TRINITY RIVER RIPARIAN WILDLIFE SURVEY - 1990

FINAL REPORT - PREPARED FOR:

Wildlife Task Group

Trinity River Restoration Project

Weaverville, California

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INTRODUCTION

The construction of Trinity and Lewiston Dams on the Trinity River has resulted in major changes in the riparian zone both above and below the dams. These impacts on riparian habitats have probably resulted in significant changes in population densities and habitat availability for wildlife in the Trinity River Basin. Riparian and upland habitats were inundated for many stream miles with the filling of the two reservoirs during the mid-1960s. This habitat is irretrievable. Riparian habitat has changed below Lewiston Dam due to diversion of historic flow volumes and regulation of the existing releases. Riparian vegetation has responded to these changes in flow regime with changes in overall acreage, species composition, and successional stage.

A comparison of pre- and post-project conditions reveals a tremendous expansion and encroachment of riparian vegetation occurred between 1960 and 1977 (Evans 1980). Small patches of streamside vegetation were present prior to project construction, but the post-project riparian zone is characterized by a narrow (usually less than 30 meters wide) strip of vegetation on both sides of the river (Evans 1980).

Stable flows during the May-October period, rather than reduced discharge, was thought to be the main factor favoring vegetal encroachment (Pelzman 1973). The lack of abrasive winter and spring flood flows after dam construction is thought to be another factor favoring encroachment of riparian vegetation (Pelzman 1973).

<u>Impacts on Wildlife</u>

These changes in the riparian habitat structure may influence the wildlife species abundance and richness of the Basin. Along much of the mainstem channel below the dam, riparian vegetation has reached later successional stages because it is seldom subject to the stresses of periodic flood flows. Wildlife use patterns of these older riparian patches are unknown and the regeneration potential for this older riparian stands without periodic flooding is uncertain (Pelzman 1973). Seasonally flooded marsh areas, historically caused by cut-off meanders and side-channel pools, have been largely eliminated or are now filled. Because of the decline in fish populations since the dam, the use of these areas by bald eagles, osprey, and other fish dependent wildlife species was probably adversely impacted.

An adequate assessment of the effects of all of these changes on riparian-associated wildlife species has yet to be completed. Evans (1980) conducted a study that recorded presence or absence of wildlife species along the Trinity River, but did not provide quantification. Field work is needed to determine the current habitat use patterns of wildlife in the basin and to identity wildlife species that may be potential "indicator species" to monitor wildlife population trends in the upper Trinity basin.

OBJECTIVES

The goal of this study was to conduct a wildlife inventory of the Trinity River between Lewiston Dam and the North Fork and identify riparian associated species. To achieve this goal, this study addressed two primary objectives:

1. Quantify the relative abundance and habitat association patterns of wildlife species in riparian habitats.

    - Gather baseline data on diurnal birds using fixed point counts in all available riparian habitat types.

    - River surveys of fixed distances will be conducted to gather data on riverine birds, mammals and reptiles to determine relative abundances, distributions, and associated habitats.

    - Gather baseline data on small mammal populations using pitfall traps.

    - Gather baseline data on herpetofauna (salamanders, frogs, lizards, snakes) using pitfall traps and time-constrained searches.

2. Identify sensitive riparian-associated species.

- Define the types of riparian habitat present and describe the species associated with each.

- Suggest research needs for sensitive wildlife species.

- Propose management guidelines to maintain and/or enhance populations of sensitive wildlife species in the study area.

STUDY AREA

We studied a 39 mile stretch of the mainstem Trinity River from below Lewiston Dam downriver to the confluence with the North Fork of the Trinity River (hereafter called North Fork), Trinity County, California. Sixty percent of the land adjacent to the river along this stretch is managed by the Bureau of Land Management. The majority of the remainder is privately owned, with a small portion belonging to the U.S. Forest Service. The elevation of the river ranges between 420 and 550 meters.

The dominant canopy tree species include Alnus rhombifolia (white alder), Salix lasiandra (yellow willow), and rarely Populus Fremontii (Fremont cottonwood) or P. trichocarpa (black cottonwood). Sub-canopy tree and shrub species include Salix Hindsiana (sand-bar willow) and Salix melanopsi. Understory species include Rubus spectabilis (salmonberry), sedges (Carex spp.), rushes (Juncus spp.), horsetail (Equisetum arvense), and various annuals. Evans (1980) defined four broad habitat types within the riparian zone: (1) bare rock or gravel bar, (2) willow dominant, (3) willow/alder mix and, (4) mature alder/cottonwood. The width of the riparian zone varies from 5 m to 50 m wide. The oldest and most mature areas are closest to the dam because of the controlled flows, which prevent flooding. Further downstream, feeder streams contribute variable flows and create periodic flooding, resulting in some younger riparian vegetation. Mining tailings are extensive along the bottom third of the study area; some with scattered willows, and others barren of vegetation. Humans inhabit many areas along the floodplain, possibly affecting wildlife composition, distributions, and movements.

The associated upland habitat may be categorized as montane hardwood-conifer or montane hardwood (Mayer and Laudenslayer 1988). The north facing slopes fit the description of montane hardwood-conifer, a diverse habitat consisting of a broad spectrum of mixed, vigorously growing conifer and hardwood species. Conifers, to 65 m (200 ft) in height, form the upper canopy and broadleaved trees, 10-30 m in height, comprise the lower canopy. Common trees species associates are ponderosa pine, Douglas-fir, California black oak, tanoak, Pacific madrone, and Oregon white oak. South facing slopes adjacent to the Trinity River are labeled as montane hardwood, containing a pronounced hardwood tree layer, with a poorly developed shrub stratum, and a sparse herbaceous layer. Knobcone pine, ghost pine (previously called Digger pine), Oregon white oak, and coast live oak are abundant on these slopes at lower elevations along the river.

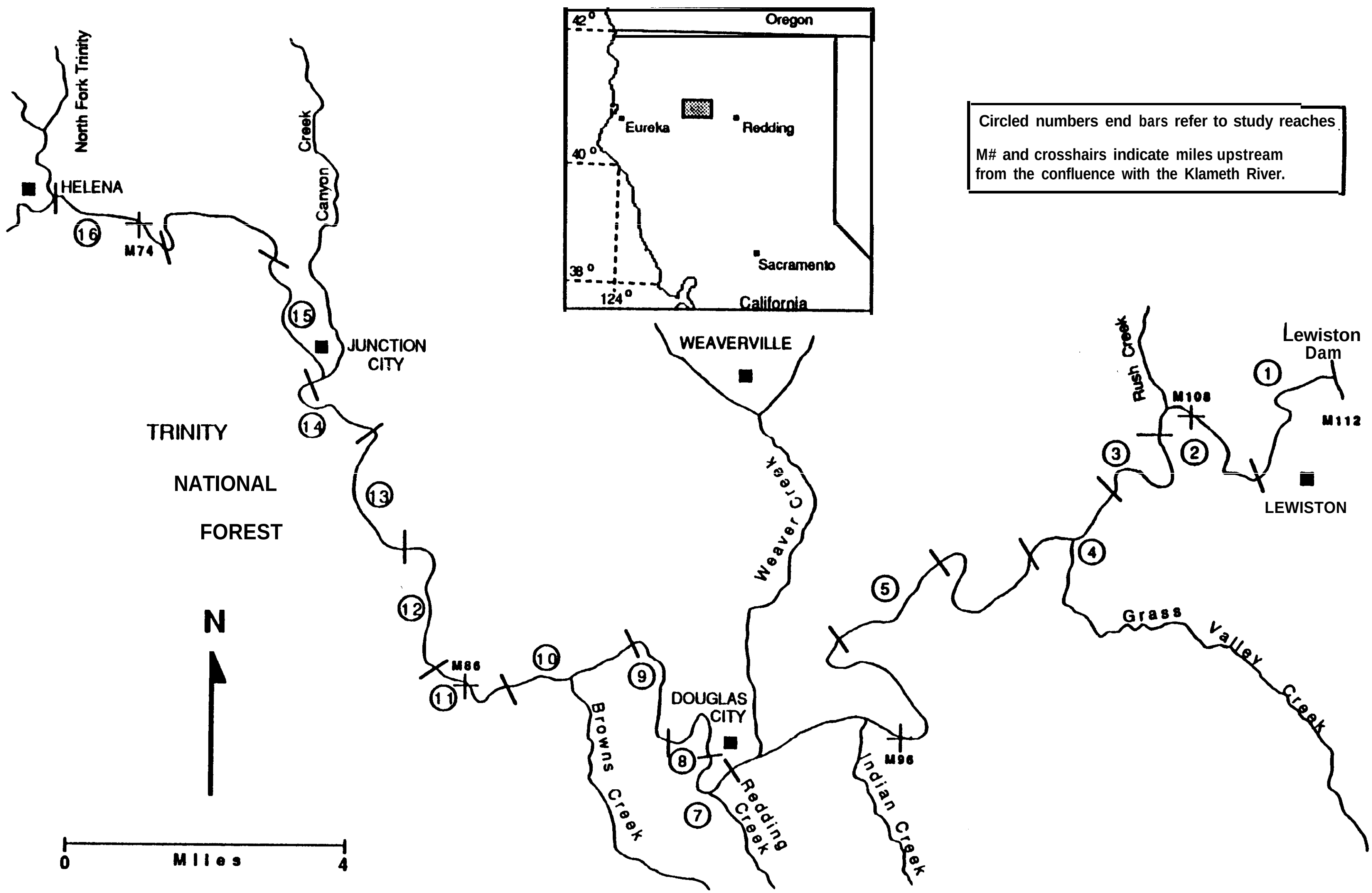


Figure 1. Location of study reaches along the main fork of the Trinity River Trinity county, California.

METHODS AND ANALYSIS

To adequately survey the 39 mile stretch of the Trinity River from Lewiston Dam to the North Fork, we traveled in inflatable kayaks. This stretch of the river was primarily Class I-II water (rapids with little maneuvering necessary to avoid hazards).

Survey and Analysis Levels

Sampling and analyses were conducted at four levels: reach, station, geomorphological type, and riparian type.

Reach and Station

The river was divided into 16 unequal length segments, henceforth called Reaches, averaging 1.95 miles (3.14 km) in length, and were determined by boat launch access (Fig. 1). Actual length varied between 1.5 and 2.5 miles (2.41 and 4.02 km). Within each Reach, survey stations were systematically placed every 250-300 m, with one station on each side of the river at each location. Bird census stations were centered in the riparian habitat; the distance from shore was determined by the width of the vegetation but no greater than 25 m from the river. Census points were marked with flagging and a spray painted spot on the nearest tree. A few census points were located at the riparian/upland edge in areas where riparian vegetation was less than 10 m wide. Eleven Reaches contained 20 census points (10 stations on each side of the river), and four Reaches contained 18 census points (nine per side), totaling 292 points. Reach number 6 was not censused because stations could only be located on the right side of the river due to private property.

Geomorphology

The river was divided into three geomorphological types based on large scale habitat characteristics. Sections of river had similar characteristics with regards to valley width, channel gradient, and levels of silt deposition. Valley width is an indication of the distance to the nearest upland habitat and an index of potential riparian habitat width. Constrained valleys have narrow valley widths with increased channel gradients. The three types were defined as: (1) Geomorphological I - (Reaches 1-4, from Lewiston Dam to Grass Valley creek, Fig. 1) - this type lacked the influence of feeder creeks. Water flows were governed by dam releases, with few, if any, scouring flows or silt deposition; (2) Geomorphological II - (Reaches 7-11, Douglas City to Evans Bar, Fig. 1) - characterized by a generally narrow valley floor with surrounding uplands very close to the river (Reach 5, from Poker Bar to Steel Bridge, had characteristics similar to Geomorph II Reaches, but was not included due to its distance from them, approximately 5 miles); (3) Geomorphological III - (Reaches 12-16, Evans Bar to the North Fork, Fig. 1) - characterized by a wide valley floor, with abundant mining tailings and some natural gravel bars.

Riparian Vegetation

Survey stations were categorized as being in one of four riparian vegetation types (Evans 1980). We considered only the vegetation within a 25 m radius of the bird census station and defined the types as follows: (1) gravel/cobble bar - more than 2/3 of the area was gravel/cobble bar or sandy areas; (2) Willow (Salix sp.) dominant - greater than 2/3 of the vegetation cover was willow; (3) willow/alder mix (Salix sp. and Alnus sp.) - at least 1/3 of vegetation cover was willow and 1/3 is alder; (4) mature/alder dominant - greater than 2/3 of vegetation cover was alder or cottonwood (Populus sp.).

Vegetation Estimation

Measuring vegetation

To accurately describe the floristics and structure of the riparian vegetation along the Trinity River, we sampled 186 of the 292 survey stations spaced systematically along the river. All 47 time-constrained search stations and 45 pitfall stations (see below) were sampled. The remaining stations were sampled alternating sides at each successive station (e.g. 1-right, 2-left, 3-right, etc.), for a mininum of 10 stations per Reach with 5 on either side.

Data was collected at each station in 4 broad categories: general site characteristics, ground cover variables, under- and over-story cover, and tree counts (see Appendix A for a more detailed account). Ground cover variables were recorded only at the 47 pitfall and time constraint stations; all other variables were recorded at 186 stations.

Vegetation variables were summarized and presented to characterize both the different riparian types and geomorphological types. Variables are presented as means, standard errors, and ranges for each riparian type or geomorphological type as follows: (1) ground variables (time-constrained and pitfall sites only) are expressed as percents of the total transect measured in the macrohabitat riparian vegetation type; (2) under- and over-story variables are expressed as percents of the total transect in the riparian vegetation; (3) tree count variables are presented as numbers per hectare.

Bird Censuses

Census Method

To investigate bird habitat use along the Trinity River, we used the fixed point count method described by Hutto, et. al. (1986). The protocol was as follows: a Reach (Fig. 1) was randomly selected (without replacement) to census each day. A crew of two people started at the upper end of the Reach within 15 minutes of sunrise, floated to the first station, and hauled-out on either side of the river.

At each census point the observers recorded three kinds of data within a 10 minute period: (1) the number of individuals of each species detected within a 25 m radius surrounding the observer (at the census point), (2) the number of birds detected of each species beyond the 25 m radius but still within riparian vegetation (any questionable calls were put into 'other' category), and (3) the number of birds of each species detected in upland habitats. The level of detectibility varied between census stations due to factors such as river noise, road noise, gravel operation noise, and density of vegetation, type of vegetation species, type of terrain (open area versus steep canyon wall), etc. Recording birds within 25 m ensured a comparable probability of detection within this unit area among all stations. Bird detections were recorded immediately upon arrival at the station's center and continued for 10 minutes. As suggested by Hutto et al. (1986), birds that flushed from within the 25-m-radius circle upon the observer's arrival were recorded as "inside" detections. This was done because some birds are very shy and will temporarily leave an area occupied by human observers. Birds that were detected but unidentified before the end of the 10 minute count period were pursued after the end of the count for identification. Detections were recorded as singing (S), calling (C), or visual (V).

One Reach was censused per day. All stations were censused twice during the spring. Censusing began the last week of April and was completed by mid-June.

Data Analysis

Our objective was to quantify the relative abundances and habitat association patterns of bird species closely associated with riparian vegetation. Bird abundances were analyzed for comparison by geomorphological type, riparian vegetation type, and riparian vs upland. All analyses were calculated using the census that yielded the largest numerical abundance per species (Blondel 1981).

Geomorphological type

Species abundances were recorded by geomorphological type as mean number of detections per Reach in both riparian and upland habitats. Riparian bird abundances were summarized for birds detected within the 25-m-radius circle surrounding each station and for those detected outside. Those birds detected outside the 25-m-circle were included because some bird species are very difficult (quiet or move away) to detect during a census (Hutto et al. 1986).

Riparian type

Census stations were categorized as occurring in one of four riparian vegetation types. Only 2 stations were categorized as gravel/cobble bar so we eliminated them from analysis. Species abundances were recorded as mean numbers detected per station within a 25-m-radius circle of each station for each riparian type. Only data taken within the 25-m-radius circle were included in this analysis because of unequal probabilities of detection at larger distances. To test the hypothesis of no difference in abundance between riparian types, a Proportion test (Zar 1984:p.395) was run comparing the proportion of stations in each riparian type at which each species was detected.

Species richness was summarized by riparian type as the total number of species detected during each census across all stations in a given type.

Riparian versus upland

Comparisons were made between riparian and upland habitats by listing the top ten species detected in each. Census points were located in riparian vegetation at various distances from upland, so abundance measures could not be directly compared. However, comparisons among habitat types can show species habitat affinities. i.e. of those species we detected, which ones were more often in upland or riparian. However, abundances were summarized as percent of all stations (n = 292) at which a species was detected in riparian or upland habitat types. Opportunistic sightings (see below) are also listed.

These data should be interpreted with caution because some species detected only in the riparian areas may well have used upland habitats. Since our survey stations were located either in riparian vegetation or at the riparian/upland border, I must emphasize that we did not adequately sample the upland habitat; and any ranking of bird abundances in upland should not be taken as truth.

Float Surveys for Riverine Wildlife

Survey Method

River surveys were conducted to survey wildlife species that were closely associated with the water itself. The entire 39 mile stretch of river was surveyed 5 times between May 15, 1990 and August 2, 1990. Two surveys were conducted between 6 and 11 a.m. (5/15 to 5/21, and 7/23 to 8/2); two between 3 and 8 p.m. (5/29 to 6/7, and 7/5 to 7/9), and one between 10 a.m. and 3 p.m. (6/19 to 6/21).

Three days were needed (5 Reaches each) to complete the entire 39 miles of river. A survey involved two people floating the river in a kayak, one person navigating while the other recorded data. Since different species were active at different times of the day, 2 float surveys took place in the morning, 2 in the evening, and one at mid-day. See Appendix B. for variables taken during the float surveys.

A concerted effort was made to avoid double counting, as certain species were commonly flushed downriver by observers (common mergansers, wood ducks, and foraging green herons). This was done by keeping track of birds (flocks) advancing downriver and not counting new birds seen until the ones already recorded flew upriver overhead. Since we have no way of determining the bias (error), statistical significance is not presented with the analyses (see below).

Data Analysis

The primary goal of the float surveys was to characterize the distribution and relative abundance of riverine wildlife species. Species abundances are presented as mean numbers detected per survey for each Reach (1-16). To compare species abundances between surveys, total numbers detected by Reach for each survey are also presented. Twelve species with greater than 10 total detections were used for this analysis.

Use of different river mesohabitat types (glide, run, rapid, pool) and substrate use were compared for the same 12 species described above. Percent of total use in each category was presented using observations from all surveys, for each species.

Detection times were lumped into two-hour blocks. Total detections were analysed to determine the time block for which detections were most frequent.

Common mergansers were of special interest in that they are a fish predator and very common along this section of river. This species gathers in large flocks of adults and large families. Besides characterizing their abundance by Reach, we also compared the number of flocks and family units by survey. Number of males detected are also presented for each survey.

Wood ducks are a species of concern because of their specialized nesting requirements (large cavities in trees), and their intolerance of disturbance (Bent 1940). We paid particular attention to their family size and abundance along the river. Flocks and families were recorded and presented as numbers detected per survey.

Time-constrained Searches

The Method

Time-constrained searches (timed-search) were used to gather data on the distribution and relative abundance of herpetofauna. This method consisted of two people moving systematically through a designated area searching under cover items, raking leaf litter, and examining vegetation for herpetofauna (see Welsh 1987 for details). Three to four of the 18-20 survey stations were sampled in each of 15 Reaches for a total of 47 stations; Reach 6 was omitted due to its location adjacent to highway 299 and private land. This sub-sample of stations was systematic. One station (one side of the river or the other) was surveyed at every third survey location, starting at the dam and working downriver. Periodically sites other than the third station were chosen, to avoid private land in-holdings and areas of high human use (e.g.

fishing access points). Timed-searches were conducted once at each station, in early April through early May 1990. A one person-hour timed search (two people searching for 1/2 hour) was conducted at each station. Searchers worked within a 30 m radius around the bird census point and covered all habitats. Timers were only stopped when an animal was positively identified (and escaped) or was captured and data recorded.

Data were taken at four spatial scales: the general site (station), the macrohabitat around each animal observation, the mesohabitat around each observation, and the microhabitat for each observation. Data were also taken on sex, age, size and weight of each animal observed (see Appendix B for a detailed description of variables recorded at each level).

Data Analysis

Time-constrained search data were analyzed to provide information on species composition, relative abundance, and habitat associations. Mean relative abundance of all species and species groups (e.g. frogs, lizards, etc.) are described. We used one-way analysis of variance (ANOVA) to investigate the relative abundance of species, captured at greater than incidental levels, among the three geomorphological types and three of the four riparian vegetation types (a single gravel/cobble bar site was excluded). Greater than incidental levels is defined as at least 30 total captures with individuals observed at 10 or more stations.

We describe macro and microhabitat associations for the three most abundant species. Substrate use was the only microhabitat variable summarized for this report. General site conditions and mesohabitat data (Appendix B) were not summarized for this report.

Pitfall Trapping

Pitfall Method

We used pitfall traps (pitfall) to gather data on small mammals and herpetofauna found. This is a passive sampling method in which 2 gallon, plastic buckets (22 cm deep) are buried slightly below ground level. The buckets are sheltered using a 30 cm by 30 cm wooden shake or piece of plywood which was elevated above the opening providing a narrow cover space attractive to small animals. When an animal attempts to use the artificial cover, it falls into the bucket and is trapped (see Welsh 1987 for details).

