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STATE OF CONNECTICUT
DEPARTMENT OF
ENVIRONMENTAL PROTECTION
Sidney J. Holbrook
Commissioner

Federal Aid in Sport Fish Restoration
F-66-R: Final Report
1987 - 1995

A Survey of Connecticut Streams and Rivers

Statewide Summary

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STATE OF CONNECTICUT

Department of Envrionmental Protection

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Federal Aid in Sport Fish Restoration F-66-R

Final Report

Project Title: A Survey of Connecticut Streams and Rivers

Job 2. Stream Survey

Job 3. Angler Survey

Period Covered: April 1, 1987 to March 31, 1995

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ABSTRACT

A comprehensive survey of Connecticut's rivers and streams was done over a seven year period between 1988 and 1994. The objectives of this study were: development of trout stocking models to optimize allocation of hatchery fish, compilation of a database which will allow timely and accurate completion of environmental permitting and reviews, quantification of the state's coldwater and warmwater stream resources, development of models to accurately predict species composition and biomass in Connecticut streams, and dissemination of this information to the general public. This report presents our technical analysis of the data collected during this survey. This analysis will be used as the basis for a statewide trout management plan to be developed and presented to the public during 1996-97.

Data on fish populations, physical habitat and water chemistry were collected from 978 sites on 800 streams. These samples covered 98.3 km or roughly 0.9% of the total length of perennial streams in Connecticut. Invertebrate populations were assessed by collecting 4,141 samples from 855 sites. Fishing effort, catch and socioeconomic value were determined by doing 85 angler surveys on 53 streams.

We estimate that wild trout inhabit 6,500 km of streams in Connecticut. These waters contain a minimum of 2.9 million wild trout of which 88% are brook trout and 12% are brown trout. Trout populations with balanced age distribution and high densities are most common in the northwest portion of the state. The average carrying capacity of trout in unimpacted Connecticut streams was found to be 55 kg/ha (0-186kg/ha). Hatchery trout comprised 14.6% of all trout sampled and accounted for 35% of the total number of harvestable size trout present in midsummer. Fifty-six fish species were collected during the survey (Appendix A), including the first ever record of longnose sucker (*Catostomus catostomus*) in Connecticut.

Data from 34 stable smallmouth bass populations were analyzed. In general, smallmouth bass inhabited the larger warmer streams of the State. Length-at-age ranged widely and did not appear to be related to density. Bass exhibited slow growth and, on average, did not reach 280mm (10 inches) until age six. Fluctuations in year-class strength appeared to be related to environmental variables (high flows and low temperatures reduced survival of young bass).

Invertebrates from seven phyla, 17 orders and 74 families were identified. Comparisons of invertebrate numbers and biomass with trout population characteristics did not produce any significant relationships.

Predicted standing crop values from HQI (Habitat Quality Index) and WNHF (Wild, Nontrout, Habitat, and Fertility) models did not correlate well with measured standing crop. The evaluation of these models pointed out the need to develop separate models for brook trout and brown trout.

The best models developed from our data predicted biomass of brown trout (R^2 = 0.85) and numbers of brook trout/km (R^2 = 0.52). The brown trout model, which is based on deep water, cover and temperature variables, is only applicable to streams having a somewhat restricted range of values. The best brook trout model, which was based on width, depth, velocity and substrate variables, was more widely applicable.

Angler effort in Connecticut streams ranged from undetectable in most nonstocked streams to a high of 7,576 angler hours/km in the Salmon River Fly-Fishing-Only area. Effort in streams managed under statewide regulations and stocked with adult sized trout ranged from 100-6,552 angler hours/km. Predictive equations were developed that allow accurate estimation of angler utilization based on stocking density (R^2 = 0.84).

The hours of fishing provided per trout stocked was highest in Trout Management Areas (2.8 hrs per trout stocked), followed by Fly Fishing Only Areas (2.0), stocked streams managed under statewide regulations (1.6), and streams stocked with yearling brook trout (0.5). Angler use of Connecticut's only Wild Trout Management Area was comparable to an average yearling-stocked stream but without the cost of stocking.

