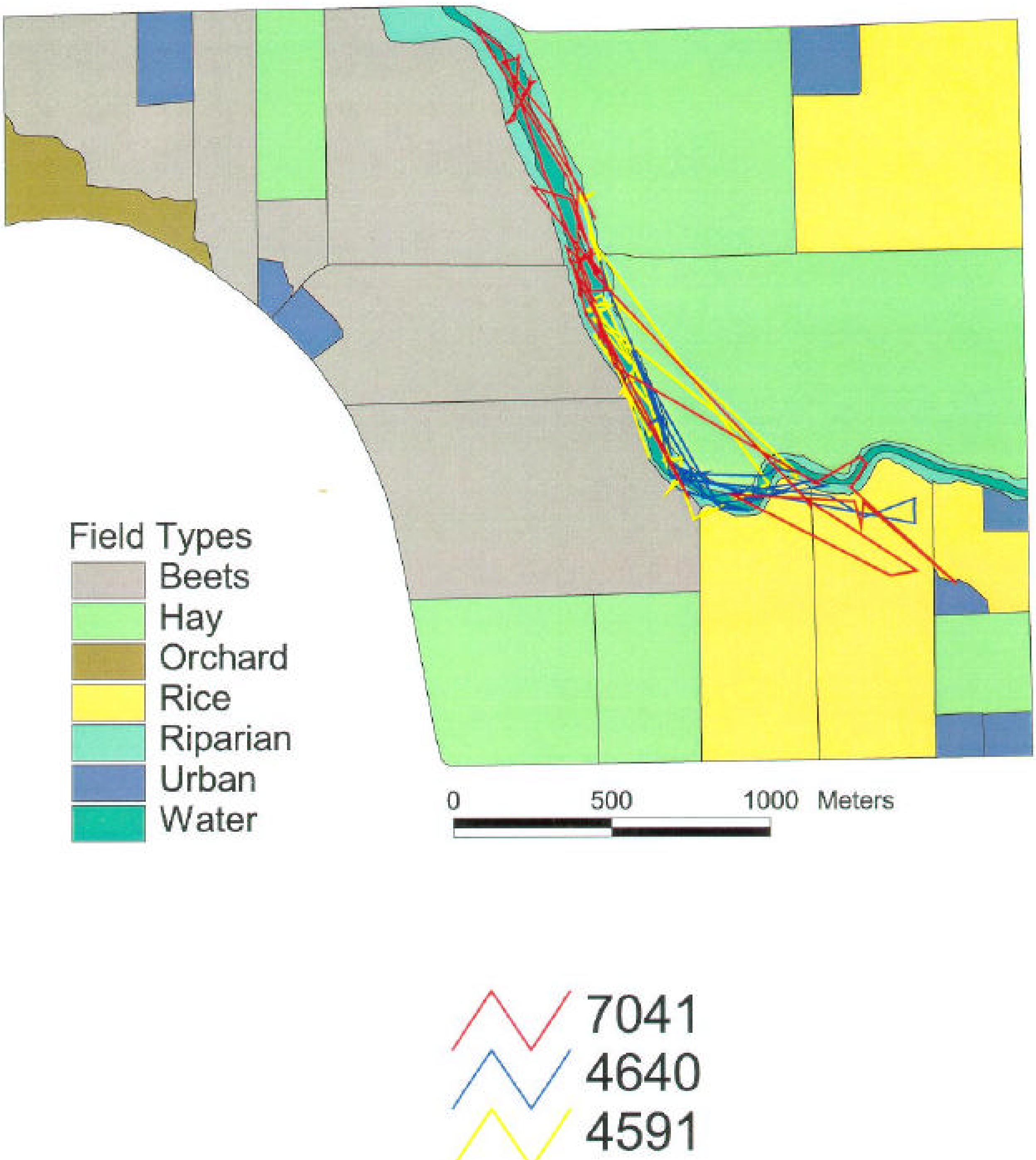
Figure 12. Movement patterns of individual radio-marked giant garter snakes at the Fisherman's Lake site.

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