Pitfall buckets were placed at most of the same stations we had conducted time-constrained samples. Ten buckets were placed at 45 of the 47 timed-search stations in a 2 x 5 grid (two stations were omitted because they were areas of relatively high human use). Each line began at water's edge and ran perpendicular to the shoreline 5m on either side of the bird census point. Pitfall traps were placed 5 m apart and within 1 m of flagging marking the trap location. Traps were placed next to a natural structure (logs, tree trunk, rock, bank, etc.) whenever possible. The traps were opened the first week of July 1990 and closed 8 weeks later, at the end of August 1990. The first four weeks the buckets were dry and the last four weeks they were filled with approximately two inches of water to increase the likelihood of catching small mammals that can jump out. Traps were checked weekly and data was taken on species, sex, age, size, and parasites (see Appendix B for detailed descriptions of variables). Live animals were toe clipped and released for future identification. At the end of the field season traps were removed.

Data Analysis

We used pitfall data to describe species composition, relative abundance, habitat associations, and effectiveness of the two trap types (dry or wet). All capture rates were standardized to "captures per 1000 trap-nights". A trap-night was one trap, at one station, open for one night. If traps were disturbed (e.g., cover shake was missing or pulled out of the ground) when they were checked, they were considered "not available" for the time that had elapsed from the last check date. Removing these traps from the data set for each week allowed standardization of captures of animals to captures per 1000 trap-nights so that stations, Reaches, etc. could be compared.

Distributions of species along the 39 mile study Reach were presented descriptively. We compared relative abundance of species captured at greater than incidental levels and species groups (mammals, amphibians, reptiles) among the three geomorphological types and three of the four riparian vegetation types using one-way analysis of variance (ANOVA). For this analysis, each station was designated as being in a particular geomorphological type and riparian type and incidental levels was the same as for timed searches. Macrohabitat associations of selected species and species groups were examined by designating a vegetation type (gravel/cobble bar, riparian, or upland) for each pitfall trap. We then compared species distributions among these types using one-way analysis of variance (ANOVA), with the trap as the unit of analysis. Traps designated as riparian were then categorized as one of the three types (willow, willow/alder mix, and alder/mature) and animal abundances by these types are described. Effectiveness of trap types is also summarized.

Herpetofauna Species Richness Analysis

Data from timed-search, pitfall, and opportunistic observations (see below) were used to generate species lists for each station. Forty-five stations where both pitfall and timed-search sampling occured were initially included. These data were used to examine the relationship between species richness and habitat diversity (i.e. percent of survey area that is gravel/cobble bar, riparian vegetation or upland vegetation). We used the relative amount of riparian vegetation at each station to examine this relationship. This variable was created by subtracting the portion of the vegetation line transect that was river from 50 m (the length of the line transect) and then dividing the result by the length of the line that was riparian vegetation (see vegetation estimation methods). In the final analysis two stations were considered outliers and removed as result of unique vegetation characteristics.

Opportunistic Observations of Wildlife

Opportunistic observations of uncommon herpetofaunal species were recorded traveling to and from sample stations, during vegetation sampling, and during pitfall sampling (animals seen outside of traps). Data recorded for each observation included species, sex (if known), date, time, Reach, station, side of the river, and a brief description of habitat associations.

Opportunistic sightings were also recorded for riverine species that were difficult to observe during daytime float surveys (e.g. river otter, mink, beaver), and uncommon species (e.g. bald eagles, accipiters, ospreys). The same data was recorded for these species as during the scheduled float surveys (Appendix B).

RESULTS AND DISCUSSION

We report few statistically significant differences in relative abundances for those species tested in habitat use by reach, geomorphological type, or habitat classification. However, the nature of this effort was that of a broad survey across many taxa. Our sample sizes for most species were small which may account for our lack of significant results. We did note some trends and patterns for several species which are reported below.

Vegetation Analysis Results

Decreasing human impact was evident from Lewiston Dam to the end of Reach 13 (2 miles upriver of Junction City). The reaches with the least human disturbance were 9-13 (Fig. 2). Beaver sign varied through our study area. A decrease was evident as one moved downriver, away from the dam (Fig. 2).

Geomorphological Type

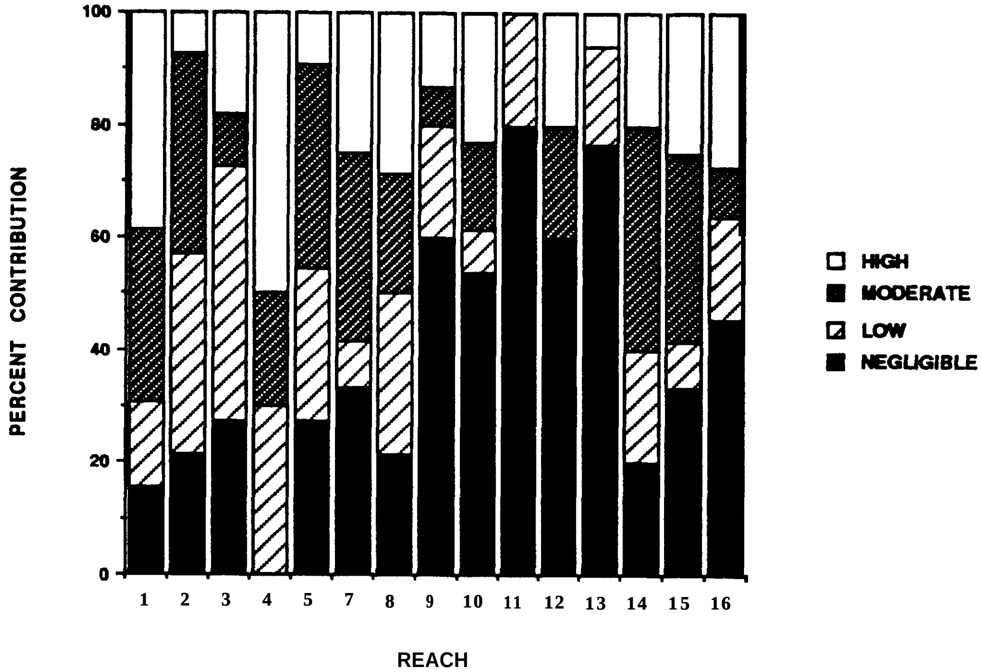
Riparian vegetation is summarized by geomorphological type in Appendix C. Canopy height was greatest in geomorphological type II, averaging 12.97 meters tall. Geomorphological type I had the greatest values for understory canopy cover, number of alders per hectare, and number of snags per hectare. Geomorphological type II had the highest means in the following measurements: canopy height, percent alder canopy cover, and number of logs per hectare. Geomorphological type III had the highest values for overstory willow cover and understory alder cover. There were trends moving downriver (from geomorphological type I to III) in the following variables: decreasing cover of shrubs and grass/herbs; decreasing understory canopy cover; increasing number of willows per hectare; decreasing number of alders per hectare; and increasing number of debris piles per hectare (Appendix C).

Riparian Type

The riparian vegetation at each station was subjectively characterized as either willow dominant (>2/3 willow cover), alder dominant (>2/3 alder cover), or willow/alder mix. Results in Appendix D confirmed our separation of vegetation into these three categories. Mean canopy height increased from willow (8.52 m) to willow/alder (13.4 m), to alder (15.34 m). Valley width showed little difference between willow (377 m) and willow/alder (384 m); however, alder was found in narrower (319 m) valleys. Transect measurements showed alder vegetation with greater values than willow in the following variables: low shrub cover (predominantly Rubus spp.), both under- and overstory alder cover, and overstory canopy cover. Willow vegetation had greater values than alder with regards to percent grass/herb in the understory, percent willow in both the under- and overstory, and understory canopy-cover (Appendix D).

Count data mirrored the transect data with regards to willow and alder vegetation. Number of willows (>5 cm dbh), varied from 21 trees per hectare in willow dominant vegetation to 4 trees per hectare in alder dominant vegetation. Alders showed the opposite pattern, with an average of 5 trees per hectare in willow dominant vegetation to 54 tree/ha in alder dominant. The number of logs showed no pattern (Appendix D). Snags were more abundant in alder dominant vegetation; while number of debris piles was greater in willow dominant vegetation (Appendix D).

a) HUMAN IMPACT



b) BEAVER IMPACT

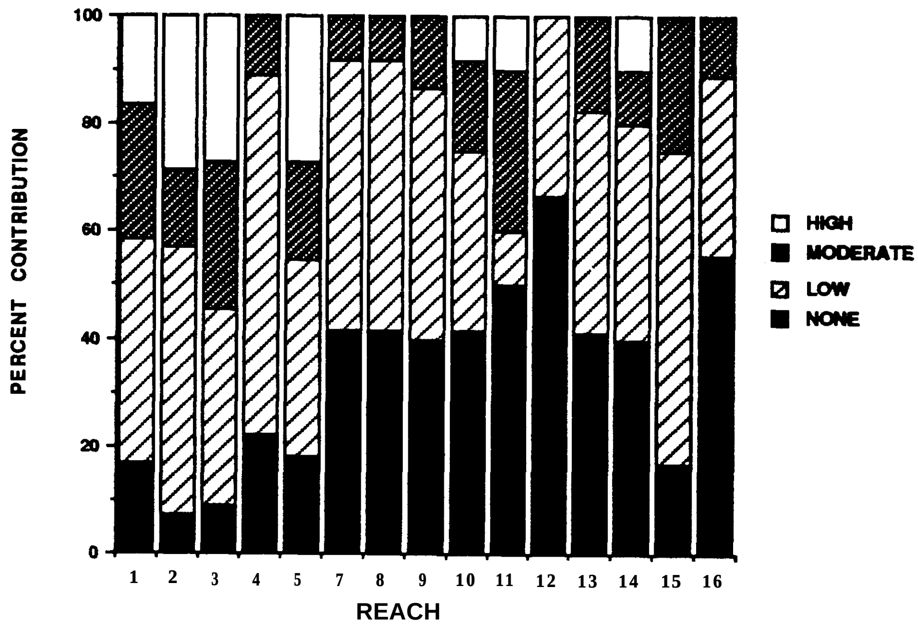


Figure 2. Comparisons by reach of a) human impact, and b) beaver impact along 39 miles of the Trinity River below Lewiston Dam. Histograms depict the percent of the total for each category.

Bird Community

Bird Censuses

Habitat Use

A list of birds detected along the 39 mile study area is presented in Table 1. Bird abundances are given as a percent of stations where a species was detected.

The total number of bird species detected between March and September 1990 was 100 in riparian and 72 in upland habitats. Census data alone picked up 83 species in riparian habitat and 66 in upland habitats. The two habitats had 45 (58%) species in common. The number of species unique to each habitat type included 28 (36%) in riparian vegetation and 6 (6%) in upland vegetation.

Of the 100 bird species detected in riparian vegetation, 42 species are known to have a strong affinity for this habitat. Twenty-five of the 42 species (52%) are riparian dependent species. The remaining 17 species use other habitats, but are found in greatest abundance in riparian habitats (Grinnell and Miller 1951). The numbers presented in Table 1 for riverine species such as herons, waterfowl, spotted sandpipers, American dippers, and belted kingfisher do not reflect their abundance, as many are not vocal and were best detected by the float survey method (see below).

Seventeen species were detected opportunistically, prior to or after the breeding season. These include winter visitors such as great egret, hooded and red-breasted mergansers, lesser yellowlegs, hermit thrush, western bluebird, ruby-crowned kinglet, yellow-rumped warbler, Townsend's warbler, white- and golden-crowned sparrows. Species detected opportunistically, but believed to nest either in the riparian or upland habitats include canada goose, golden eagle, Virginia rail, common snipe, western screech owl, winter wren, marsh wren, and common nighthawk. Vagrants and migrants (those just passing through) include gray flycatcher and lincoln's sparrow (Table 1).

Table 1. List of bird species along the Trinity River between Lewiston Dam and the North Fork, Trinity County, California. Mnemonics, residency status, riparian affinity, nest type and frequency of occurrence are listed for all species. Frequency of occurrence indicates the percent of all stations (292) that a species was detected (a + sign indicates only 1 individual recorded, * indicates opportunistic sighting). Bird species are listed in taxonomic order.

SPECIES	MNEMONIC	RES.[1] CODE	RIP[2] AFF.	NEST[3] TYPE	HABITAT[4] RI	RO	UP
Great Blue Heron (Ardea herodias)	GBHE	R	P	tree	1.0	2.1	+
Green-backed heron (Butorides virescens)	GRHE	R	P	tree	6.6	7.6	0.0
Great Egret (Casmerodius albus)	GREG	M/W	P			*	
Black-Crowned Night Heron (Nycticorax nycticorax)	BCNH	U	S		0.0	+	0.0
Canada Goose (Branta canadensis)	CAGO	R	S	ground		*	
Mallard (Anas platyrhynchos)	MALL	R	P	ground	1.0	1.4	0.0
Green-Winged Teal (Anas crecca)	GWTE	M	S		+	0.0	0.0
Wood Duck (Aix sponsa)	WODU	R	P	cavity	4.5	3.1	0.0
Hooded Merganser (Lophodytes cucullatus)	HOME	W	P			*	
Common Merganser (Mergus merganser)	COME	R	P	cavity	3.8	4.8	+
Red-Breasted Merganser (Mergus serrator)	RBME	W	S			*	
Turkey Vulture (Cathartes aura)	TUVU	S	-	cavity	0.7	0.0	+
Sharp-Shinned Hawk (Accipiter striatus)	SSHA	R	-	tree	0.0	0.0	+
Cooper's Hawk (Accipiter cooperii)	COHA	R	P	tree		*	*
Red-Tailed Hawk (Buteo jamaicensis)	RTHA	R	-	tree	+	0.0	1.4
Golden Eagle (Aquila chrysaetos)	GOEA	R	-	tree		*	*
Bald Eagle (Haliaeetus leucocephalus)	BAEA	R	P	tree	6.7	+	+
Osprey (Pandion haliaetus)	OSPR	R	P	tree	1.0	1.4	+

table 1 continued

SPECIES	MNEMONIC	RES.[1] CODE	RIP[2] AFF.	NEST[3] TYPE	HABITAT[4] RI	RO	UP
Merlin (Falco columbarius)	MERL	W	-		+	0.0	0.0
California Quail (Callipepla californica)	CAQU	R	-	ground	4.5	16.9	8.3
Mountain Quail (Oreortyx pictus)	MOQU	R	-	ground	+	1.4	14.1
Virginia Rail (Rallus limicola)	VIRA	R	P	ground		*	
Killdeer (Charadrius vociferus)	KILL	S	P	ground	1.0	1.4	0.0
Common Snipe (Gallinago gallinago)	COSN	W/S	P	ground		*	
Spotted Sandpiper (Actitis macularia)	SPSA	S	P	ground	2.8	13.5	0.0
Greater Yellowlegs (Tringa melanoleuca)	GRYE	M/W	P			*	
Mourning Dove (Zenaida macroura)	MODO	S	S	tree	2.1	4.5	6.9
Western Screech Owl (Otus kennicottii)	WSOW	R	S	cavity		*	
Common Nighthawk (Chordeiles minor)	CONI	S	-	ground		*	*
Black-Chinned Hummingbird (Archilochus alexandri)	BCHU	S	P	tree	0.0	+	0.0
Anna's Hummingbird (Calypte anna)	ANHU	R	-	tree	4.5	2.1	0.0
Belted Kingfisher (Ceryle alcyon)	BEKI	R	P	bank	3.8	6.6	0.0
Northern Flicker (Colaptes auratus)	NOFL	R	P	cavity	+	2.4	10.4
Pileated Woodpecker (Dryocopus pileatus)	PIWO	R	-	cavity	0.0	0.0	1.4
Acorn Woodpecker (Melanerpes formicivorus)	ACWO	R	-	cavity	0.0	1.4	3.8
Red-Breasted Sapsucker (Sphyrapicus ruber)	RBSA	R	-	cavity	3.8	2.8	0.7
Hairy Woodpecker (Picoides villosus)	HAWO	R	-	cavity	1.4	2.4	3.5
Downy Woodpecker (Picoides pubescens)	DOWO	R	P	cavity	1.7	3.1	2.4
Western Kingbird	WEKI	S	-	tree	1.0	0.7	0.7

table 1 continued

SPECIES	MNEMONIC	RES.[1] CODE	RIP[2] AFF.	NEST[3] TYPE	HABITAT[4] RI	RO	UP
(Tyrannus verticalis)							
Ash-Throated Flycatcher (Myiarchus cinerascens)	ATFL	S	-	cavity	2.8	8.6	3.8
Black Phoebe (Sayornis nigricans)	BLPH	R	S	platform	1.7	4.1	1.0
Say's Phoebe (Sayornis saya)	SAPH	M	-			*	
Willow Flycatcher (Empidonax traillii)	WIFL	S	P	tree	1.7	5.5	0.0
Gray Flycatcher (Empidonax wrightii)	GRFL	M	P			*	
Pacific slope Flycatcher (Empidonax difficilis)	WEFL	S	S	tree	4.8	11.0	29.0
Western Wood Peewee (Contopus sordidulus)	WWPE	S	-	tree	18.6	52.8	26.6
Olive-Sided Flycatcher (Nuttallornis borealis)	OSFL	S	-	tree	0.0	0.0	1.0
Tree Swallow (Tachycineta bicolor)	TRSW	S	P	cavity	15.2	22.1	1.0
Northern Rough-Winged Swallow (Stelgidopteryx serripennis)	NRWS	S	S	bank	4.8	4.5	+
Barn Swallow (Hirundo rustica)	BASW	S	-	platform	0.0	+	0.0
Cliff Swallow (Hirundo pyrrhonota)	CLSW	S	-	platform	1.0	1.0	0.0
Steller's Jay (Cyanocitta stelleri)	STJA	R	-	tree	7.2	14.5	24.8
Scrub Jay (Aphelocoma coerulescens)	SCJA	R	-	tree	8.3	9.7	7.6
Common Raven (Corvus corax)	CORA	R	-	tree	0.7	2.8	3.8
American Crow (Corvus brachyrhynchos)	AMCR	R	P	tree	+	2.1	2.8
Black-Capped Chickadee (Parus atricapillus)	BCCH	R	P	cavity	+	0.0	0.0
Chestnut-Backed Chickadee (Parus rufescens)	CBCH	R	S	cavity	1.0	0.0	+
Bushtit (Psaltriparus minimus)	BUSH	R	-	tree	9.7	4.8	0.7

table 1 continued…

SPECIES	MNEMONIC	RES.[1] CODE	RIP[2] AFF.	NEST[3] TYPE	HABITAT[4] RI	RO	UP
White-Breasted Nuthatch (Sitta carolinensis)	WBNU	R	-	cavity	+	1.0	2.4
Red-Breasted Nuthatch (Sitta candensis)	RBNU	R	-	cavity	0.7	+	0.7
Brown Creeper (Certhia americana)	BRCR	R	-	tree	0.0	0.0	0.7
Wrentit (Chamaea fasciata)	WREN	R	-	shrub	1.0	1.7	5.2
American Dipper (Cinclus mexicanus)	AMDI	R	P	platform	0.7	1.0	0.0
House Wren (Troglodytes aedon)	HOWR	S	S	cavity	0.7	2.8	1.4
Winter Wren (Troglodytes troglodytes)	WIWR	R	-	cavity			*
Bewick's Wren (Thryomanes bewickii)	BEWR	R	S	cavity	6.9	17.6	4.1
Marsh Wren (Cistothorus palustris)	MAWR	R	P	shrub		*	
American Robin (Turdus migratorius)	AMRO	R	-	tree	7.6	7.9	19.7
Hermit Thrush (Catharus guttatus)	HETH	W	-	tree	+	0.0	0.0
Western Bluebird (Sialia mexicana)	WEBL	W?	-	cavity			*
Blue-Gray Gnatcatcher (Polioptila caerulea)	BGGN	S	-	tree	3.5	1.7	0.7
Ruby-Crowned Kinglet (Regulus calendula)	RCKI	W	-	tree		*	*
Cedar Waxwing (Bombycilla cedrorum)	CEWA	S/W	P	tree	+	+	0.0
European Starling (Sturnus vulgaris)	EUST	R	-	cavity	0.7	2.1	0.0
Hutton's Vireo (Vireo huttoni)	HUVI	R	S	tree	1.0	+	2.4
Solitary Vireo (Vireo solitarius)	SOVI	S	S	tree	4.8	7.9	37.9
Warbling Vireo (Vireo gilvus)	WAVI	S	P	tree	17.9	28.6	11.0
Orange-Crowned Warbler (Vermivora celata)	OCWA	S	S	ground	12.1	33.5	22.1

table 1 continued

SPECIES	MNEMONIC	RES.[1] CODE	RIP[2] AFF.	NEST[3] TYPE	HABITAT[4] RI	RO	UP
Nashville Warbler (Vermivora ruficapilla)	NAWA	S	-	ground	9.0	12.4	25.9
Yellow Warbler (Dendroica petechia)	YEWA	S	P	tree	56.2	77.9	4.1
Yellow-Rumped Warbler (Dendroica coronata)	YRWA	S/W	-	tree	1.0	0.7	1.0
Black-Throated Gray Warbler (Dendroica nigrescens)	BTGW	S	-	tree	3.5	6.9	49.3
Townsend's Warbler (Dendroica townsendi)	TOWA	S/W	-	tree	+	0.0	+
Hermit Warbler (Dendroica occidentalis)	HEWA	S	-	tree	0.7	+	3.8
MacGillivray's Warbler (Oporornis tolmiei)	MAWA	S	S	shrub	9.3	18.3	2.8
Common Yellowthroat (Geothlypis trichas)	COYE	S	P	shrub	0.0	+	0.0
Yellow-Breasted Chat (Icteria virens)	YBCH	S	P	shrub	19.3	54.8	0.7
Wilson's Warbler (Wilsonia pusilla)	WIWA	S	P	ground	9.3	14.8	2.4
Red-Winged Blackbird (Agelaius phoeniceus)	RWBL	R	P	shrub	3.5	10.7	1.0
Brewer's Blackbird (Euphagus cyanocephalus)	BRBL	S	-	tree	4.8	4.8	+
Northern Oriole (Icterus galbula bullockii)	NOOR	S	P	tree	4.5	12.1	2.4
Brown-Headed Cowbird (Molothrus ater)	BHCO	S	P		5.5	7.9	3.1
Western Tananger (Piranga ludoviciana)	WETA	S	-	tree	3.8	9.7	49.0
Black-Headed Grosbeak (Pheucticus melanocephalus)	BHGR	S	P	tree	19.0	34.5	36.6

table 1 continued

SPECIES	MNEMONIC	RES.[1] CODE	RIP[2] AFF.	NEST[3] TYPE	HABITAT[4] RI	RO	UP
Lazuli Bunting (Passerina amoena)	LABU	S/M	S	shrub	3.1	4.8	3.1
Purple Finch (Carpodacus purpureus)	PUFI	S/W	-	tree	3.5	5.5	11.0
House Finch (Carpodacus mexicanus)	HOFI	R	-	tree	+	+	+
Lesser Goldfinch (Spinus psaltria)	LEGO	S	-	tree	15.9	34.8	20.0
Rufous-Sided Towhee (Pipilo erythrophthalmus)	RSTO	R	S	ground	22.1	44.5	11.4
California Towhee (Pipilo crissalis)	CATO	R	S	shrub	1.0	3.5	1.0
Dark-Eyed Junco (Junco hyemalis)	DEJU	R	-	ground	1.4	+	8.6
Chipping Sparrow (Spizella passerina)	CHSP	S	-	shrub	+	+	1.0
White-Crowned Sparrow (Zonotrichia leucophrys)	WCSP	W	-			*	
Golden-Crowned Sparrow (Zonotrichia atricapilla)	GCSP	W	-		0.7	+	0.0
Lincoln's Sparrow (Melospiza lincolnii)	LISP	M	P			*	
Song Sparrow (Melospiza melodia)	SOSP	R	P	shrub	63.8	78.3	0.7