Anglers caught approximately 81% of all trout stocked in streams under statewide regulation. Hatchery brown trout made up the majority of the catch. Wild trout contributed 5.5% of the catch in those streams with wild trout populations; however, this resulted in the harvest of up to 66% (mean = 40.6%) of all wild trout larger than six inches. Trout Management Areas had higher catch rates than other areas because reduced creel limits or catch-and-release regulations resulted in stocked trout being caught two or more times on average (return-to-the angler ≥ 200%).

Angler expenditures had a net economic impact of $21.80 to $45.78 for each day of trout fishing in Connecticut. The average angler places an additional value (consumer surplus) of approximately $20.00 per angler-day on fishing trips. A total of $4.9-$10.0 million in net economic impact, and $4.1-$8.4 million in consumer surplus, is generated each spring by the State's trout stocking in Connecticut streams. The benefit/cost ratio for stocking in streams exceeded 10:1 in waters stocked with yearling or adult sized trout, and exceeded 20:1 in Trout Management Areas and Fly Fishing Only Areas.

1.0 Introduction:

This is the final project report for Federal Aid in Sport Fish Restoration project F66-R, a comprehensive survey of the streams and rivers of the state of Connecticut by the Department of Environmental Protection (DEP) Fisheries Division. This report will summarize the information collected from 1988 through spring 1994. During an eight year period, 800 streams at 978 sites were sampled to collect physical, chemical and biological data (Figure 1). A total of 85 angler surveys were done on 53 rivers to obtain information on fishing effort, catch and socioeconomic value. Two or more samples were collected on seven streams to collect information from areas having different management regulations and covering different time periods (early spring, spring and fall).

The objectives of this study include: development of trout stocking models to optimize allocation of hatchery fish, compilation of a database which will allow timely and accurate completion of environmental permitting and reviews, identification and quantification of the state's coldwater and warmwater stream resources, development of models to accurately predict species composition and biomass in Connecticut streams, and dissemination of this information to the general public in a useful and comprehensible form. Data from this study will be used as the basis for a statewide trout management plan to be developed during 1996-97.

The state of Connecticut has 8 major hydrological basins (Table 1, Figure 2). Two of these basins, the Pawcatuck River and Hudson River basins, form only a small percentage of our stream resources (1.0% and 0.3% respectively). Three of the basins form major south flowing drainages within the state, culminating in large 5th and 6th order rivers: the Connecticut River (6th), Housatonic River (5th) and Thames River (6th). The three coastal basins are groups of parallel coastal streams that drain directly into Long Island Sound. Each of the coastal basins is separated from one another by one of the large rivers (Figure 2).

Table 1.-Number of sample sites with physical data and population samples, total stream kilometers, basin area in Connecticut, and density of sample sites within each basin. Percentage of total stream kilometers in ( ).

Basin Name	Number of Sites	Kilometers of Streams	Area(km^2)	Density of Samples (km of stream/site)
Pawcatuck River	17 (1.0)	183	74	10.8
Eastern Coastal	43 (3.8)	667	380	15.5
Thames River	287 (26.7)	4,737	3,810	16.5
Connecticut River	206 (25.9)	4,602	4,310	22.3
Central Coastal	62 (9.8)	1,734	532	27.9
Housatonic River	294 (24.1)	4,284	5,042	14.5
Western Coastal	62 (8.4)	1,488	584	24.0
Hudson River	6 (0.3)	58	49	9.6
Total	978	17,753		18.1