1./RESIDENCE CODES: R) resident-year round; W) winter resident; S) spring/summer resident; M) migrant, spring or fall; U) unknown.
2./Riparian affinity: P indicates a primary affinity for riparian or aquatic habitat (lacustrine, fluviatile, or marsh); S indicates a ranking of 2 or 3 with regards to use of riparian, lacustrine, fluviatile or marsh habitat (Miller 1951).
3 /Nesting: trees, shrubs and ground indicate preferred substrate for open nests; cavity nesters are both primary excavators (woodpeckers) and secondary cavity nesters. Bank nesters dig nest holes in soft soil along the river. Platform nesters include those using ledges on cliffs, bridges, or vertical surfaces
4 /Habitat: RI is the area within a 25-m-radius circle centered at each station; RO indicates riparian habitat, though outside the 25 m cicle; UP indicates upland habitat.

Riparian Versus Upland Associates

Many species were detected more frequently in upland than in the riparian habitats. Twenty-four of the 66 (36%) bird species detected in upland vegetation were more abundant in this habitat than in the riparian habitat (Table 1). There was very little overlap between the most abundant species detected in riparian and upland habitats (Table 2).

Table 2. Comparison between Riparian and Upland habitat of the ten most abundant breeding bird species along the Trinity River between Lewiston Dam and the North Fork of the Trinity. Numbers indicate total frequency of detection across all stations (290). This study took place during April-June 1990. Rank is indicated in parentheses

	HABITAT[1]					
SPECIES	**RI**		**RO**		**UP**	
Song Sparrow	304	(1)	340	(2)		
Yellow Warbler	231	(2)	361	(1)		
Tree Swallow	98	(3)	155	(7)		
Black-Headed Grosbeak	85	(4)	120	(8)	135	(4)
Rufous-Sided Towhee	76	(5)	178	(5)		
Yellow-Breasted Chat	68	(6)	208	(3)		
Lesser Goldfinch	67	(7)	160	(6)	77	(8)
Warbling Vireo	63	(8)	203	(4)	91	(7)
Western Wood Peewee	58	(9)	96	(10)		
Orange-Crowned Warbler	47	(10)	112	(9)	75	(9)
American Robin					77	(8)
Black-Throated Gray Warbler					217	(2)
Solitary Vireo					148	(3)
Steller's Jay					98	(6)
Western Tananger					222	(1)
Western Flycatcher					103	(5)
Nashville Warbler					91	(7)

1- RI = riparian within 25-m-radius of station; RO = riparian outside 25 m circle; UP = upland.

Bird Abundance by Riparian Type

Bird species abundances were compared among riparian vegetation types (Table 3). The 16 species presented represented over 80 percent of the total bird detections. Few species showed a significant difference between riparian types. Yellow-breasted chat occurred in a greater proportion of willow dominant stations than either of the other types (Table 3). No other species were significantly more abundant in the alder/mature vegetation, or even showed a trend of greater abundance. However, examining mean numbers detected per station, trends do appear with regards to affinity for the earlier successional willow vegetation. Willow flycatchers (though in small numbers) were found only in willow or willow-alder mix riparian vegetation. Yellow warblers, rufous-sided towhees, and Wilson's warblers were more abundant in willow vegetation. The mean number of total birds detected/station decreased from willow vegetation to willow-alder, to alder dominant riparian vegetation (Table 3).

Table 3. Comparisons of bird abundance between riparian vegetation types. Abundances reflect the average number of birds detected within a 25m radius circle of each station. Numbers in parenthesis indicate the percent of stations per riparian type that a bird is detected. * indicates a significant difference in percent occurrence between riparian type (proportions test, Zar 1984:400).

	Willow[1] (n=68)		**Willow/Alder (n=75)**		**Alder/Mature (n=38)**	
SPECIES[2]	**Mean**	**Freq**	**Mean**	**Freq**	**Mean**	**Freq**
Willow Flycatcher	.05	(.04)	.03	(.03)	.00	(.00)
Western Wood Peewee	.21	(.18)	.21	(.20)	.13	(.13)
Tree Swallow	.25	(.15)	.31	(.15)	.26	(.13)
Scrub Jay	.07	(.06)	.24	(.13)	.05	(.05)
Bushtit	.20	(.12)	.16	(.08)	.18	(.10)
Warbling Vireo	.18	(.16)	.21	(.17)	.20	(.18)
Orange-Crowned Warbler	.19	(.13)	.24	(.17)	.20	(.13)
Nashville Warbler	.10	(.09)	.12	(.09)	.11	(.10)
Yellow Warbler	.88	(.64)	.70	(.49)	.71	(.52)
MacGillivray's Warbler	.10	(.10)	.10	(.09)	.10	(.07)
Yellow-Breasted Chat *	.49	(.42)	.18	(.15)	.23	(.18)
Wilson's Warbler	.19	(.13)	.09	(.08)	.03	(.03)
Black-Headed Grosbeak	.29	(.18)	.29	(.21)	.29	(.21)
Lesser Goldfinch	.21	(.18)	.22	(.18)	.23	(.18)
Rufous-Sided Towhee	.32	(.27)	.28	(.25)	.13	(.13)
Song Sparrow	1.09	(.68)	1.05	(.64)	.95	(.60)
TOTAL BIRDS[3]	6.20		5.72		4.42	

1- The three riparian types indicate seral stages; progressing from Willow dominant (>2/3 of vegetation), to Willow/Ald to Alder/Mature (>2/3 of vegetation being Alder).
2- Bird species are listed in taxonomic order.
3- Total birds indicates the mean number of birds (all species combined) detected within the 25-m-radius circle of each station.

Residency and Breeding Status

Bird species residency, presented in Table 1, indicates that, for those species detected during the census period (83 total in riparian vegetation), 38 species (46%) were year-round residents, 39 species (47%) spring/summer residents, and 6 species (7%) migrants or winter visitors. If one considers all species detected in riparian vegetation (census and opportunistic, n = 106), 49 species (46%) are resident, 40 species (38%) are spring/summer visitors, 11 species (10%) winter residents, and 6 species (6%) migrants. Of those species detected in upland habitats, 33 species (50%) were year-round resident and 32 species (50%) spring/summer visitors.

However, of the 106 species detected during this study, 92 species had the potential of nesting in or near the riparian vegetation. These potential breeders were summarized as to their usual choice of nesting site: 42 species (46%) used open nests in trees; 10 species (11%) used open nests in shrubs; 14 species (15%) used open nests on the ground; 20 species (22%) used cavities in trees; 2 species (3%) excavated holes in river or road banks, and 2 (3%) platform nesting species.

Of the cavity nesters, six nesters were woodpeckers and all occurred in low numbers (Table 1). The most abundant woodpecker was the downy, a riparian associated species. The remaining 14 cavity nesting species used either natural cavities or old woodpecker cavities. We detected two riparian species, wood ducks and common mergansers, that require large cavities to nest in. Of the ten most abundant species detected in riparian vegetation, only the tree swallow nested in cavities. Of the 21 species detected that nest in cavities, fourteen were residents. None of the top ten species we detected in the upland habitats were cavity nesters.

Conclusions

The bird species richness along this section of river compares favorably with other riparian habitats in the west. Gaines (1979) and Motroni (1979) recorded 69 and 71 bird species, respectively, during the breeding season in the central valley of California. We recorded 83 bird species using the riparian habitat between March and August of 1990. The greater species richness along the Trinity River may be due to the proximity of the upland habitat. Though riparian zones support more diverse avifauna than upland habitats, the uniqueness of a riparian zone is influenced by adjacent upland vegetation (Knopf 1985).

The importance of riparian vegetation is demonstrated by the fact that 42 percent of the bird species we detected have a strong affinity for this habitat; and, 25 percent of those we detected are riparian obligate species (Miller 1951). While there was considerable overlap between upland and riparian bird use (58%), a far greater number of birds were detected only in riparian than vice-versa; only six percent of those species detected in upland were not detected in the riparian. Our results are consistent with other studies, such as Gaines (1977), who found that 43% of the species breeding in riparian zones along the Sacramento River exhibited a "primary affinity to that vegetation type".

Successional Stages of Riparian Vegetation

An important consideration for managing riparian habitat is the successional stage of the vegetation. We found no species more abundant in mature/alder, though we did find green heron nests and rookeries in mature forests. Raptors were found most often in the mature alder stands and the willow/alder mix stands, presumably for both foraging and perching. Knight (1987) stresses the disproportionately high raptor use of riparian habitats in the Pacific Northwest. He found that 23 of 30 raptors in the Blue Mountains of Oregon are either dependent on or use riparian habitat more than other habitats.

California blackberry (Rubus ursinus) and Himalaya-berry (R. procerus), were found predominantly in the alder and willow/alder mix riparian vegetation. The berries these plants produce are beneficial to many wildlife species, including cedar waxwings (which showed up in large numbers during late summer when the berries were ripe), robins, jays, etc.

The mature forests provide snags, an important resource used by many birds for nesting and foraging. Alder dominant vegetation contained the greatest number of snags, as did the upper 4 Reaches of our study area. Tree swallows are secondary cavity nesters and are found in greatest abundance in riparian habitats. As expected, we found them in greatest abundance in our study area where snags were in greatest abundance, the 10 miles immediately below Lewiston dam (Appendix D, Table 4). Snags are also important to primary cavity nesters. Six woodpecker species were recorded in the riparian vegetation (Table 1), and 4 of these (the northern flicker, downy woodpecker, hairy woodpecker, and red-breasted sapsucker) were confirmed nesting. Only 20 percent of the species we detected were cavity nesters. This is low compared to what Gaines (1977) found in the Sacramento Valley, where 41 percent of the species detected were cavity nesters. It is possible that the riparian forests in the Sacramento Valley are much older and thus contain larger trees, which are known to be preferred by cavity nesting species (Wilson et. al. 1991). Snags are also important for wood ducks and common mergansers, as these species nest in large cavities. Wood ducks are known only to use cavities, whereas common mergansers will also use dense wood or rock piles (Bent 1944) for nesting. We found few, if any tree cavities large enough for use by these species in the riparian zone along the river. However, wood ducks are known to use tree cavities in adjacent uplands (Ehrlich et al. 1988, Bent 1944), areas we did not search.

Few studies have looked at, or documented successional riparian habitat preferences by wildlife species. In the Sacramento Valley riparian habitats, winter bird numbers were greatest in young willow dominant seral stages (Gaines 1977). Anderson documented increases in bird abundance of two to three times in willow vegetation during winter due to its open nature and seed availability (willow, herbs, etc.). Motroni (1984) also recorded greater winter use of early successional riparian vegetation by birds, especially seed eaters. He states "the importance of early successional stage riparian vegetation to total bird numbers and overall species diversity on a seasonal level is significant". We found during our one breeding season of census work, that several species showed a trend of greater abundance in willow dominant riparian vegetation. However, several scientists recommend against drawing habitat association conclusions based on one year's data (Rice et al. 1983). Rice et al. (1983) reviewed several studies done over consecutive years and found that "all reported differences among years in species composition". Though summer bird communities were more sTable than other times of the year, "even local breeders have turnover rates between 25-35 percent". However, with this in mind, we did find certain species to be more abundant in early successional willow habitat. This includes three species that are not only riparian obligates, but also "state species of special concern" (yellow warbler, yellow-breasted chat) and a state listed endangered species (willow flycatcher).

Riverine Birds

Twelve avian species were recorded during float surveys (Appendix E). Three herons were recorded, with green-backed herons being most abundant. Waterfowl detected included the common merganser, mallard, and wood duck. Five raptors were recorded, all in low numbers: bald eagle, osprey, red-tailed hawk, sharp-shinned hawk, and Cooper's hawk. Three additional river dependent species include the American dipper, belted kingfisher and spotted sandpiper.

Green-backed herons

This riparian obligate averaged 39.8 birds per survey (Appendix E), with numbers nearly doubling between late May (34 detections) and early August (54 detections) with the appearance of fledglings . This species was fairly evenly dispersed along the river (Fig. 3).

Green-backed herons were observed using a variety of substrates, including dead wood and branches hanging over or in the river (Appendix F).

This species was most often observed along runs (50%), but also seen along pools (25%) and rapids (20%)(Appendix G).

Grinnell and Miller (1944) described green-backed herons as preferring slow flowing streams, lakes and willow-bordered sloughs. They forage from concealed and shaded perches just above the water. We believe this species may have benefited from the habitat changes resulting from the dam. Many sections of the river are lined with dead woody debris, which now never move downstream due to constant low flows. This debris provides ideal foraging perches for herons.

Grinnell and Miller (1944) believed this species to breed as solitary pairs. We found this to be generally the case indicated by the fairly uniform distribution along the river (Fig. 3), however, we found one location where 6-8 pairs were nesting within a 100 m radius. We found green-backed herons nesting in mature alders, both along the mainstem of the river and along side channels. This species is believed to be a summer resident only (Grinnell and Miller 1944).

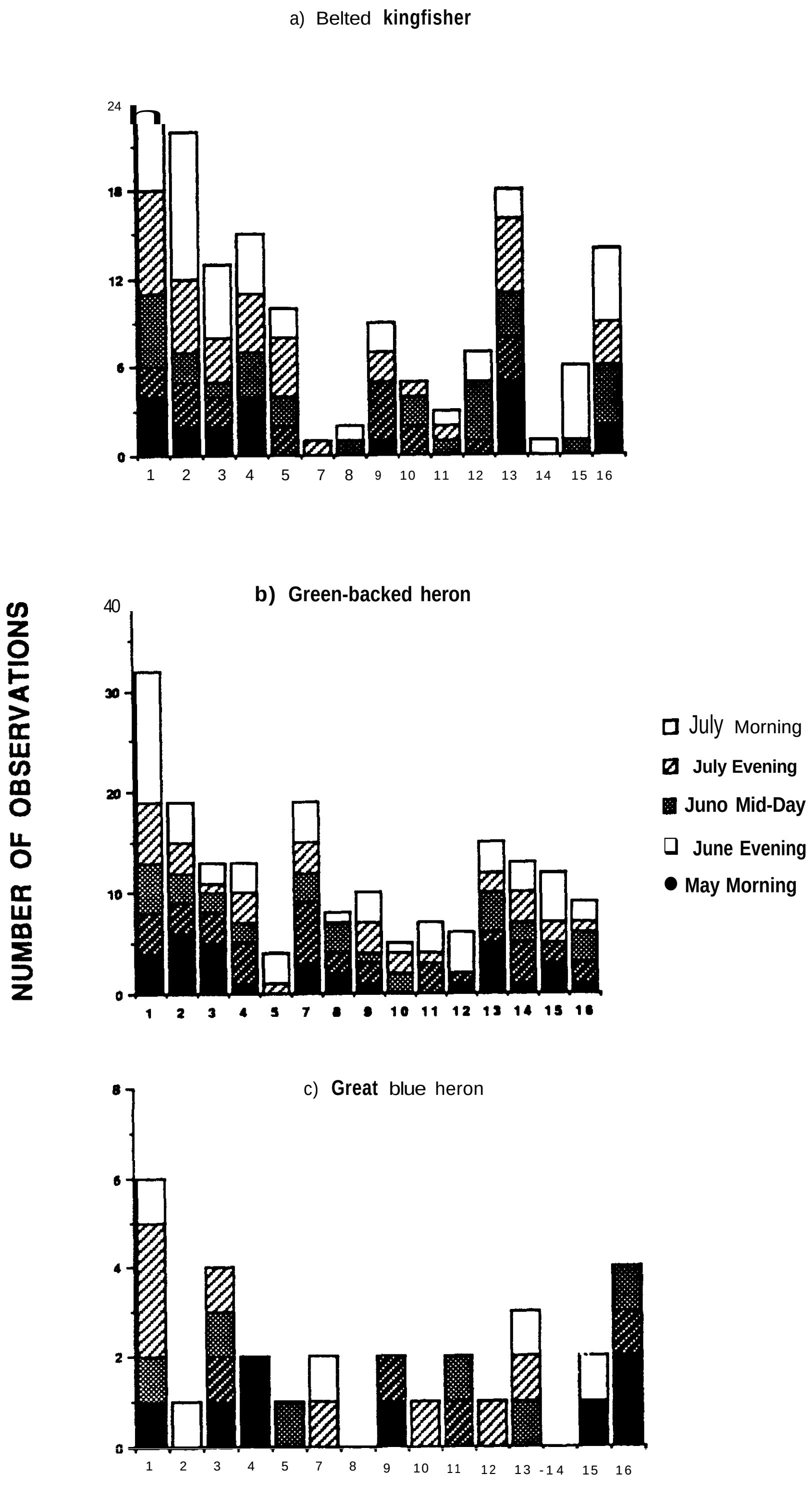


Figure 3. Comparisons of riverine wildlife species abundance by Reach along the Trinity River, Ca. (1990). Histograms depict total number of individuals during each survey.

Great-blue heron

This species was present in small numbers and averaged 6.6 birds per survey (Appendix E). They were fairly evenly distributed and detected on 13 of 15 Reaches (Fig. 3). Substrate use (Appendix F) was quite variable and included rocks, downwood, snags, or gravel bar. Water habitat use was nearly identical to green-backed herons (Appendix G), most often observed in runs (50%).

This is a species that we believe has been negatively impacted by changes in the river since the dam. Great-blue herons usually forage by wading, and requires shallow river edges (Grinnell and Miller 1944). Much of the river has become channelized with unsuitable steep edges. The severe reduction in fish abundance may have also reduced food availability for great-blue herons. Improving fish populations would benefit this species.

Belted kingfisher

This species averaged 32 individuals per survey (Appendix E); increasing from 20 during survey 1 to a high of 48 during survey 5 (Fig. 3). During survey 1, belted kingfishers were detected on 7 of 15 Reaches, whereas by survey 5, 13 of 15 Reaches had detections. The upper Reaches contained the most kingfishers, with Reach 1 averaging 5.2 birds/survey and Reach 2 averaging 4.4 birds/survey. Reaches 7, 8,and 14 had the fewest (Fig. 3).

The greater abundance of belted kingfishers in the upper Reaches may be attributed to three factors: a greater abundance of prey near the fish hatchery (small fish), more foraging perches (snags), and adequate nesting sites. Our vegetation analysis does show that the upper Reaches have a greater abundance of snags than the lower Reaches (Appendix D). As for nesting requirements, kingfishers need "friable, earthen, or sandy banks above water" to dig their round nest cavities (Ehrlich et al. 1988). We have confirmed nesting locations on Reaches 2, 3, 4, 13, and 16.

This species may have benefited from the increased vegetation (especially snags) along the river since dam construction.

Common merganser

This species averaged 74.2 individuals per survey (Appendix E), with a low of 61 during survey 1 and a high of 89 during survey 2. Only 63 individuals were detected during the last survey and most of those were young of the year. Common mergansers occurred throughout the 39 mile stretch of river, but varied in abundance by Reach. Reaches 13 and 2 had the most, averaging 13.2 and 11.0 birds per survey, respectively. The upper Reaches (1-7) averaged the most individuals, while the lower Reaches (11-16) averaged fewer (Fig. 4).

Male mergansers were recorded only during the first two surveys. 82 percent of those males detected during Survey 1 were in Reaches 1 to 3. No male common mergansers were detected after the end of June.

Family units were detected during the second through the fifth survey (May - Aug.). Numbers of family units detected per survey was fairly constant and averaged 5.5. There was tremendous variation in family size, ranging from 1-25 young. The majority of families (58%) had less than 10 individuals, however, five groups of 20 or more young were observed.

Common mergansers are known to have clutches up to 17 eggs (Ehrlich et al. 1988). It is probable that clutches larger than 20 were two or more families that joined. Merging of family groups has been documented (Bent 1940) and we saw at least one group with two adult females.

Flocks (groups of adult birds) averaged six sightings during the first three surveys, then dropped off to four and one flocks detected during surveys 4 and 5, respectively.

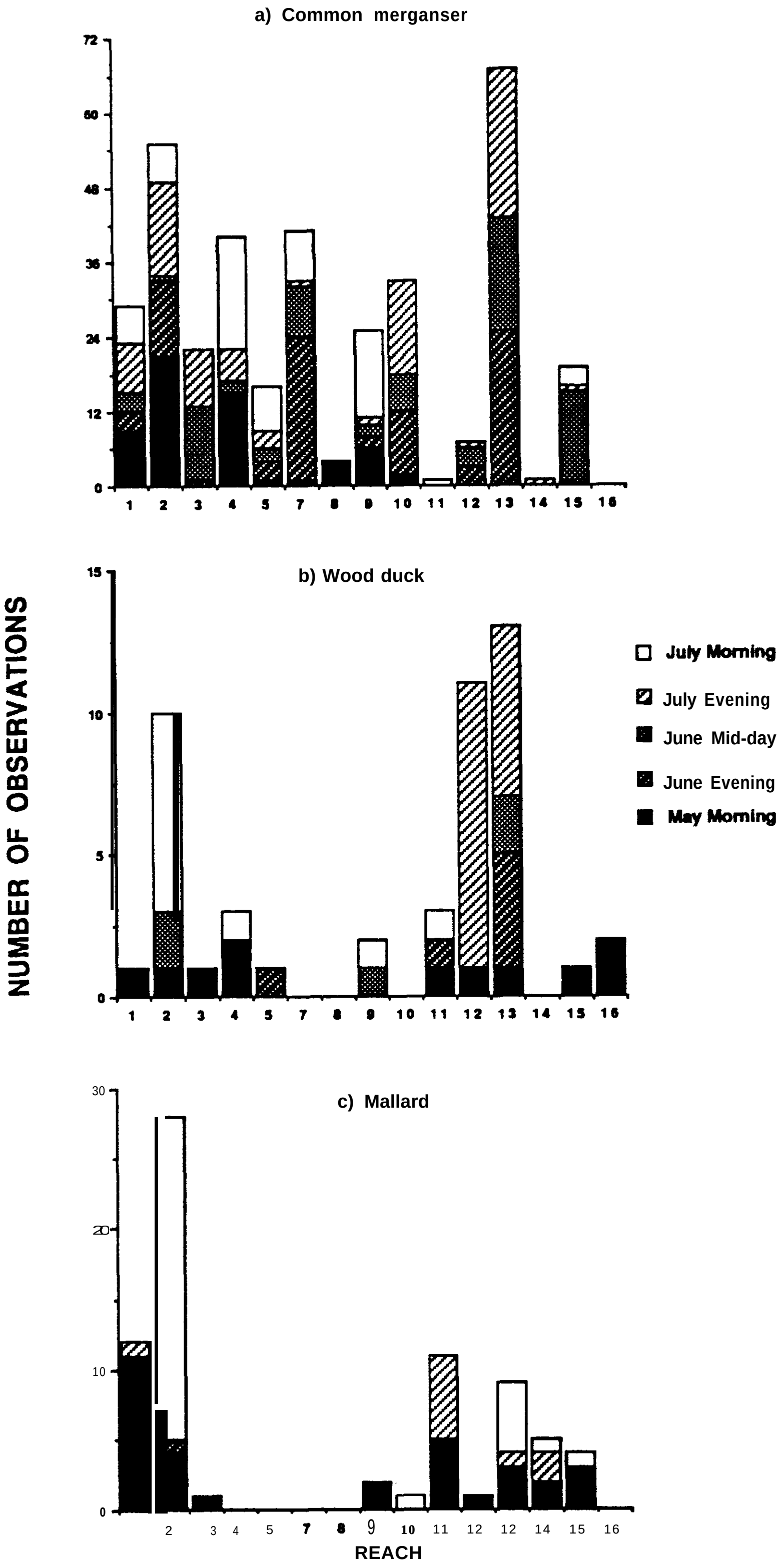


Figure 4. Comparisons of riverine wildlife species abundance by Reach along the Trinity River, Ca. (1990). Histograms depict total number of individuals detected during each survey.

Common mergansers were primarily observed swimming, flying, or resting on rocks and gravel bars (Appendix F). They were most often observed in runs (50%), rapids (25%, usually perched on rocks or gravel bar), and pools (20%, Appendix G). Common mergansers were detected during all times of the day, (Fig. 5) though they appear to be more active during the morning and after 6 p.m.

Common mergansers are a species that have probably benefited from the changes in the river since the dam. Though strong swimmers, they prefer to forage in slow moving waters (Miller 1951). The controlled flows have created more glide habitat, and less riffle/rapid. This species is distributed throughout the study area. They use large tree cavities for nesting, but will also nest on the ground in debris piles or rock cavities (Bent 1940).

Wood duck

This species occurred in small numbers in our study area, averaging 11.0 individuals per survey (Appendix E). Wood ducks were seen on 11 of the 15 Reaches, however only Reach 2, 12, and 13 averaged greater than two individuals per survey, and only six Reaches had detections during more than one survey (Fig. 4). Detections were primarily individuals, a few pairs, or females with young. However, three family units were detected during the last two surveys; they averaged just under four individuals per family. Four additional families were seen by opportunistic sighting. Two large flocks (19 and 10 individuals, respectively) were observed opportunistically in mid-August. This species was found mostly in pools (45%) and runs (45%)(Appendix G).

Wood ducks are very shy and are most often found in secluded backwaters and pools along the river (Grinnell and Miller 1944). This species nests in large tree cavities (Ehrlich et al. 1988), of which there appear to be few along this section of river. Our survey suggests that their abundance and reproductive success is very low in this system. It could be due to predation (e.g., mink and otter), or lack of adequate nest sites. The latter situation could be improved by putting up nest boxes at secluded locations along the river away from human disturbance. This species has probably benefited from changes in the river since the dam, with the increase in slower, deeper waters. Wood ducks have lost habitat throughout their range (Remsen 1989) and the potential exists to mitigate for some of that loss along the Trinity River.

Mallard

We found no indication of reproduction along this section of river, however, this species was detected throughout the summer in small numbers. A mean of 15.6 birds was detected per survey (Appendix E), however, none were family groups. Their numbers fluctuated dramatically, from zero to 31 individuals detected per survey.

Mallards were observed in the water 80 percent of the time, in pools and runs equally (40%)(Appendix G).

American dipper

This species occurred in small numbers along the river, averaging 9.4 individuals per survey over all 15 Reaches (Appendix E). Their abundance increased between survey 1 and survey 5 (Appendix E). Dippers were seen on 10 of 15 Reaches (Fig. 6); however, only 7 Reaches had detections during more than one survey. Young birds were seen on Reaches 2, 3, 7, and 15 during survey 5.

American dippers were most often observed on rock (40%) and gravel bar (22%), followed by perches in dead parts of live trees (12%) near water. The type of river mesohabitat they favored was predominantly rapids (>60%), followed by runs (35%)(Appendix G).

This species may have been negatively affected by the dam. They prefer swift-flowing waters (Grinnell

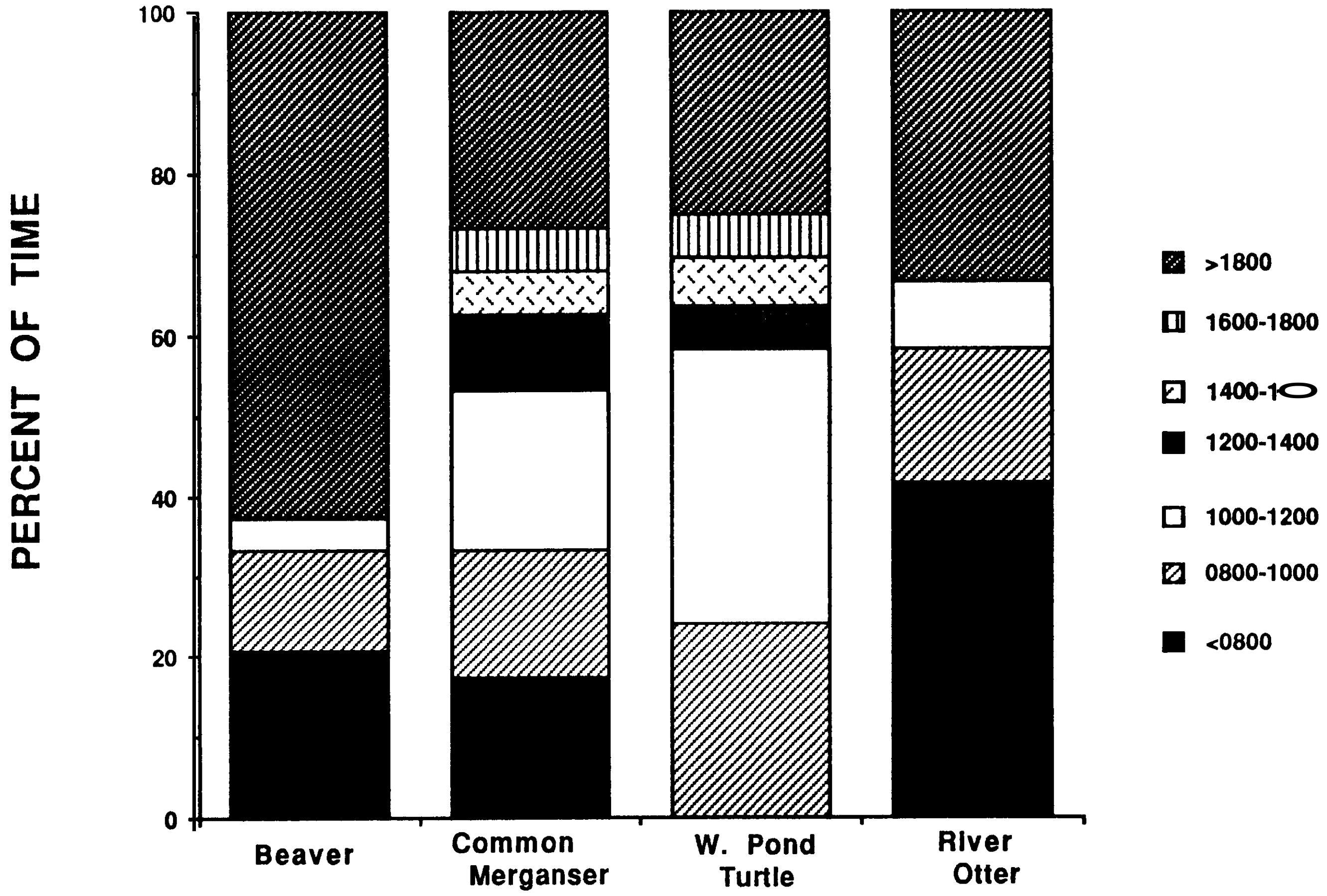


Figure 5. Time of day that certain wildlife species were detected along the Trinity River during the 1990 float surveys. Histograms depict the percent of detections by time of day.

and Miller 1944) which has declined with the controlled flows since the dam. They nest on cliff ledges next to the water, or use bridges as surrogates (Ehrlich et al. 1988). We found dippers nesting on most bridges in the study area, from Lewiston dam to the North Fork. Two nests were found at one site, suggesting that nest sites may be a limiting factor. This species is known to by polygynous. We observed them foraging in side channels, which may partially mitigate for loss of riffle habitat in the mainstem.

Spotted sandpiper

Spotted sandpipers were fairly abundant and averaged 32.8 detections per survey (Appendix E). They were most abundant during the first (50 detections), and least abundant during the last two surveys (20 and 28, respectively). This species was found on all Reaches and increased in abundance from upper to lower portions of the river (Fig. 6).

Spotted sandpipers were most often observed on gravel bar (30%), followed by rock (18%). This species was easily frightened, explaining the high number of detections in flight from flushing (30%). They were most often observed in runs (58%) and rapids (38%)

It is difficult to assess the effect of the dam on spotted sandpipers. It is clear that they prefer early successional riparian, adjacent to shallow shorelines and gravel bars (Grinnell and Miller 1944). This habitat has declined since the sTable flows after the dam (Evans 1980). However, this species also needs low sedge or grassy vegetation for nesting (Ehrlich et al. 1988). We found this species very commonly nesting on gravel bar islands.

The timing of the artificial high flow releases (late May to early June) may have negatively affected this species breeding success. This species arrives mid to late April and begins nesting when the flows start to decrease after the spring runnoff. We believe that high flows at the end of May may have flooded some nests. This species is polyandrous; the females lay up to 20 eggs during a breeding season, leaving the care of the eggs and young to four or five different males (Ehrlich et al. 1988). With the capacity to lay eggs over an extended period of time, this species may well be adapted to stochastic events such as late high river flows. More effort is needed to ascertain the effects of spring releases on spotted sandpipers.

Raptors

Bald eagles and ospreys were detected in low numbers, both during our surveys (Appendix E), and opportunistically. We did not locate nests of either species and saw no young birds that would indicate nesting. However, during May 1991 (unpublished data), we did locate an active Osprey nest near Poker Bar. Bald eagles were seen on two Reaches (1 and 10) during the first two surveys. One other eagle was seen opportunistically on Reach 5. Osprey were seen on seven Reaches, however, only Reach 1, 2 and 13 had detections on more than one occasion. They were detected on four occasions on Reach 1 and 2 and during three of the five surveys on Reach 13.

Accipiters were detected primarily opportunistically, with Cooper's hawks on 5 Reaches and sharp-shinned hawks on 4 Reaches. Cooper's hawks prefer riparian habitats (Grinnell and Miller 1944). Between 1972 and 1981 this species was on Audubon's Blue List due to it's apparent widespread decline (Remsen 1989). Since DDT was outlawed in 1972, its populations have steadily increased. Our study showed this species to be present during the breeding season, though breeding was not confirmed. Several individuals were also detected during migration (late August). They are known to build nests in conifers or broad-leaved trees from 35-45 feet up (Ehrlich et al. 1988). Before any mature riparian vegetation is removed, surveys for breeding pairs should by conducted.

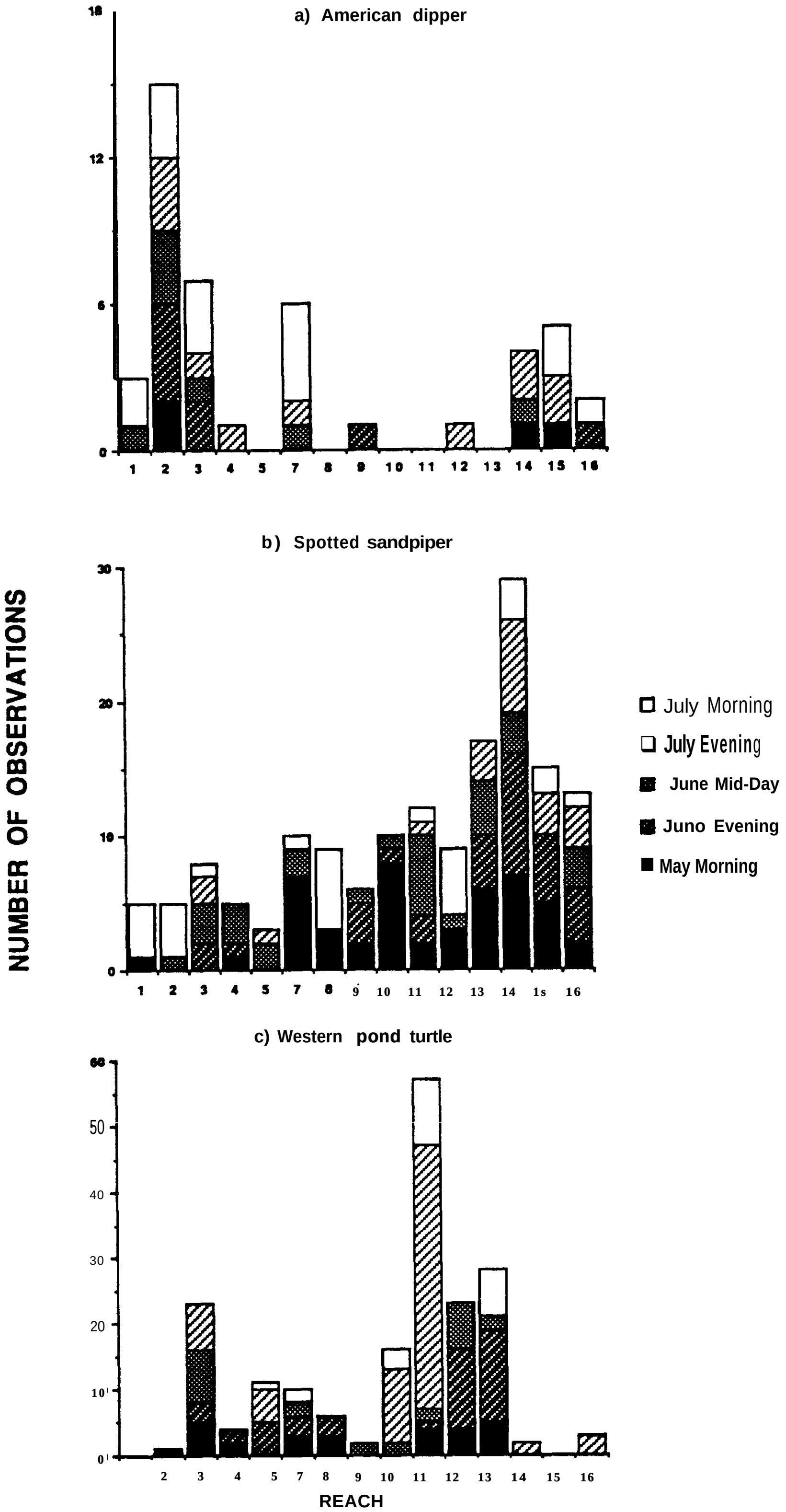


Figure 6. Comparisons of riverine wildlife species abundance by Reach along the Trinity River, Ca. (1990). Histograms depict total number of individuals detected during each survey.

Mammal Community

Small Mammals

Capture Rates

We captured a total of 526 small mammals in 8 weeks of pitfall trapping (Fig. 7). Eleven species were captured, but only shrews occured at greater than incidental levels (at least 30 total captures occuring at 10 or more stations). Evans (1980) found primarily mice (Peromyscus sp.) and voles (Microtus sp.) in his study of the Trinity River riparian zone. Shrews were probably under-reprepresented in his sample because he used snap traps which are not as effective for capturing shrews as pitfall traps (Taylor et. al. 1988).

Comparisons Among Geomorphological Types

We found no statistical differences, however, several species demonstrate patterns of increased abundance along various portions of the 39 mile study area. Mammals, as a whole, were somewhat more abundant on the middle Reaches (Geomorphological type II) with most species following this pattern (Table 4). We hypothesize that this is a result of the confined channel morphology of geomorphological II, where upland habitats are relatively closer to the river resulting greater habitat diversity. Deer mice were captured on 11 of the 16 Reaches and occured in similar numbers throughout the study area.

Comparisons Among Riparian Types

Though again we found no significant differences in abundance of shrews or mammals (all species combined) among stations classified by riparian type, we noted a trend toward greater abundance of shrews in later successional stages of riparian (Table 4).