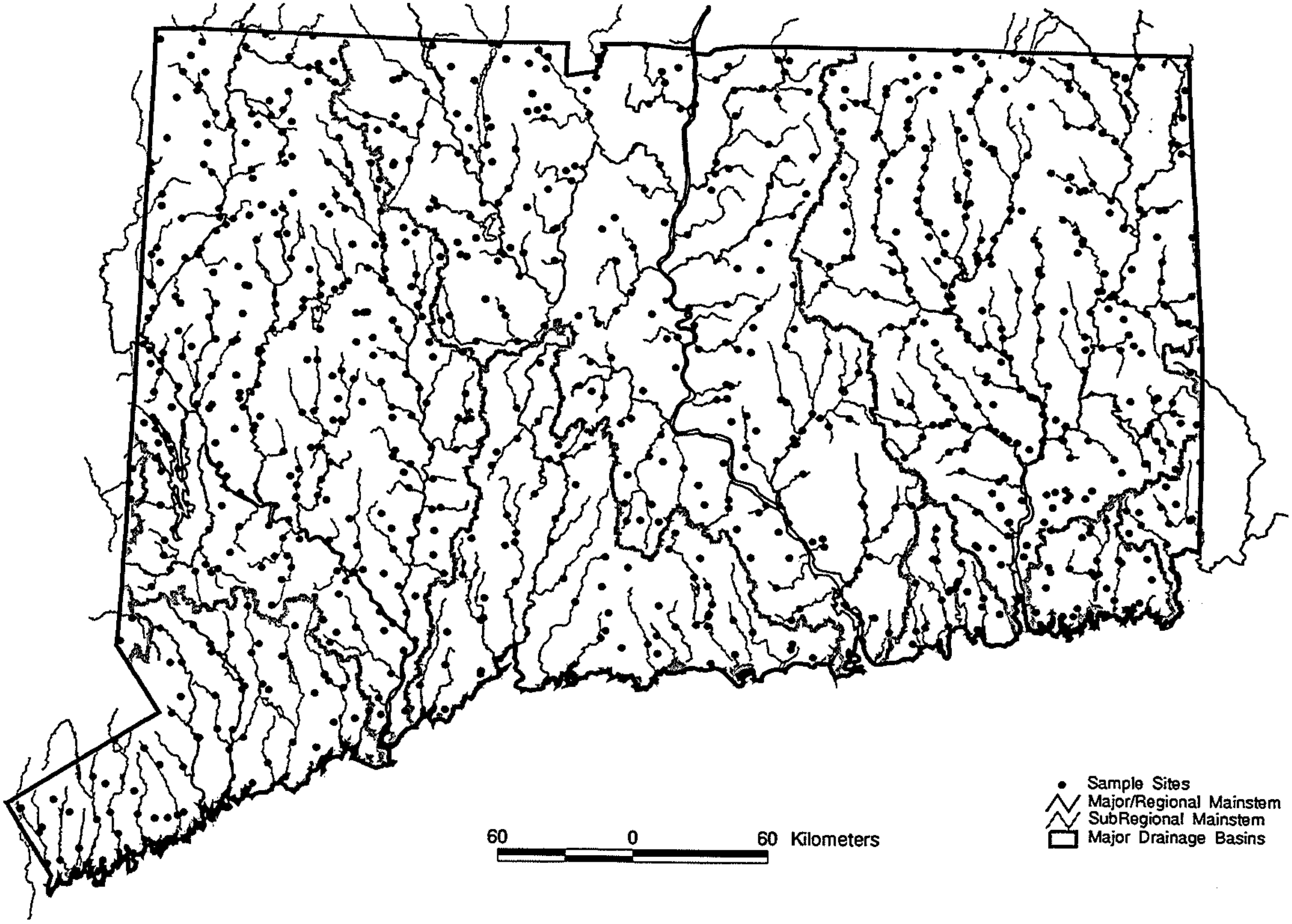


Figure 1. All stream survey sites sampled 1988-1994.