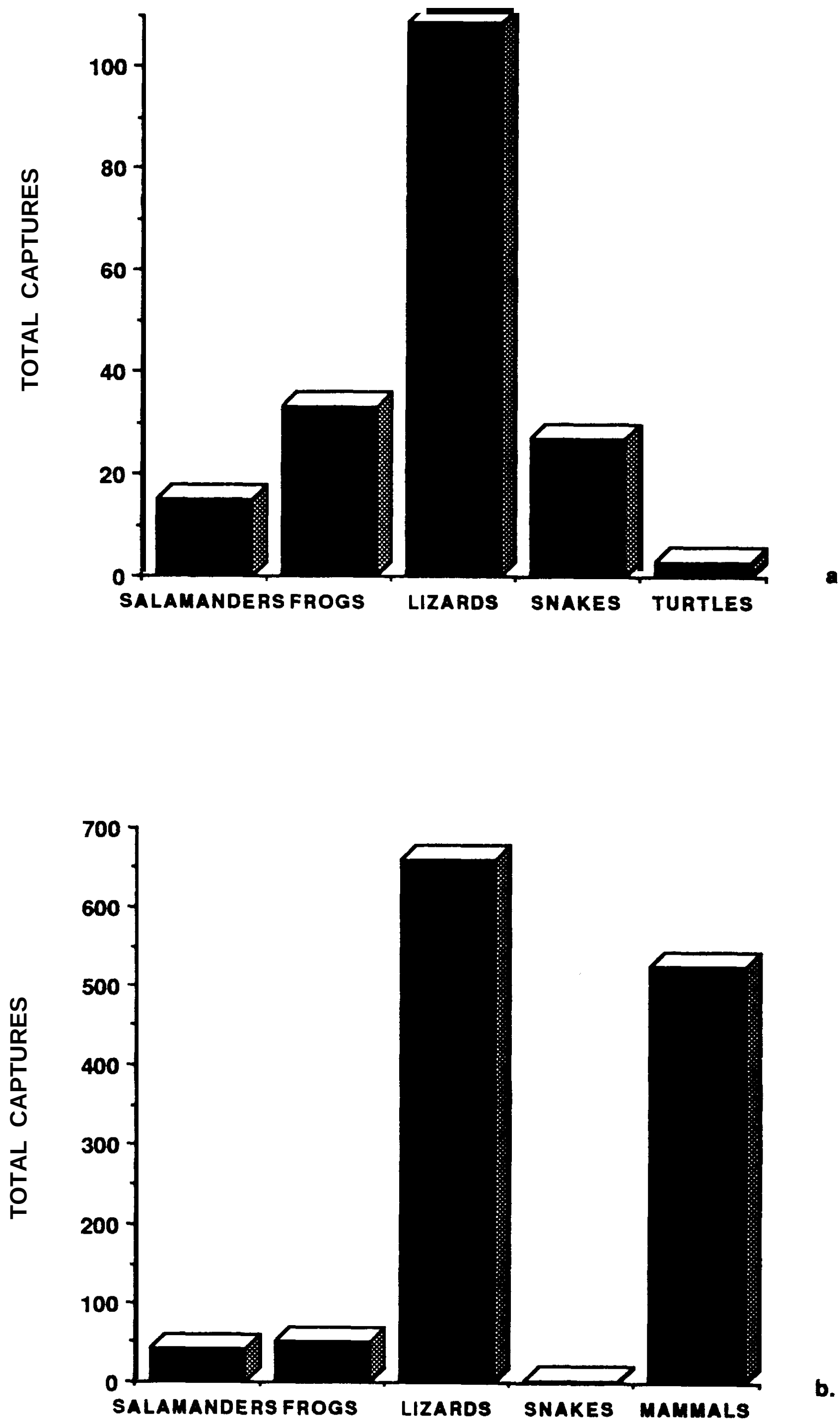


Figure 7. Captures by (a) time-constrained searches and (b) pitfall trapping along the Trinity River in 1990.

Table 4. Animal abundance (captures per 1000 trap-nights) from pitfall sampling, by geomorphic type and riparian type. Data were collected from July 1 to August 30, 1990 at 45 stations were along a 39 mile stretch of the Trinity between Lewiston Dam and the North Fork of the Trinity.

SPECIES[1]	**I**	**II**	**III**	**Willow**	**Willow/ Alder**	**Alder/ Matur**
MAMMALS						
Trowbridge shrew	0.00	2.58	2.70	1.70	2.78	4.66
Shrew sp	14.02	20.49	16.00	16.88	16.67	27.97
Shrew mole	0.33	1.23	0.47	0.40	0.98	1.10
Botta's pocket gopher	0.33	0.24	0.00	0.20	0.00	0.00
Hermanns kangaroo rat	0.00	0.12	0.00	0.00	0.16	0.00
Western harvest mouse	0.17	0.00	0.00	0.10	0.33	0.00
Deer mous	2.00	0.86	0.70	1.20	1.14	1.37
Pinon mous	0.00	0.24	0.18	0.20	0.16	0.00
California vole	0.67	0.37	0.23	0.60	0.16	0.27
Long-tailed vole	0.00	0.24	0.18	0.10	0.00	0.27
Vole sp.	0.17	0.00	0.35	0.20	0.33	0.00
Mammal totals	**17.69**	**26.37**	**20.81**	**21.58**	**22.71**	**35.64**
AMPHIBIANS						
Rough-skinned newt	2.67	1.35	0.35	1.40	1.14	1.92
Ensatina	0.17	0.24	0.23	0.00	0.00	0.55
Black salamander	0.00	0.00	0.23	0.00	0.16	0.00
Western toad	0.33	1.84	1.06	2.50	0.16	0.00
Pacific treefrog	0.67	0.37	0.82	0.60	0.82	0.27
Foothill yellow-leg. Frog	0.33	0.00	0.82	0.30	0.49	0.00
Amphibian totals	**4.17**	**3.80**	**3.51**	**4.80**	**2.77**	**2.74**
REPTILES						
Western Fence lizard	22.03	19.14	21.05	20.38	15.04	23.31
Sagebrush lizard	0.17	2.58	4.94	1.10	2.29	3.01
Lizard sp.	0.00	0.00	0.47	---	---	---
Western skink	1.33	1.59	0.82	1.20	1.31	0.00
W. whiptail lizard	0.00	0.12	0.00	0.10	0.00	0.00
N. alligator lizard	0.00	0.00	0.47	0.00	0.00	0.82
S. alligator lizard	0.17	0.24	0.59	0.40	0.16	0.82
Common garter snake	0.00	0.00	0.18	0.00	0.16	0.27
Reptile totals	**23.70**	**23.67**	**28.52**	**23.08**	**18.96**	**28.23**
Total animals	**45.56**	**53.84**	**52.84**	**49.46**	**44.44**	**66.61**

1- Species' scientific names are listed in Appendix H.
2- Geomorphic type: I = reaches 1-4; II = reaches 7-11; III = reaches 12-16, characteristics of each are defir the text.
3- Riparian vegetation types are categorized by the dominant plant species at that station: Willow = greater tl 2/3 covered by Salix sp.; Alder = greater than 2/3 covered by Alnus sp.; or Willow/Alder = mix of the twc

Habitat Associations

The passive nature of pitfall trapping does not allow direct observations of animals using certain habitats. However, given the relatively small home ranges of the species captured by this method it is probably safe to assume that these animals are using the habitats they were captured in, not just passing through.

Mammals, as a group, and shrews were captured in greatest abundance in riparian and upland traps and less in gravel bar traps (ANOVA for shrews: $F = 6.11$, $p = 0.002$)(Table 5, Fig. 8a). Among riparian types, shrews were most abundant in alder/mature traps (Fig. 8b).

Several recent studies have compared species richness and abundance in riparian and upland forests adjacent to forested streams in Oregon (Cross 1985, Anthony et al. 1987b, Doyle 1990). These studies used several different sampling techniques (snap traps, live traps, and pitfalls) but found similar results. Cross (1985) and Doyle (1990) found higher species richness and overall abundance in riparian than upland habitats, but the associations of individual species were inconsistent between the two studies. Anthony et al. (1987b) examined differences between riparian and ecotonal habitats. His study found greater species richness in the riparian (especially insectivores) but concluded that no species was "dependent" on the riparian. Our study did not have sufficient trapping effort in upland habitats to determine if there were differences in abundance among riparian and upland habitats.

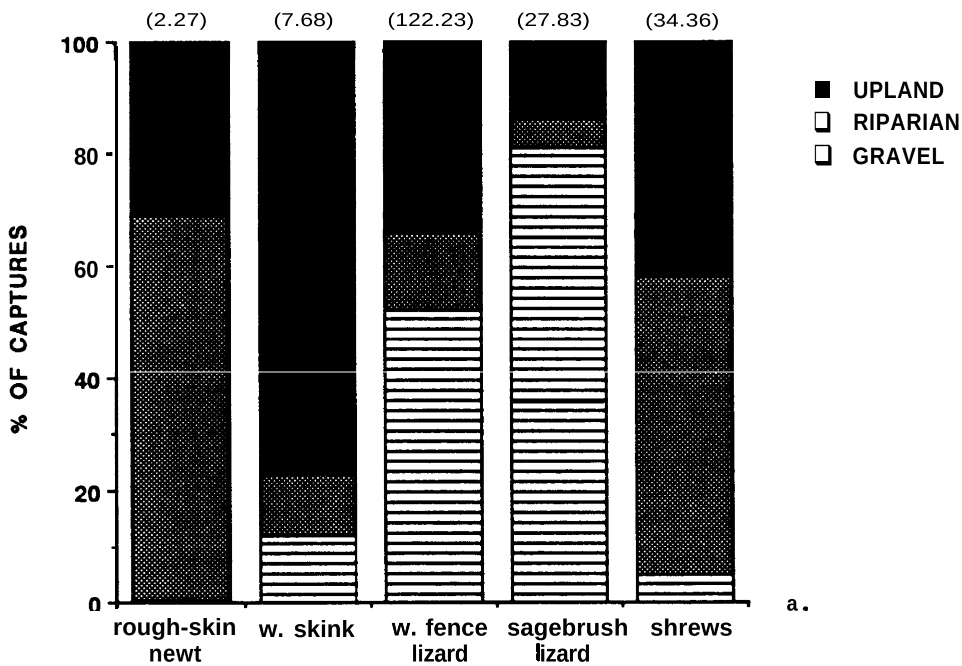
Effectiveness of Trap Types

Effectiveness of pitfall trap types could not be statistically compared because trapping with the two types was not done simultaneously (i.e. there were four weeks of dry traps followed by four weeks of wet traps). However, partly filling traps with water, did allow us to capture mice and voles and get some measure of their abundance in the study area. Capture rates of deer mice did increase after water was placed in traps (Table 5). However, other trends (e.g. decreases in captures of shrews) cannot necessarily be attributed to trap type, but are more likely an artifact of temporal differences in activity or diminished populations as a result of "trapping out".

Table 5. Animal abundance (captures per 1000 trap-nights) from pitfall sampling, by habitat type and trap type. Data were collected from July 1 to August 30, 1990 at 45 stations were along a 39 mile stretch of the Trinity between Lewiston Dam and the North Fork of the Trinity.

	HABITAT TYPE[2]			TRAP TYPE[3]	
SPECIES[1]	**Gravel Bar**	**Riparian**	**Upland**	**Dry**	**Wet**
MAMMALS					
Trowbridge shrew	0.00	1.77	2.80	3.76	0.00.
Shrew sp	1.88	18.13	14.35*	23.84	10.58
Shrew mole	0.00	0.69	1.05	0.51	0.87.
Botta's pocket gopher	0.00	0.10	0.70	0.26	0.08
Hermanns kangaroo rat	0.00	0.05	0.00	0.00	0.08
Western harvest mouse	0.00	0.15	0.00	0.00	0.24
Deer mouse	1.88	1.18	0.70	0.26	1.99
Pinon mouse	0.00	0.15	0.00	0.00	0.24
California vole	0.00	0.39	0.35	0.26	0.48
Long-tailed vole	0.00	0.10	0.00	0.00	0.24
Vole sp	0.00	0.20	0.00	0.00	0.24
Mammal totals	**3.76**	**22.**	**19.95**	**28.89**	**15.04**
AMPHIBIANS					
Rough-skinned newt	0.00	1.57	0.70	0.68	2.07
Ensatina	0.00	0.15	0.70	0.26	0.16
Black salamander	0.00	0.05	0.3	0.08	0.08
Western toad	1.88	1.28	0.35	1.45	0.95
Pacific treefrog	0.94	0.64	0.00	0.08	1.03
Foothill yellow-leg. Frog	1.88	0.34	0.00	0.08	0.64
Amphibian totals	**4.70**	**4.03**	**2.10**	**2.63**	**4.93**
REPTILES					
Western Fence lizard	62.97	17.59	41.67*	13.41	30.72
Sagebrush lizard	22.56	1.42	3.85*	0.94	4.22
Lizard sp.	3.76	0.00	0.00	0.00	0.32
Western skink	0.94	0.79	5.95*	1.79	1.03
Western whiptail lizard	0.00	0.05	0.00	0.08	0.00
N. alligator lizard	0.00	0.15	0.35	0.17	0.16
S. alligator lizard	0.00	0.39	0.70	0.43	0.40
Common garter snake	0.00	0.05	0.00	0.08	0.00
Reptile totals	**90.23**	**20.44**	**52.56**	**16.90**	**36.85**
Total animals	**98.69**	**47.38**	**74.57**	**48.42**	**56.82**

1- Species' scientific names are listed in Appendix H.
2- Each pitfall bucket was located in either gravel bar, riparian or upland habitat.
3- Trap type: Dry - first 4 weeks of sampling; Wet - second four weeks of sampling.
*- significant difference in habitat use, oneway analysis of variance.



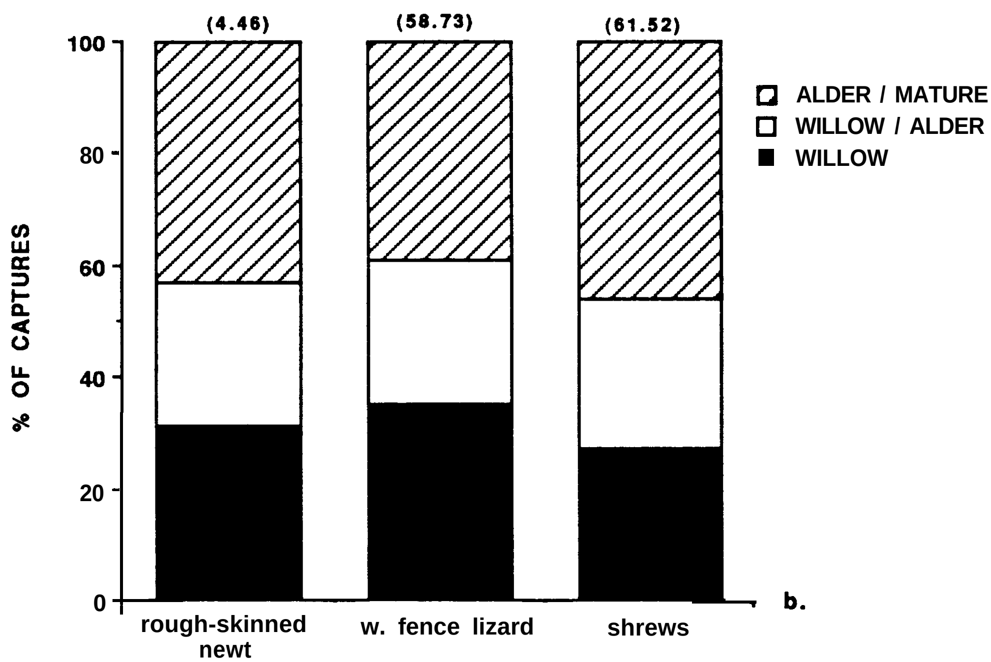


Figure 8. Percent of pitfall captures by (a) habitat type and (b) riparian type for four species of herpetofauna , and shrews. Numbers in ( )'s are total captures per 1000 trap-nights.

Riverine Mammals

River Otter

This species was detected during 3 of the 5 surveys and averaged 5.8 individuals per survey (Appendix E). They were detected on 11 Reaches, eight during float surveys (Fig. 9) and three opportunistically. Families were seen on Reaches 2, 3, 4, 5, 10, 12 and 13.

Otters were seen swimming, as well as sitting on snags, downed wood, or on shore (Appendix F). Seventy-eight percent of detections were in runs and twenty percent in pools (Appendix G). They were seen primarily before eight a.m. (38%) and after six p.m. (37%)(Fig. 5).

Otters are primarily piscivorous and depend on healthy fish populations. Manning (1990), and many other studies have shown that otters take game fish (Salmonids) less frequently than other fish (Catostomidae and Cyprinidae). Catostomidae (suckers) are slow moving and were the most abundant prey captured by otters on the Mendocino National Forest (Manning 1990). Otters may in fact benefit game fish populations by preying on their competitors. Other prey items for this species include crayfish, snakes, aquatic insects (particularly stoneflies, caddisflies, and dragonflies), and western pond turtles (Manning 1990).

Beaver

This primarily nocturnal species was detected during 4 of the 5 surveys (Fig. 9), averaging six individuals (Appendix E). Beaver were detected on 11 Reaches; eight Reaches during float surveys and three opportunistically. The greatest number (6) were detected on Reach 5 during an evening survey.
Beaver were detected most often after 6 p.m. (>60%, Fig. 5) and before 8 a.m. (20%), with 75 percent of detections in the water and 20 percent on land (Appendix F). River meso-habitat use was primarily runs (60%) and pools (30%).

The increase in riparian vegetation and slow moving water since the dam has undoubtedly benefited the beaver. They appear to be abundant throughout the study area, as evidenced both by our float surveys and vegetation assessment of beaver impacts. Beavers have been called a "keystone species" (Dahm et al. 1987) because it plays a pivotal role in regulating the entire ecosystem. While investigating the decline of coho salmon, Dahm et al. (1987) discovered that fish depended on the stored water and increased productivity of beaver ponds. Studies in Juneau, Alaska, have found that beaver ponds provide particularly good winter habitat for coho salmon (Bryant 1984). Beavers contribute considerable organic matter to the waterways by eating approximately 2500 pounds of leaves and small branches a year and defecating the organic waste into the water (Dahm et al. 1987). A comparison of beaver pond habitat and adjacent stream habitat at Sagehen Creek north of Truckee, California, found a higher standing crop of aquatic organisms, and a higher abundance of trout, in beaver ponds (Gard 1961).

Mink

This riparian associated species was seen on nine Reaches, three during surveys and six opportunistically. Reach 2 had the most detections (9). Reaches 3, 12, and 15 had greater than two detections (Appendix E).

This riparian species has probably benefited from increased vegetation along the river as a result of the dam. Mink prefer areas with a dense tree canopy and shallow streams (Burgess and Bider 1980). We have observed mink foraging along the river edge. Gerell (1970) analyzed mink scat and concluded that mink diet consisted of small mammals, crayfish, frogs, squirrels, fish, and aquatic insects. Burgess and Bider (1980) found that voles, deer mice, and shrews were a large portion of the mink's diet. Our pitfall trapping effort (see below in pitfall section) showed an abundance of these animals (especially shrews) along the

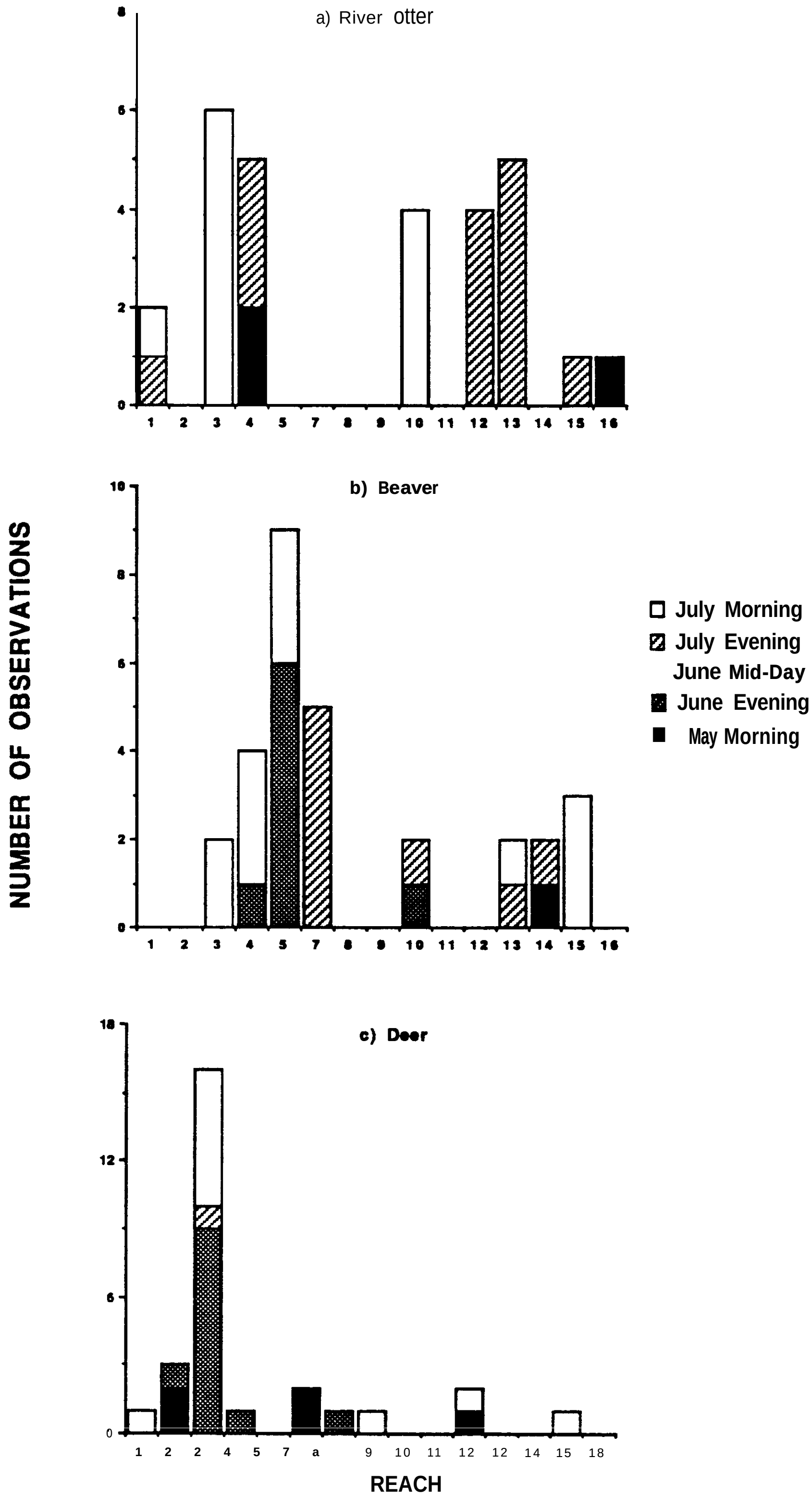


Figure 9. Comparisons of riverine wildlife species abundance by Reach along the Trinity River, Ca. (1990). Histograms depict total number of individuals detected per survey.

Trinity River.

Two studies that address the mink's impact on game fisheries show conflicting results (Alexander 1976, Day and Linn 1972), one positive and the other negative. These results indicate that food habits studies must be site specific and cannot be generalized.

Herpetofauna Community

Timing and Effectivness of Capture Methods

There are some important differences between our sampling methods that affect both the types and numbers of species that are captured or observed. Time-constrained searches (timed-searches) were done in the spring when there was still moisture available for terrestrial salamanders and it was also warm enough for reptiles to be active, following their winter "hibernation" period. Pitfall trapping was done in mid-summer making capture of terrestrial salamanders unlikely, but intercepting many metamorphosing aquatic amphibians (e.g. rough-skinned newts and western toads) and hatchling reptiles (e.g. western fence lizard and sagebrush lizard) as they dispersed. Snakes are only rarely captured in pitfall traps (Welsh 1987). Timed-searches are an active method and provide reliable data on microhabitat associations of most species. The passive nature of pitfall trapping does not allow direct observations of animals using certain microhabitats. However, given the relatively small home ranges of the species captured by this method it is probably safe to assume that these animals are using the habitats they were captured in, not just passing through.

The float survey method was used to describe distributions and habitat associations of western pond turtles because the other methods are ineffective for turtles.

Capture Rates

Timed-Searches

We observed a total of 187 amphibians and reptiles at 47 stations. Lizards (primarily the western fence lizard) accounted for 58.3 % of all observations. Frogs, snakes, and salamanders accounted for about 40 % and western pond turtles for only 1.6 % (Appendix H). We observed 20 species of herpetofauna, including three salamanders, four frogs, five lizards, seven snakes, and the western pond turtle. We captured one species not previously known from Trinity County, California (Bury 1970), the sharp-tailed snake.

Only the western fence lizard was observed at greater than incidental levels (more than 30 total captures occuring at 10 or more stations) and was used in statistical analyses of geomorphological type and riparian type, and to describe habitat associations (Appendix H, see below).

Pitfall Trapping

We captured a total of 754 amphibians and reptiles in 8 weeks of pitfall trapping: 88 % reptiles and 12 % amphibians (Appendix H). One common garter snake was caught in a pitfall, but all the rest of the reptiles were lizards. Of the amphibians, approximately half were salamanders and half were frogs (Appendix H). This method was not appropriate for sampling turtles. Fourteen species were captured in pitfalls; 6 amphibians and 8 reptiles.

Several species occured at greater than incidental levels: rough-skinned newt, western skink, western fence lizard, and sagebrush lizard. These species were used in statistical analyses of geomorphological and riparian types.

Comparisons Among Geomorphological Types

Analysis of variance of western fence lizards among stations classfied by gemorphological type demonstrated no significant differences using either timed-search or pitfall data. We believe this is due to our limited sample sizes, as abundances of some species demonstrated increasing and decreasing trends as one moved downstream from the dam (Tables 4 and 6).

Rough-skinned newts were captured most frequently on the upper and middle Reaches by pitfall, and in small numbers throughout the study area by timed-searches. Pitfall captures were primarily newly metamorphosed juveniles and timed-search captures were sub-adults and adults.

Bullfrogs were found in greater abundance in geomorphological types I and III (timed-search - Table 6). Foothill yellow-legged frogs were found primarily on the lower Reaches of the river (Reach 10 and downstream) except for two pitfall captures on Reach 2 and 3 (Tables 4 and 6). This species of frog tends to inhabitat relatively open habitats (Stebbins 1985; Hayes and Jennings 1988) which are more abundant in geomorphological type I and III.

Western toads and the western skink were found in greater abundance at stations in the middle Reaches (geomorphological type II) (Tables 4 and 6). Both species have an affinity for forested upland habitats in this portion of their ranges; skinks inhabitat such habitats year round and toads inhabitat them during the non-breeding season (Nussbaum, et al. 1983). Western racers also were found primarily in the middle Reaches (timed-search, Table 6). As a result of the confined channel morphology of the middle Reaches, upland habitats are relatively closer to the river, than in other Reaches.

Northern alligator lizards were found only in geomorphological type III (Reaches 13 and 16), while southern alligator lizards were found on both geomorphological types II and III (Reach 5 and downstream) (Tables 4 and 6).

Western fence lizards occured at constantly high abundance from Lewiston Dam to the North Fork, while sagebrush lizards were most abundant in the middle and lower Reaches (geomorphologial types II and III) (Tables 4 and 6). These patterns are probably due to the habitat affinities of these two species. The western fence lizard has been found to have a wide variety of habitat associations, but is rarely found in large open areas without rock or shrub cover and the sagebrush lizard is found primarily in open habitats with small shrubs and sandy substrates (Marcellini and Mackey 1970, Rose, 1976 and Adolph, 1990). Geomorphological type III contained more open habitat, including mine tailings and gravel bars, than did the other types.

Comparisons Among Riparian Types

Analysis of variance of species captured at greater than incidental levels among stations classfied by riparian type demonstrated no significant differences for either timed-search or pitfall data. There also appear to be some differences between the results for the two methods and some patterns do not concur with known habitat associations. For example, pitfall captures of the sagebrush lizard indicated that when it was found in riparian, it was most often found in the alder/mature type (Table 4). This is not consistent with our timed-search results (Table 6) or its documented associations with open scrubland (Marcellini and Mackey 1970). One possible explanation is that classifying a whole station as a riparian type ignores the small patches of other vegetation types present to which the animals may be responding.

Table 6. Captures per person-hour (Time-constrained search method) of amphibians and reptiles on sites in three geomorphological types and three riparian types. Data were collected in April and May 1990 along the main fork Trinity River between Lewiston Dam and the North Fork.

	GEOMORPHOLOGICAL TYPE[2]			RIPARIAN TYPE[2]		
SPECIES[1]	**I**	**II**	**III**	**willow**	**willow/ alder**	**alder/ mature**
	(12)[3]	**(15)**	**(17)**	**(19)**	**(17)**	**(10)**
<u>Amphibians</u>						
Pacific giant salamander	0.00[4] (0.00)	0.00 (0.00)	0.06 (0.06)	0.00 (0.00)	0.06 (0.06)	0.00 (0.00)
Rough-skinned newt	0.25 (0.13)	0.13 (0.09)	0.29 (0.17)	0.26 (0.15)	0.18 (0.10)	0.20 (0.13)
Ensatina	0.00 (0.00)	0.20 (0.15)	0.00 (0.00)	0.05 (0.05)	0.00 (0.00)	0.30 (0.21)
ALL SALAMANDERS	**0.25 (0.13)**	**0.33 (0.21)**	**0.35 (0.19)**	**0.32 (0.15)**	**0.24 (0.14)**	**0.50 (0.13)**
Western toad	0.00 (0.00)	0.00 (0.00)	0.59 (0.59)	0.00 (0.00)	0.06 (0.06)	0.00 (0.00)
Pacific treefrog	0.17 (0.17)	0.07 (0.07)	0.06 (0.06)	0.05 (0.05)	0.18 (0.13)	0.00 (0.00)
Foothill yellow- legged frog	0.00 (0.00)	0.13 (0.13)	0.35 (0.30)	0.00 (0.00)	0.47 (0.31)	0.00 (0.00)
Bullfrog	0.50 (0.36)	0.00 (0.00)	0.65 (0.46)	0.42 (0.29)	0.71 (0.44)	0.00 (0.00)
ALL FROGS	**0.67 (0.45)**	**0.20 (0.15)**	**1.12 (0.74)**	**0.47 (0.29)**	**1.41 (0.74)**	**0.00 (0.00)**
ALL AMPHIBIANS	**0.92 (0.50)**	**0.53 (0.24)**	**1.47 (0.80)**	**0.79 (0.37)**	**1.65 (0.77)**	**0.50 (0.31)**
<u>Reptiles</u>						
Western pond turtle	0.00 (0.00)	0.13 (0.13)	0.00 (0.00)	0.11 (0.11)	0.06 (0.06)	0.00 (0.00)
Western fence lizard	2.00 (0.51)	1.60 (0.41)	1.12 (0.32)	1.90 (0.40)	1.41 (0.32)	1.10 (0.46)
Sagebrush lizard	0.00 (0.00)	0.13 (0.13)	0.41 (0.29)	0.16 (0.16)	1.12 (0.12)	0.40 (0.40)

Table 6. (cont.)

SPECIES[1]	GEOMORPHOLOGICAL TYPE[2] I	II	III	RIPARIAN TYPE[2] willow	willow/ alder	alder/ mature
	(12)[3]	**(15)**	**(17)**	**(19)**	**(17)**	**(10)**
	(0.00)	(0.00)	(0.27)	(0.11)	(0.26)	(0.10)
Southern alligator lizard	0.00	0.20	0.35	0.32	0.12	0.20
	(0.00)	(0.11)	(0.19)	(0.17)	(0.08)	(0.13)
ALL LIZARDS	**2.17**	**2.13**	**2.41**	**2.53**	**2.06**	**2.20**
	(0.00)	**(0.50)**	**(0.44)**	**(0.42)**	**(0.46)**	**(0.73)**
Ringneck snake	0.00	0.13	0.00	0.00	0.00	0.20
	(0.00)	(0.09)	(0.00)	(0.00)	(0.00)	(0.13)
Sharptail snake	0.08	0.00	0.00	0.05	0.00	0.00
	(0.08)	(0.00)	(0.00)	(0.05)	(0.00)	(0.00)
Western racer	0.08	0.73	0.12	0.73	0.59	0.30
	(0.08)	(0.47)	(0.12)	(0.40)	(0.06)	(0.21)
Striped racer	0.08	0.00	0.00	0.00	0.06	0.00
	(0.08)	(0.00)	(0.00)	(0.00)	(0.06)	(0.00)
Gopher snake	0.00	0.00	0.06	0.00	0.06	0.00
	(0.00)	(0.00)	(0.06)	(0.06)	(0.00)	(0.06)
Western terrestrial garter	0.00	0.00	0.06	0.00	0.06	0.00
	(0.00)	(0.00)	(0.06)	(0.00)	(0.06)	(0.00)
Unidentified garter	0.00	0.00	0.06	0.00	0.06	0.00
	(0.00)	(0.00)	(0.06)	(0.00)	(0.06)	(0.00)
Western rattlesnake	0.00	0.07	0.00	0.05	0.06	0.00
	(0.00)	(0.07)	(0.00)	(0.05)	(0.06)	(0.00)
ALL SNAKES	**0.25**	**0.93**	**0.29**	**0.84**	**0.35**	**0.50**
	(0.13)	**(0.47)**	**(0.14)**	**(0.40)**	**(0.15)**	**(0.22)**
ALL REPTILES	**2.42**	**3.20**	**2.71**	**3.47**	**2.47**	**2.70**
	(0.51)	**(0.85)**	**(0.48)**	**(0.69)**	**(0.45)**	**(0.73)**

1- Species' scientific names are listed in Appendix H.
2- Types are defined in the text.
3- Number of sites in each geomorphological or riparian type.
4- Mean (standard error) captures for type.

Habitat Associations

We summarized pitfall captures into three general habitat types (gravel/cobble bar, riparian, and upland) and three riparian types (willow dominant, willow/alder mix, and alder/mature). Timed-search observations had one additional general habitat category (ecotone) and upland was broken into two types. Because of these differences we present the results separately.

Time-constrained Searches

Bullfrogs were found only in riparian habitats and of these were most frequently observed in willow/alder mix and alder/mature (Fig. 10a & b). Western fence lizards were found in a wide variety of macrohabitats, but most frequently in willow/alder mix and ecotonal habitats (Fig. 10a & b). Western racers were found most frequently in ecotonal and ghost pine/oak upland habitat (Fig. 10a & b).

Pitfall Trapping

The rough-skinned newt was captured in greatest abundance in riparian habitat with almost half of all captures in alder/mature habitats (Table 4, Fig. 8a and b).

Several frog species, the western toad, the Pacific treefrog, and the foothill yellow-legged frog, were captured most frequently in gravel/cobble bar and rarely in upland (Table 4). This may be a seasonal phenomenon. Treefrogs occur in a variety of habitats as long as moisture is available and may move into upland habitats during winter rains (Nussbaum et. al. 1983). Most of the toads captured in pitfalls were newly metatmorphosed juveniles and were probably dispersing through the riparian. Adult toads are primarily terrestrial and may be found great distances from water in non-breeding season (Nussbaum, et al. 1983).

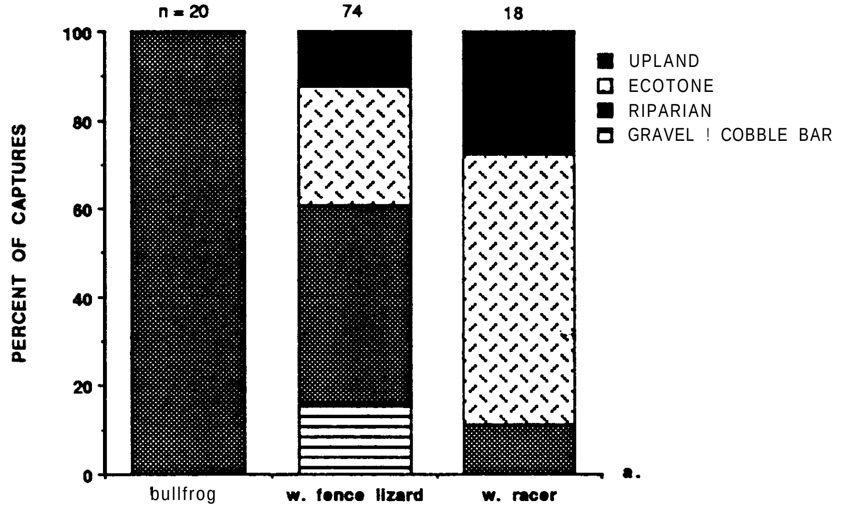
Three species of lizards were captured in different abundances in the three habitat types. Western fence lizards were captured most often in gravel/cobble bar and upland habitat, with a lower rate of occurence in riparian (ANOVA: $F = 35.86$, $p < 0.0001$)(Table 5, Fig. 8a). Within the riparian, fence lizards were captured in nearly equal abundances among the three types (Table 4, Fig. 8b). Sagebursh lizards were captured most commonly in gravel bar habitat (ANOVA: $F = 47.21$; $p < 0.0001$) and western skinks were captured most frequently in upland habitat (ANOVA: $F = 27.40$, $p < 0.0001$) (Table 5, Fig. 8a). These results are in line with known habitat associations of all these species (Marcellini and Mackey 1970 and Rose 1976).

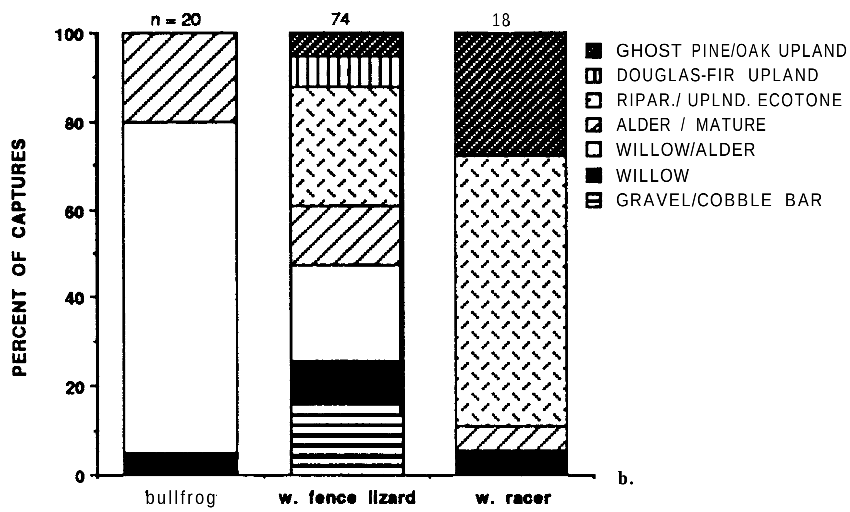
Substrate Use (Time-constrained Searches Only)

Bullfrogs were most commonly found in or near water on soil, sand, or leaf litter. Western fence lizards were found on a wide variety of substrates, but most frequently on loose rock, shrubs, logs, and debris piles. Western racers were found primarily in leaf litter and on herb or grass substrates (Fig. 10c).

Trap Types (Pitfall Trapping Only)

Several species of herpetofauna were caught in greater numbers in wet traps than dry (Table 5). We believe this is an artifact of the timing of these samples; traps were dry in July and wet in August. Newly metamorphosed rough-skinned newts, and hatchling western fence and sagebrush lizards usually appear in late summer (Nussbaum, et al. 1983). This recruitment probably resulted in the increased numbers of captures in wet (later) versus dry (earlier) traps (Table 5).





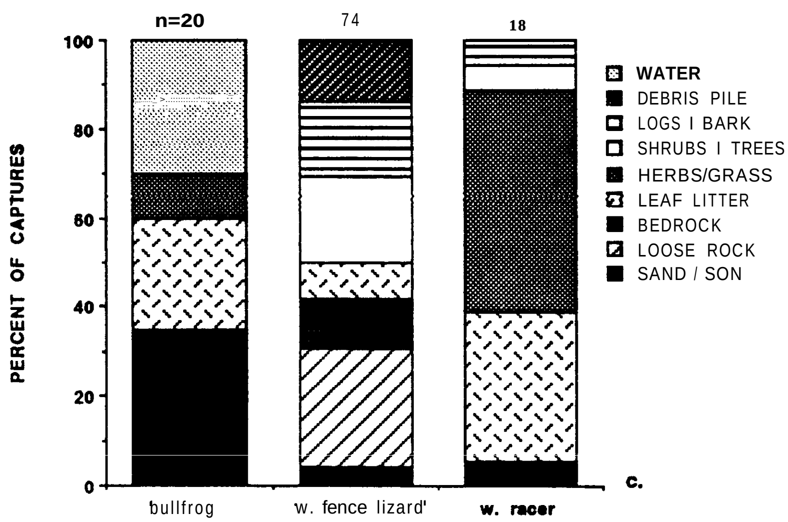


Figure 10. Habitat (a), vegetation community (b), and substrate (c) associations of bullfrogs, w. fence lizards and w. racers from timed-searches along the Trinity River in 1990.

Herpetofaunal Species Richness and Vegetation Associations

Comparing species richness with the percent of each station that was riparian vegetation cover, demonstrated a trend toward increased richness at intermediate amounts of riparian and decreased richness at the extremes (Fig. 11). This would be expected, as areas with intermediate amounts of riparian vegetation would also have significant amounts of upland or gravel bar habitats, providing more diverse habitat overall.

Western Pond Turtle

We used float surveys to sample pond turtles in our study area. Pond turtles averaged 42.6 individuals per survey across all Reaches (Appendix E), ranging from 23 (survey 5, morning) to a high of 68 individuals (survey 4, afternoon-evening). They were found on 13 of the 15 Reaches surveyed, with a high of 11.4 per survey on Reach 11 and no detections on Reaches 1 and 15 (Fig. 6). The high abundance on Reach 11 was due primarily to survey 4, in which 40 individuals were detected.

Eighty percent of pond turtles were detected while basking on downed wood protruding from water; usually within 15-30 cm of the water surface (Appendix F). They were observed on rocks (<10%) and shore (<10%) to a lesser degree. This species was detected from 8 a.m. until late evening, however, 60 % of the detections occurred between 8 and 12 p.m.

Pond turtles may have benefited from the changes in the river since the dam. They are poor swimmers (Holland, pers. comm.) and prefer slow moving water; 60 % of our observations were along pools (Appendix G). Pool and glide habitats have increased in abundance with the controlled flows and channelization of the river. However, the amount of habitat for hatchling turtles (shallow, slow-flowing river margins) has certainly decreased. We also know little about the availability of turtle prey and nest sites. The artificially low water temperatures resulting from deep lake water releases may affect activity periods, reproduction, and foraging abilities of turtles.