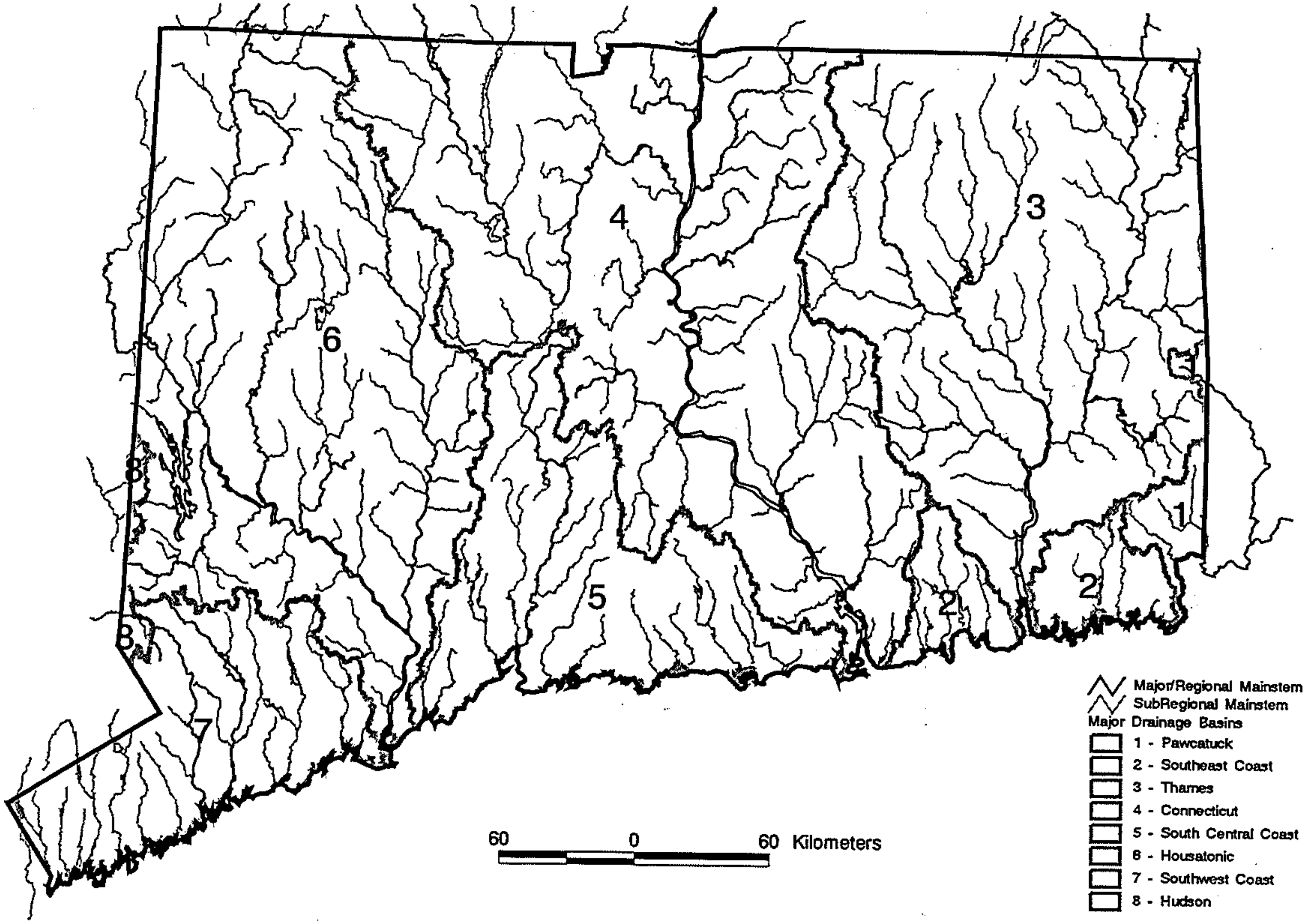


Figure 2. Major drainage basins of Connecticut.

2.0 Methods:

2.1 Resource Identification:

The locations of all stocking sites in the study area were identified from stocking maps marked by state Conservation Officers. Public access areas were identified from the Connecticut DEP Property Map.

All surface waters within the bounds of the state were located on 1:24,000 scale USGS topographic maps and transposed on to single mat, 0.3 mil. mylar overlays. Vellum copies of the original overlays were made and used for field checks.