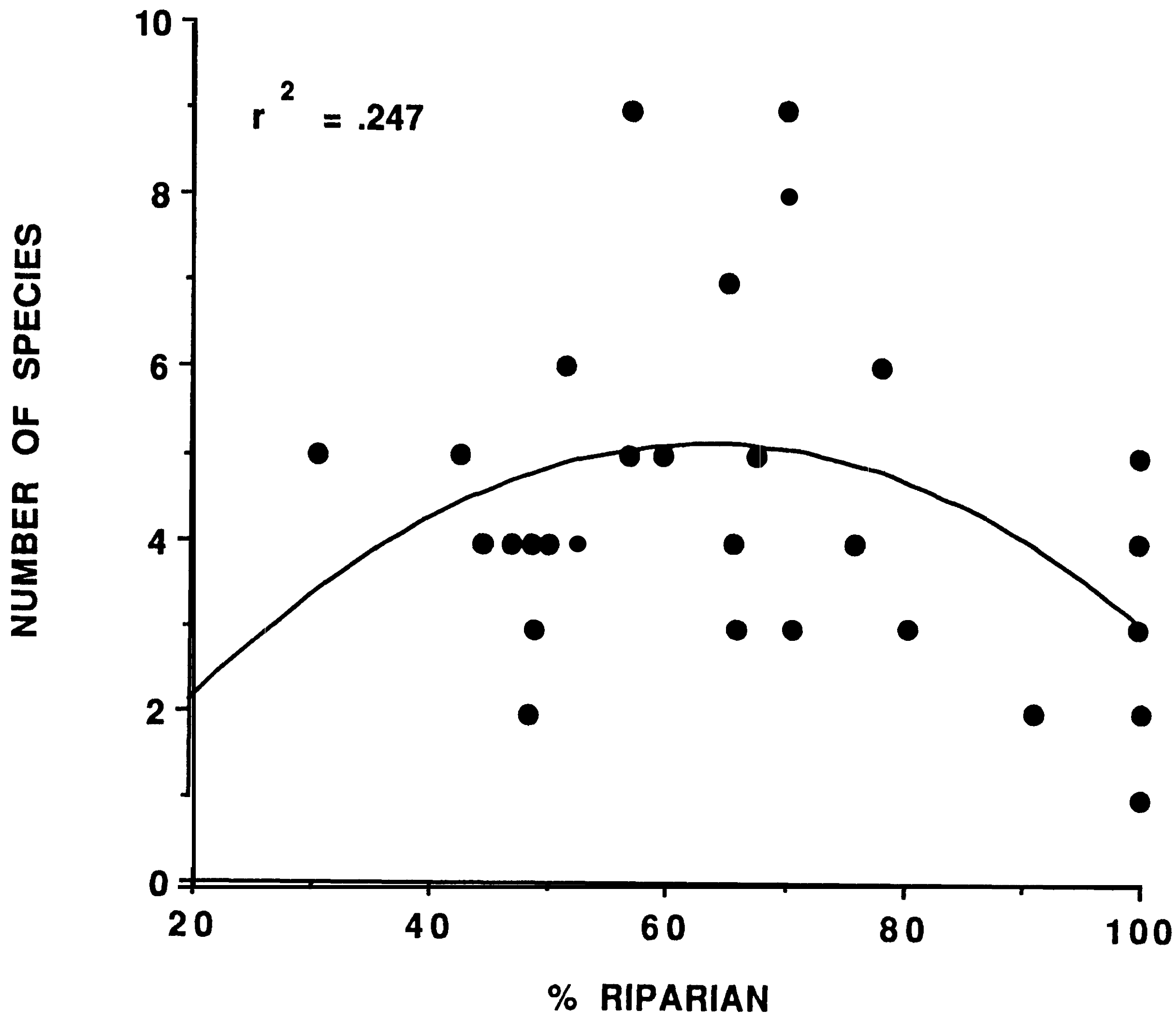


Figure 11. The relationship between herpetofauna species richness and the percent riparian canopy cover along the Trinity. Low percent cover of riparian indicates high percent cover of gravel bar or upland.

MANAGEMENT RECOMMENDATIONS

Sensitive Species

Birds

The Department of Fish and Game has determined that California's avifauna can best be helped by focusing efforts on "a few key problems and critical areas". Preserving habitat in riparian woodlands is at the top of their list (Remsen 1989). Greater than 90% of California's original riparian woodlands have been destroyed (Sands 1980). Fourteen "species of special concern" are restricted to Colorado River riparian woodland, while the Central Valley riparian woodlands contain seven species. We found seven "species of special concern" along the Trinity River. These include: 1) the state listed endangered willow flycatcher, 2) highest priority Merlin, 3) second priority species such as osprey, yellow warbler, and the yellow-breasted chat; 4) and third priority sharp-shinned hawk, and Cooper's hawk (Remsen 1989). We also found several species that are being considered as candidates for special concern due to an apparent continuing decline in their abundance. These include green-backed heron, wood duck, tree swallow and common yellowthroat (Remsen 1989).

The Trinity River riparian woodland was not listed by the Department of Fish and Game as an important area with significant riparian habitat in California (Remsen 1989). We believe it should be considered as significant new (since 1962) riparian habitat in California. Evans (1980) documented an almost 400% increase in riparian vegetation since the dam was built. Our study showed an abundant population of several of the avian species of special concern, including yellow warblers, yellow-breasted chats, tree swallows, and green-backed herons. The remaining species of special-concern were present in low numbers: osprey, merlin (winter only), willow flycatcher, Cooper's hawk, sharp-shinned hawk and wood duck. The species diversity in this area is significant and shows the importance of this habitat type to bird life.

Yellow-breasted chat

This is the only species that occured significantly more often in willow dominant habitat (Table 3). It's habitat preference is for "low, dense riparian plant growth, consisting most commonly of willow thickets and tangles of tall weeds, blackberry vines and grapevines" (Grinnell and Miller 1944). We found this bird at 42 percent of the willow dominant riparian stations and at only 18 percent of the alder dominant. Though shrub cover is fairly equal between riparian types, understory willow and canopy cover is greater in willow dominant riparian vegetation (Appendix C). This may explain their preference for this riparian vegetation type.

Yellow warbler

This species showed a tendency for earlier successional vegetation, but the differences were not statistically significant (Table 3). It was once a common summer resident in riparian areas throughout California (Grinnell and Miller 1944), but today its populations are much reduced and even extirpated in some areas. Populations in the Sacramento Valley and San Joaquin Valley have virtually disappeared (Gaines 1974; Remsen and Gaines 1973). Only 5% of available habitat is occupied in the upper Sacramento Valley (Laymon 1984). The reasons for its decline include destruction of riparian habitat and susceptibility to brown-headed cowbird parasitism (Gaines 1978). This species was very abundant in our study area (Table 1 and Table 2). It's preferred habitat is described by Grinnell and Miller (1944) as "riparian plant associations composed of willows, cottonwoods, aspens, sycamore, and alders up to 40 feet in height". This species appears to be doing well along the Trinity River where new post-dam habitat may partly mitigate for the excessive loss of riparian vegetation throughout much of California.

Willow flycatcher

The willow flycatcher was once a common breeding bird in suitable habitat throughout California (Grinnell and Miller 1944). However, due to destruction of willow riparian habitat and nest parasitism by the brown-headed cowbird (Gaines 1974, 1977), this species has undergone a drastic population decline. Today, it has apparently been extirpated from all known localities in the Central Valley (Remsen 1989). In June 1990, it was state listed as endangered (Remsen 1989). Combining survey and opportunistic data, we detected approximately 20 willow flycatchers. These were mostly singing individuals, all of which were detected in willow and willow/alder vegetation, with most sightings located in three sections of the river, Reaches 2, 3, and 15 (Fig. 1). Direct evidence of breeding was not confirmed. However, along one stretch of river, 6 males were evenly spaced and counter-singing, suggesting territorial behavior and indirect evidence of reproduction. This species was detected at only 5% of the willow dominated census stations. A detailed study is needed to determine the reproductive status of the willow flycatcher along the Trinity River.

Herpetofauna

The importance of pristine riparian habitat for many species of herpetofauna is well-documented (see Brode and Bury 1987 for a review). Brode and Bury (1987) indicated that dam and reservoir construction had detrimental effects on native herpetofauna. Other studies of dammed river systems also have indicated negative effects on herpetofauna (Warren and Schwalbe 1985; Szaro and Belfit 1986).

We observed two species of herpetofauna that we feel may be good indicators of riparian habitat quality and deserve further attention. The foothill yellow-legged frog (Rana boylei) and the western pond turtle (Clemmys marmorata) are both State Species of Special Concern: the yellow-legged frog throughout the state and the pond turtle in the southern portion of its range (Jennings, 1987).

Foothill Yellow-legged Frog

There is international concern that amphibian populations, especially frogs are in decline (Blaustein and Wake 1990). Habitat destruction is frequently cited as a cause on a local scale. Others have speculated that native frogs (especially those in the family Ranidae) have been negatively impacted by introduced bullfrogs and non-native fishes (Moyle, 1973; Hayes and Jennings 1986; Schwalbe and Rosen 1988). Historically, the Trinity River probably contained little habitat suitable for bullfrogs (Evans, 1980). The construction of the dam and the resulting flow regulation and lack of seasonal flooding has led to channelization of the river and created areas of stable aquatic vegetation, including cattail marshes. These areas are prime habitat for bullfrogs and poor habitat for yellow-legged frogs (Stebbins 1985; Hayes and Jennings 1988).

Our sampling indicated that foothill yellow-legged frogs were found primarily along the lower Reaches (geomorphological type III) of the study area, associated with gravel/cobble bars (Tables 4 and 6). These associations are consistent with known habitat use of this species reported elsewhere (Zweifel 1955; Moyle 1973; Stebbins 1985; Hayes and Jennings 1988). The lower Reaches are more influenced by natural flood regimes of tributary streams, are less channelized, and have more open gravel bars than the upper Reaches (Evans 1980).

Western Pond Turtle

Southern California populations of western pond turtles have declined rapidly over the past 50 years due to urbanization and habitat destruction (Brattstrom 1987; Holland 1989). It has also experienced severe population declines in the extreme northern portion (Oregon and Washington) of its range (Holland, 1989). A proposal to list this species as threatened throughout its range is expected later this year (D. Holland, pers. comm.). Consequently, this species deserves special attention within the Trinity River basin.

Based on our float surveys it appears that there is a good population of pond turtles along some portions of the river (Fig. 6). Adult and sub-adult turtles appear to be using downed woody debris protruding from the water along slow moving sections of the river (Appendices F and G). However, we lack important information about hatchling habitat use, nest site availability, and potential effects of low water temperatures.

Future Research Needs

Our study of the 39 mile stretch of the Trinity from Lewiston Dam to the North Fork provides information on distributions and relative abundances of most wildlife species in the Trinity Basin. The results of this study have suggested several other questions about wildlife species in the Trinity Basin. We recommend the following research projects:

1. In depth study of Willow flycatcher to determine breeding status, habitat use and distribution along the Trinity River.

2. A study of the distribution, habitat associations, and reproductive biology of the yellow-legged frog on the main fork with comparison study sites on an undammed river, such as the south fork of the Trinity.

3. A study of the demography and reproductive biology of the western pond turtle. Information on nest sites and hatchling distribution is needed and could be gathered using radio telemetry. Information on the relationships of pond turtles to water temperatures and its possible effect on reproduction and activity is also needed.

4. Fall/winter bird censuses to determine bird abundance and habitat use of riparian along the Trinity River. Many studies have documented the importance of riparian vegetation during times other than the breeding season. Gaines (1974) found greater numbers of birds in the winter than during the summer. Abramski (1980) documented the importance of riparian vegetation to migrants. Anderson and Ohmart (1977) found along the lower Colorado River that birds have narrower habitat breadths and show less habitat overlap (i.e. are more specialized) during the winter, and suggest that winter is potentially the time of greatest stress. They recommend that winter requirements "should receive at least equal attention" as the breeding season.

5. Second year of breeding bird census work to confirm (or deny) abundance and frequency of species and habitat associations.

6. Year round float survey to document riverine species seasonal use of Trinity River.

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APPENDICES

Appendix A. Variables and sampling method used to describe the vegetation at census stations (birds, timed searches, and pitfall) along a 39 mile stretch of the Trinity River between Lewiston Dam and the North Fork.

Variable	**Description**
Reach	numbered 1-16
Station	numbered 1-10, left or right of river
Observers	two observers initials
Date	
Site Characteristics (25 m Radius of Each Station)	
Aspect	direction in compass degrees slope faces
Slope	steepness (%) of adjacent upland slope taken with a clinometer
Upland Type	indicates dominant conifer type of associated upland (ie. Ghost Pine , or Douglas Fir)
River Mesohabitat	recorded as a glide, pool, ripple/rapid, or run (after McCain et. al. 1990)
Human Impact	visual estimate from negligable to high, indicating degrees of human access and disturbance
Beaver Impact	ranges from none to high indicating degree of beaver activity
Canopy Height	average canopy height in meters of the riparian and upland (if present within 25 m circle) overstory
Valley Width	floodplain width in meters measured from USGS 7.5 minute topo quads
Variables Measured Along 50 m Tape, Centered on Station and Perpendicular to the River	
Macrohabitat	number of meters measured in gravel bar, riparian, upland, or river habitat
Ground Cover: The following were analyzed as percents of the total measured in each macro habitat t	
Talus	measured in meters along 50m tape
Litter	sticks and debris < 10 cm DBH
Bare Soil	
Grass-Like Vegetation	includes grass, rushes, and sedges
Herb	all forbes
Log	stems > 10 cm DBH
Water	includes river water, side channels, ponds, and streams
River Rock	gravel, pebble, cobbles, and boulders
Bedrock	
Sand	
Under and Overstory: All vegetation between 0.5 m and 2.0 m; and taller than 2.0 m that intersects th and analyzed as percent of the total for each macrohabitat type.	
Ferns and Horsetails	
Shrubs	includes blackberries and wild grape
Willows	Salix species
Alders	Alnus species
Cottonwood	Populus species
Other riparian hardwoods	Oregon ash, Big-leaf Maple, etc.
Upland hardwoods	Oaks, Madrone, Bay, etc.
Conifers	Ponderosa pine, Digger pine, Sugar pine, Douglas fir
Open	no vegetation present
Grass/herb	grasses and herbs

Appendix A (cont.)

<u>Band Tree Counts</u>

Small to medium size trees	numbers of trees by species between 10-40 cm DBH within a 5 m band on eit line in both riparian and upland habitats.
Large trees	numbers of trees greater than 40 cm DBH within a 10 m band on either side c transect line. Analyzed by species in both riparian and upland habitats (when
Snags	number of snags > 10 cm DBH within a 10 m band on either side of the transe
Debris piles	number of debris piles (> 1 m diameter) within 10 m band on either side of th transect line.
Logs	number of logs > 10 cm DBH within 10 m band on either side of the transect

Appendix B. Descriptions of variables recorded during float surveys, time-constrained searches, and pitfall trapping along a 39 mile stretch of the main fork of the Trinity River, from Lewiston Dam to the North Fork, April through August of 1990.

Variable	Description
	VARIABLES RECORDED FOR ALL ANIMAL SAMPLING METHODS
Reach	reach number on the river, 1-16.
Station	station in reach, l-11, and left or right side river
Date and Time	month, day, and year, time
Observers	initials of observers
Species	scientific name of the animal observed
Sex and Age	animals were designated as juveniles or adults and male or female, if possible
Body Measurements	captured animals were measured as follows: herpetofauna - snout to vent and total length mammals total and tail length
	FLOAT SURVEYS - ADDITIONAL VARIABLES
General Habitat	habitat animal was in: water, land, island, or unknown
River Mesohabitat[1]	water habitat the animal was in or near: glide, pool, riffle/rapids, run
Substrate and Species	material and vegetation species the animal was on, in, or using
Height	height of animal above ground
Activity	activity of animal prior to disturbance by observer
Group Size	indicated whether the observation was of a single individual, pair, family, or flock
	TIME-CONSTRAINED SEARCHES - ADDITIONAL VARIABLES
Weather and cloud cover	Precipitation index and estimate of percent cloud cover
Macrohabitat	dominant vegetation within a 10 m radius circle around the observation, (seven categories)

Appendix B. (cont.)

Variable	Description
	TIME-CONSTRAINED SEARCHES, continued

Mesohabitat

Mesohabitat represented the habitat conditions within a 2.5 m radius around each observation.

Ground/Vegetation Cover	Visual estimates of the visible layer of ground level material (water, litter, logs, rock, etc..) and vegetation cover in four height classes were made
Litter depth	mean of four measurements taken randomly throughout the 2.5 m radius circle
Dominant shrub and tree	the species of shrub and tree with the greatest percent cover in the circle

Microhabitat

Microhabitat represented the habitat conditions within the immediate vicinity of the animal

Substrate Type and Temperature	the material the animal was on or in and the temperature of that material
Cover and Decay Class	the material above the animal either directly in contact with or hanging over the animal; downed woody material was classified as sound or rotten
Distance to water	visual estimate of the distance (in meters) from the animal to the nearest body of water (with $\geq 1\ m^2$ area).

PITFALL TRAPPING - ADDITIONAL VARIABLES

Trap Number and Habitat	number of trap and habitat the trap was in
Catalogue Number	museum tag number assigned to dead animals taken as specimens
Parasites	presense or absense of ticks, mites, or botte flies
Tail Autotomy	notes on injuries to reptile tails

[1]Habitats adapted from McCain et. al. (1990).

Appendix C. Comparisons of vegetation variables in different riparian types along the Trinity River between Lewiston Dam and the North Fork. Mean, range (in parenthesis), and standard error (S.E.) are listed for each variable (see Appendix A for variable descriptions).

	RIPARIAN TYPE[1]					
	Willow (n=65)		Willow/Alder (n=78)		Alder (n=38)	
Variable	Mean	S.E.	Mean	S.E.	Mean	S.E.
Canopy height(m)	8.515 (3-18)	0.405	13.361 (6-32)	0.539	15.342 (7-29)	0.651
Valley width[2]	377 (24-999)	27.58	384 (95-1047)	23.38	319 (119-785)	23.38
Ground[3]						
Litter	0.382 (.07-.85)	0.043	0.360 (.03-.7)	0.057	0.335 (.06-.66)	0.052
Grass	0.266 (.01-.55)	0.035	0.252 (.03-.7)	0.047	0.199 (0-.44)	0.046
Herb	0.082 (0-.23)	0.015	0.066 (0-.2)	0.016	0.049 (0-.16)	0.020
River rock	0.113 (0-.47)	0.033	0.115 (0-.44)	0.045	0.027 (0-J-7)	0.019
Transect[4]						
Shrub-low	0.226 (0-.83)	0.027	0.29 (0-.91)	0.027	0.307 (0-.81)	0.041
Grass/herb-low	0.332 (0-.96)	0.026	0.304 (0-.8)	0.022	0.237 (0-.6)	0.025
Willow-low	0.277 (0-.75)	0.022	0.195 (0-.71)	0.018	0.063 (0-.35)	0.015
Willow-high	0.546 (.02-1)	0.028	0.350 (0-.79)	0.023	0.084 (0-.55)	0.021
Alder-low	0.022 (0-.14)	0.004	0.067 (0-.4)	0.010	0.087 (0-.5)	0.020
Alder-high	0.095 (0-.5)	0.016	0.410 (0-1)	0.028	0.629 (.1-1)	0.041
Canopy cover-low	0.740 (.35-1)	0.019	0.724 (.21-1)	0.022	0.636 (.19-1)	0.039
Canopy cover-high	0.654 (.05-1)	0.029	0.689 (.13-1)	0.027	0.766 (.3-1)	0.038

Appendix C. (cont.)

	RIPARIAN TYPE[1]					
	Willow (n=65)		Willow/Alder (n=78)		Alder (n=38)	
Variable	Mean	S.E.	Mean	S.E.	Mean	S.E.
Counts[5]						
Willows	20.880 (O-86)	2.669	10.758 (0-54)	1.344	3.804 (0-34)	1.242
Alders	4.591 (0-43)	1.041	26.424 (O-106)	2.349	53.152 (7-36)	4.793
Logs	21.888 (4-64)	4.708	14.940 (3-70)	4.720	22.055 (O-108)	12.455
Snags	1.721 (O-40)	0.638	2.272 (0-15)	0.396	4.032 (0-30)	0.988
Debris Piles	1.118 (0-6)	0.206	0.842 (O-12)	0.215	0.681 (0-9)	0.305

[1]Riparian vegetation types are categorized by the dominant plant species at that station: Willow = greater than 2/3 covered by Salix sp.; Alder = greater than 2/3 covered by Alnus sp.; or Willow/Alder = mix of two.

[2]Valley width is measured in meters and reflects the distance across the valley floor between adjacent upland.

[3]Ground vegetation variables were measured at time-constrained and pitfall stations only (n = 47); expressed as percents of the total transect measured in each macro-habitat type along a 50 m tape centered on each station and perpendicular to the river (see methods).

[4]Transect variables are expressed as percents of the total transect for each macrohabitat type. Low indicates understory vegetation between .5 m and 2 m above ground. High indicates overstory vegetation intersecting the tape above 2 m.

[5]Count variables are expressed as numbers per hectare.

Appendix D. Comparisons of vegetation variables by geomorphological type along the Trinity River between Lewiston Dam and the North Fork. Mean, range (in parenthesis) and standard error are listed for each variable measured (see Appendix A for variable descriptions).

	GEOMORPHIC TYPE[1]					
	I (n=48)		II (n=64)		III (n=60)	
Variable	Mean	S.E.	Mean	S.E.	Mean	S.E.
Canopy height(m)	11.255 (4-22)	0.622	12,973 (5-32)	0.689	11.690 (4-32)	0.617
Valley width[2]	476 (190-785	25.86	236 (95-476)	12.21	456 (23-1047)	28.75
Ground[3]						
Litter	0.381 (.07-.66)	0.053	0.335 (.03-.85)	0.059	0.366 (.14-.66)	0.043
Grass	0.229 (.03-.44)	0.044	0.282 (.08-.7)	0.039	0.190 (0-.42)	0.040
Herb	0.061 (0-. 17)	0.021	0.070 (0-.23)	0.020	0.076 (0-015)	0.012
River rock	0.214 (0-.47)	0.048	0.033 (0-.13)	0.014	0.118 (0-.61)	0.050
Transect[4]						
Shrub-low	0.305 (0-.77)	0.036	0.285 (0-.81)	0.031	0.211 (0-.91)	0.028
Grass/herb-low	0.331 (0-.77)	0.031	0.297 (0-.8)	0.023	0.251 (0-.8)	0.019
Willow-low	0.249 (0-.75)	0.031	0.155 (0-.71)	0.019	0.205 (0-.66)	0.022
Willow-high	0.355 (0-l)	0.041	0.325 (0-.83)	0.032	0.398 (0-.97)	0.033
Alder-low	0.057 (0-.50)	0.015	0.035 (0-.43)	0.009	0.075 (0-.40)	0.012
Alder-high	0.319 (0-.88)	0.040	0.395 (0-1)	0.040	0.310 (0-1)	0.037
Canopy cover-low	0.789 (.04-1)	0.022	0.684 (.20-1)	0.026	0.632 (.19-1)	0.023
Canopy cover-high	0.674 (.05-1)	0.038	0.693 (.25-1)	0.028	0.687 (.19-1)	0.030

Appendix D. (cont.)

Variable	I (n=48) Mean	S.E.	II (n=64) Mean	S.E.	III (n=60) Mean	S.E.
counts 4						
Willows	11.251 (0-81)	2.716	11.938 (0-58)	1.803	15.325 (0-86)	2.412
Alders	28.834 (0-136)	4.505	26.714 (0-121)	3.266	17.490 (0-117)	2.967
Logs	10.598 (3-18)	1.310	31.956 (5-108)	12.730	20.810 (0-70)	5.476
Snags	3.452 (0-4)	1.091	2.013 (0-18)	0.454	2.243 (0-15)	0.445
Debris Piles	0.053 (0-2)	0.038	0.752 (0-12)	0.240	1.818 (0-9)	0.271

GEOMORPHIC TYPE[1]

[1]Geomorphological type: I = reaches 1 to 4; characterized as lacking influence from sediments and feeder creeks; II = reaches 7 to 11, characterized by narrow valley floor with associated upland close to river; III = reaches 12 to 16, characterized by wide valley floor, extensive mining tailings, and gravel bars.

[2]Valley width is in meters and reflects the distance across the valley floor between adjacent upland.

[3]Ground vegetation variables were measured at time-constrained and pitfall stations only (n = 47). and are expressed as percents of the total transect measured in each macro-habitat type along a 50 m tape that is centered on each station and perpendicular to the river.

[4]Transect variables are expressed as percents of the total transect for each micro-habitat type. Low indicates understory vegetation between .5 m and 2 m above ground.High indicates overstory vegetation intersecting the tape above 2 m.

[5]Counts are variables expressed as numbers per hectare.

Appendix E. Comparisons of wildlife by reach on the Trinity River between Lewiston Dam and the North Fork of the Trinity, CA. Mean number of individuals detected per float survey are presented for each Reach. Totals indicate mean number of detections per survey across all Reaches. Range is indicated in parentheses. (* indicate species detected opportunistically not during the surveys).

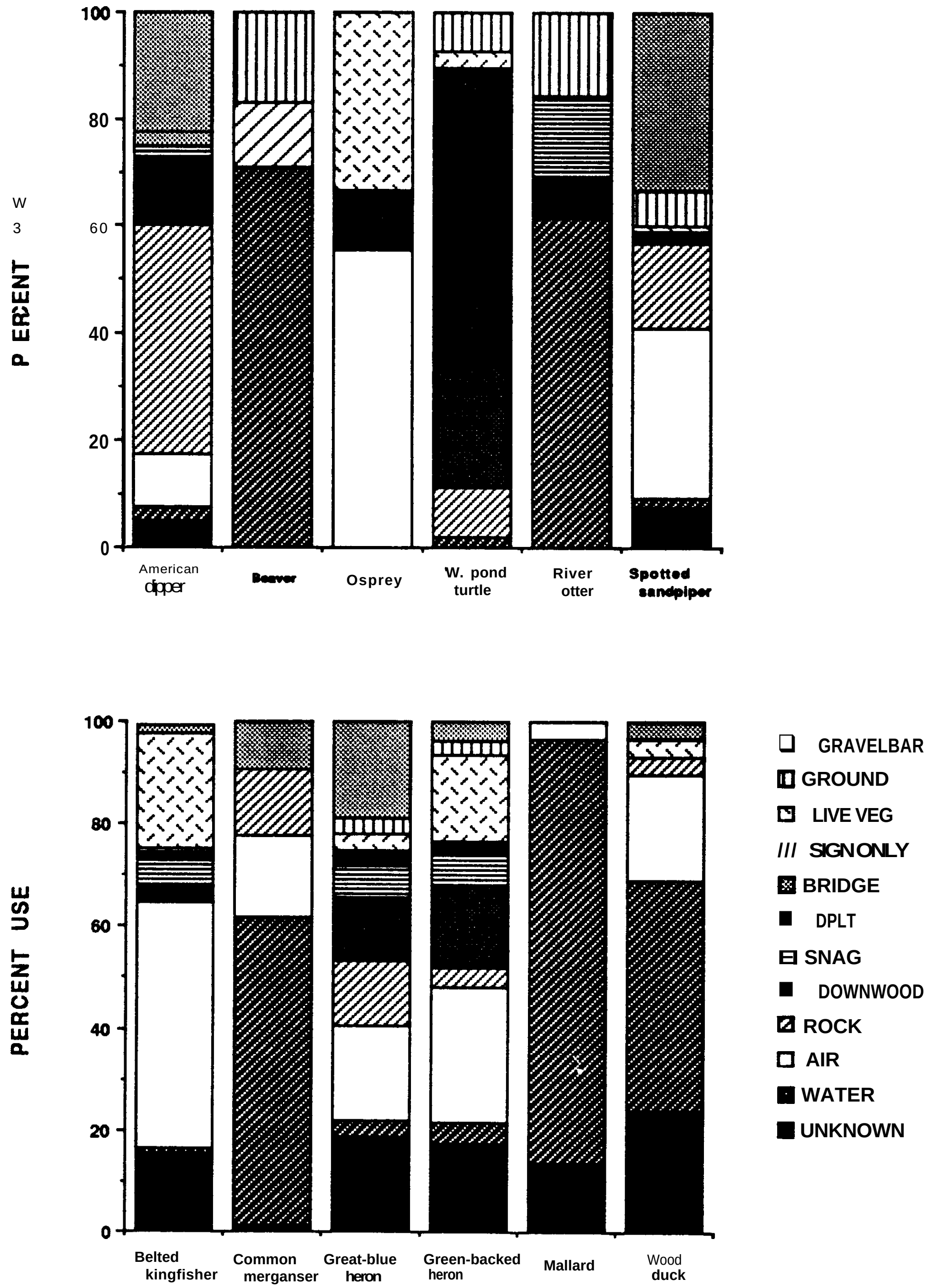
	REACH[a]															
Species[b]	1	2	3	4	5	7	8	9	10	11	12	13	1 4	15	16	Totals
Birds																
Great-blue heron	1.2 (0-3)	0.2 (0-1)	0.8 (0-1)	0.4 (0-2)	0.2 (0-1)	0.4 (0-10	0.0 (0)	0.4 (0-1)	0.2 (0-1)	0.4 (0-1)	0.2 (0-1)	0.6 (0-1)	0 0 (0	0.4 (0-1)	0.8 (0-2)	6.6 (4-9)
Green-backed heron	6.4 (4-13)	3.8 (3-6)	2.6 (1-5)	2.6 (1-4)	0.8 (0-3)	3.8 6 (3-)	1 0.6 (0-3)	2.0 (1-3)	0 1.2 (0-2)	1.4 (0-3)	1.2 (0-4)	3.0 (1-5)	2 6 (1 4)	2.4 (0-5)	1.8 (1-3)	39.8 (34-54)
Great egret	*	*	0.0 (0)	0.0 (0)	0.0 (0)	0. (0	0 (.0 0)	0.0 (0)	0 0.) (0	0.0 (0)	0.0 (0)	0.0 (0)	0 0 (0	0.0 (0)	0.0 (0)	-
Mallard	2.4 (0-11)	5.6 (0-23)	0.2 (0-1)	0.0 (0)	0.0 (0)	0. (0	0 (.0 0)	0.4 (0-2)	2 0. 1 0-)	2.2 (0-6)	0.2 (0-1)	1.8 (0-5)	1.0 (0-2)	0.8 (0-3)	0.0 (0)	15.6 (1-31)
Wood duck	0.2 (0-1)	2.0 (0-7)	0.2 (0-1)	0.6 (0-2)	0.2 (0-1)	0. (0	0 (.0 0)	0.4 (0-1)	0 (0.) (0	0.6 (0-1)	2.2 (0-10)	2.6 (0-6)	.0 .0)	0.2 (0-1)	0.4 (0-2)	11.0 (7-18)
Common merganser	5.8 (3-9)	11.0 (1-21)	4.4 (0-12)	8.0 (0-18)	3.2 (1-7)	8.2 (1-23)	0 0.8 (-4)	5.0 (1-14)	6 6. 1 0- 5)	0.2 (0-1)	1.4 (0-3)	13.4 (0-25)	2 (1)	3.8 (0-15)	0.0 (0)	74.2 (61-89)
Sharp-shinned hawk	0.0 (0)	0.0 (0)	*	0.0 (0)	0.0 (0)	0.0 (0)	0 (.0 0)	*	0 0.) (0	*	0.0 (0)	0.0 (0)	0 (0	0.0 (0)	0.2 (0-1)	0.2
Cooper's hawk	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	*	0 (.0 0)	*	(0. 0) (0	*	0.0 (0)	0.0 (0)	*	0.0 (0,	*	
Red-tailed hawk	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	*	0.0 (0)	0 (.0 0)	0.2 (0-1)	0. 0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0. (0-1)	0.0 (0,	0.0 (0,	0.6
Golden eagle	0.0 (0)	0.0 (0)	0.0 (0)	*	0.0 (0)	0 (.0 0)	0 (.0 0)	0.0 (0)	*	0.0 (0)	0.0 (0)	*	0.0 (0	0.0 (0,	0.2 (0-1)	0.2
Bald eagle	0.4 (0-2)	0.0 (0)	0.0 (0)	0.0 (0)	*	0 (.0 00)	0 (.0 0)	0.0 (0)	0.2 (0-1)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0	0.0 (0)	0.0 (0)	0.6
Osprey	*	0.2 (0-1)	*	0.0 (0)	0.0 (0)	(.0 00) (	0.0 ()	*	0 .0 (0)	0.0 (0)	0.2 (0-1)	0.6 (0-1)	0.0 (0	0.4 (0-2)	0.0 (0)	1.8
Killdeer	1.0 (0-5)	0.4 (0-1)	0.0 (0)	0.0 (0)	0.0 (0)	.0 0)	0.0 ()	0.0 (0)	0.0 (0)	0.0 (0)	*	0.0 (0)	0.2 (0-1)	0.0 (0,	0.0 (0)	1.6
Spotted sandpiper	1.0 (0-4)	1.0 (0-4)	1.6 (0-3)	1.0 (0-3)	0.6 (0-2)	.0 (0-7)	1.8 (0-6)	1.2 (0-3)	2.0 (0-8)	2.4 (1-6)	1.8 (0-5)	3.4 (0-6)	5.8 (3-9)	3.0 (0-5)	2.6 (1-4)	32.8 (28-50)
Lesser yellowlegs	0.0 (0)	0.0 (0)	0.0 (0)	*	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	-

Appendix E. (cont.)

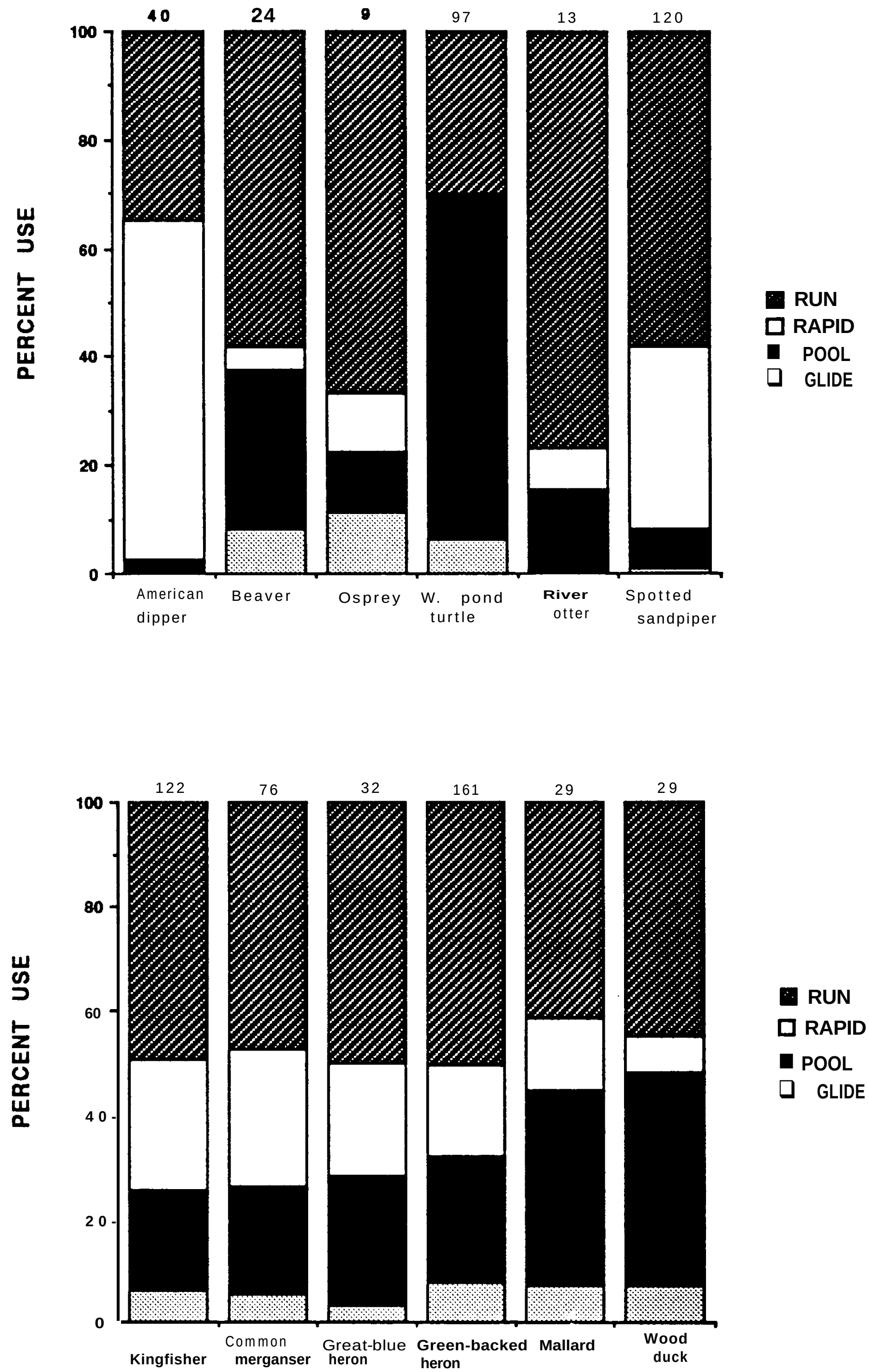
Species	REACH[a] 1	2	3	4	5	7	8	9	10	11	12	13	14	15	16	Totals
Belted kingfisher	5.2 (2-8)	4.4 (2-10)	2.6 (1-5)	3.0 (0-4)	2.0 (0-4)	0.2 (0-1)	0.4 (0-1)	1.8 (0-4)	1.0 (0-2)	0.6 (0-1)	1.4 (0-4)	3.6 (2-5)	0.2 (0-1)	1.2 (0-5)	2.8 (0-5)	31.8 (20-48)
American dipper	0.6 (0-2)	3.0 (2-4)	1.4 (0-3)	0.2 (0-1)	0.0 (0)	1.2 (0-4)	0.0 (0)	0.2 (0-1)	0.0 (0)	0.0 (0)	0.2 (0-1)	0.0 (0)	0.8 (0-2)	1.0 (0-2)	0.4 (0-1)	9.4 (5-15)
Reptiles																
Western pond turtle (*Clemmys marmorata*)	0.0 (0)	0.2 (0-1)	4.6 (0-8)	0.8 (0-2)	2.2 (0-5)	2.0 (0-3)	1.2 (0-3)	0.4 (0-2)	3.2 (0-11)	11.4 (1-40)	4.6 (0-12)	5.6 (0-14)	0.4 (0-2)	0.0 (0)	0.6 (0-3)	42.6 (23-68)
Mammals																
Beaver (*Castor canadensis*)	0.0 (0)	*	0.4 (0-2)	0.8 (0-3)	1.8 (0-6)	1.0 (0-5)	0.0 (0)	*	0.4 (0-1)	0.0 (0)	0.0 (0)	0.4 (0-1)	0.4 (0-1)	0.6 (0-3)	*	6.0 (2-12)
Raccoon (*Procyon lotor*)	0.0 (0)	0.0 (0)	0.6 (0-3)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	*	0.0 (0)	0.0 (0)	0.6
Mink (*Mustela vison*)	0.0 (0)	0.2 (0-1)	0.2 (0-1)	*	0.0 (0)	0.0 (0)	0.0 (0)	*	*	0.0 (0)	*	0.0 (0)	*	*	0.2 (0-1)	0.6
Skunk (*Spilogale putorius*)	0.0 (0)	0.2 (0-1)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.2
River otter (*Lutra canadensis*)	0.4 (0-1)	*	1.2 (0-6)	1.0 (0-3)	*	0.0 (0)	0.0 (0)	*	0.8 (0-4)	0.0 (0)	0.8 (0-4)	1.0 (0-5)	0.0 (0)	0.2 (0-1)	0.2 (0-1)	5.8 (3-15)
Deer (*Odocoileus hemionus*)	0.2 (0-1)	0.6 (0-2)	3.2 (0-9)	0.2 (0-1)	0.0 (0)	0.2 (0-2)	0.2 (0-1)	0.2 (0-1)	0.0 (0)	0.0 (0)	0.4 (0-1)	0.0 (0)	0.0 (0)	0.2 (0-1)	0.0 (0)	5.6 (1-12)

[a]Reaches are shown in fig. 1; each is approximately 2 miles long, and indicates increasing distance from Lewiston Dam.

[b]Scientific names of birds are listed in table 1.



Appendix F. Substrate use by wildlife species along the Trinity River, Ca. Histograms depict the percent contribution of each substrate category in or on which the species was detected. (DPLT means dead part of live tree).



Appendix G. Water mesohabitat use by wildlife species along the Trinity River, Ca. Histograms depict the percent occurence in each habitat type that a species was observed (sample size above each bar).

Appendix H. Common and scientific names, and total captures of mammals, amphibians, and reptiles. Timed searches (TCS) were done in April and May and pitfall trapping (PF) was done in July and August of 1990, along a 39 mile portion of the Trinity River in Trinity County, California.

Common Name	Scientific Name	Total Captures TCS	PF
MAMMALS			
Trowbridge's shrew	*Sorex trowbridgii*		44
Unidentified shrew	*Sorex* sp.		412
Shrew-mole	*Neurtrichus gibbsii*		17
Botta's pocket gopher	*Thomomys bottae*		4
Heermann kangaroo rat	*Dipodomys hermanni*		1
Western harvest mouse	*Reithrodontomys megalotis*		3
Deer mouse	*Peromyscus maniculatus*		28
Pinyon mouse	*Peromyscus truei*		3
California vole	*Microtus californicus*		9
Long-tailed vole	*Microtus longicaudus*		2
Unidentified vole	*Microtus* sp.		4
AMPHIBIANS			
Pacific giant salamander	*Dicamptodon tenebrosus*	1	
Rough-skinned newt	*Taricha granulosa*	10	34
Ensatina	*Ensatina eschscholtzi*	4	5
Black salamander	*Aneides flavipunctatus*		2
Western toad	*Bufo boreas*	1	29
Pacific treefrog	*Hyla regilla*	4	14
Foothill yel-leg. frog	*Rana boylii*	8	9
Bullfrog	*Rana catesbeiana*	20	
REPTILES			
Western pond turtle	*Clemmys marmarota*	3	
Western fence lizard	*Sceloporus occidentalis*	74	625
Sagebrush lizard	*Sceloporus gracious*	9	7
Unidentified lizard	*Sceloporus* sp.		4
Western skink	*Eumeces skiltonianus*	6	42
Western whiptail	*Cnemidophorus tigris*		1
N. alligator lizard	*Elgaria coerulea*	9	
S. alligator lizard	*Elgaria multicarinata*	11	11
Ringneck snake	*Diadophis punctatus*	2	
Sharptail snake	*Contia tenuis*	1	
Western racer	*Coluber constrictor*	18	
Striped racer	*Masticophis lateralis*	1	
Gopher snake	*Pituophis melanoleucus*	1	
Common garter snake	*Thamnophis sirtalis*		1
W. terrest. garter snake	*Thamnophis elegans*	1	
Unident. garter snake	*Thamnophis* sp.	1	
Western rattlesnake	*Crotalus viridis*	2	