Visual estimates of the width and depth of each stream were made at all accessible stream crossings. Where possible, information on ownership and access was obtained prior to further data collection.

Stream sections and subsections were identified and coded by overlaying the vellum maps onto corresponding maps of the "Natural Drainage Basins in Connecticut" (State of Connecticut Department of Environmental Protection, Natural Resources Center, USGS, 1981). Stream sections and subsections were assigned unique sequential codes based on an extension of a numbering sequence developed by the Natural Resources Center and used on the drainage basin maps (Figure 3). Each drainage basin number defines an area of a drainage basin called a "Polygon". Any area which has a permanent stream was defined as a separate polygon, and anytime a stream joined another stream or river resulting in a change in flow volume a new polygon was defined.

A list of streams and stream subsections, by stream code, with associated reference information, was generated using RBASE for DOS. The information specific to each polygon includes: stream name, length, width, township, topographic map name, stream features (dams, swamps, postings, and channelizing), stocking status, drainage area, and water quality rating based on DEP, Water Management Unit's Water Quality Classification maps.

Normal Format: 4300032R150100

Polygon Coding Components

Major Basin	Regional Basin	Subregional Basin	Drainage	Stream Order	Reach	Subreach	Stream Branch
4	3	00	03	2	R15	01	00

Figure 3.-Polygon Coding System, an extension of DEP Natural Resources Center Stream Classification System.

All streams were characterized by habitat type, longitudinally, from the confluence with the next higher order stream to the headwaters. Habitat types were defined based on stream gradient (the percentage rise over run; 0-3% meadow, 3-8% upland, >8% plunge pool) and stream alteration (impoundment, channelization, underground culverts). Length of each habitat section was measured with a planimeter and recorded sequentially on a stream kilometer basis. All dams and waterfalls were identified and their locations recorded by stream kilometer.

2.2 Site Selection:

Approximately 90-150 sample sites were sampled during each year in which normal flow regimes prevailed. Additional sites were sampled whenever flow conditions allowed for extended sampling. Sites were selected based on the following criteria.

A) **Mandatory Sites:**

1) One sample assigned to the dominant habitat type in each subregional drainage basin;

2) One sample site to a representative segment of each stocked stream (unless already included in priority 1 sites);
3) One sample to each creel survey location not covered by priority 1 or 2 sites.

B) **Optional Sites:**

4) Additional sites were assigned to the dominant stream of each subregional drainage basin as required to adequately assess the variability between significantly differing habitat types (e.g. upland vs. channelized meadow);
5) Using the list of all stream polygons sorted by widths, a random selection of sample sites was made within each stream size group (1-1.5 m, 1.6-3.0 m, 3.1-6.0 m, 6.1-9.0 m, and >9.0 m wide) until all sites were allocated.

Applying these priorities, we attempted to sample all streams with existing or potential fishery value. However, some of our largest rivers cannot be sampled using the methodology employed in this study. Small streams (width 1-1.5 m) are numerous in most of the state's major drainage basins and are typically inhabited by brook trout (*Salvelinus fontinalis*). Despite the potential fishery value of these brooks it was logistically impossible to sample all of them. After being visually inspected and categorized, they were subsampled as described in #5 above.

Each selected sample site was visually inspected to identify any previously undetected sampling problems (i.e. postings). Where necessary, landowners were contacted for permission to sample. Stream width was measured at each site to help in planning manpower needs. All streams were inspected and sites selected during the period beginning with the end of the previous field season (October) and prior to April 15 of the next year.

2.3 Invertebrate Collections:

Aquatic invertebrates were collected between June 15 and October 15 during 1988, and between May 15 and June 9 in subsequent years (during this time insect biomass and diversity were near peak levels). Samples were collected from representative riffle areas, centrally located within each sample site.

Samples were collected using a 0.065 m^2 Surber sampler with 1.02 mm mesh bag. Five samples were taken from a riffle area, starting close to the left bank, spacing the samples equidistantly from left to right and moving diagonally upstream. Exact placement of the frame was contingent on the ability to obtain a good seal with the substrate. The substrate within the frame was stirred to a depth of 2-4 cm. All adhering invertebrates were dislodged into the collection net by brushing with a scrub brush. The net was dipped into the stream several times to wash insects into the collection bag. The bag was then slowly inverted and all insects and small bits of detritus removed with forceps and placed into screw cap glass jars containing 70% ethanol. Additional ethanol was added to completely cover the sample material, and a label identifying the site and sample number was placed into each jar.

Samples were taken to the lab and all debris and detritus removed. Invertebrates were sorted, identified, and enumerated. A blotted wet weight per family was recorded for each sample. Mean number and weight by family, and total invertebrate number and weight were calculated for each site. All numbers were calculated on a square meter basis.

2.4 Low Flow Data Collection:

The majority of field data collection was done during the normal low flow period between June 15 and October 1. Sampling was delayed during periods of abnormally high runoff, and was resumed when conditions returned to normal.

2.4.1 Site set up:

The location of each sample site was recorded, usually as a street reference and a distance from major physical landmark (e.g. located at intersection of Rtes. 20 and 195 in Windham, 50 m above bridge).

A block net (6 mm mesh) was placed at the downstream end of the sample site in an area which allowed bank to bank coverage with a good bottom seal, and where the net was not overwhelmed by water current. Bridge pool areas were avoided when placing the block net. In some large streams, width and velocity prevented the use of block nets.

The length of the sample site was determined by stream width measured at the downstream block net as follows: 0-1.5 m wide (50 m long); 1.5-3.0 m wide (100 m long); and >3.0 m wide (150 m long). The length of a sample site was always at least 10 times the width, and wherever possible at least two pool/riffle combinations were included.

Sample sites were marked off into ten equidistant units using surveying flags. Care was taken to minimize disturbance of the substrate and water column while marking off subsample units. A block net was installed at the upstream end of the sample site. The exact length of a site was sometimes modified to ensure a suitable area for placement of the upstream block net.

In large streams where the use of block nets was impossible, data were collected from a length of stream approximately ten times the stream width. In 1988 mark-recapture methods were used to produce population data on all sport fish species (see section 2.4.3). Shorter sections (five times the stream width) located just upstream and downstream of the mark-recapture site were used to collect data on forage species and to control for emigration of marked sport fish. In subsequent years single-pass samples were collected in larger streams where block nets could not be set. Mark-recapture efforts were abandoned due to difficulties with handling mortality, and suspicion of biased results.

2.4.2 Physical-chemical information collection:

While marking off the subsample units, a sequential record was made of all pool and riffle lengths to the nearest 0.1 m. Runs were included with riffles and glides were included with pools. This information was used to calculate a pool/riffle length ratio and total number of pools and riffles within the sample site.

Based on observations made while marking the site, three subjective estimates were made. Total length of cover was estimated and expressed using length of cover as a percentage of the total stream section length. A subjective estimate of overhead canopy coverage was expressed as a percentage, with no canopy as zero and complete shade as 100%. An estimate of fishing pressure based on evidence of fishing activities at the site was rated on a 0 to 3 scale: 0) no fishing, 1) light fishing (believed to be <500 hrs/ha/year), 2) moderate fishing (believed to be 500-1,250 hrs/ha/year), 3) heavy fishing (believed to be >1,250 hrs/ha/year).

Water chemistry data were obtained at sample flags one, five and nine (e.g. 10, 50 and 90 meters from the bottom net in a 100 meter section). At each water chemistry flag a 500 ml water sample was collected for alkalinity analysis. A plastic bottle was plunged into the water top first and then inverted and filled. This prevented material in the surface film from influencing the sample results. The pH was measured to the nearest 0.1 pH unit with a pH meter. A Nester 8500 portable dissolved oxygen meter was used to measure dissolved oxygen concentrations to the nearest 0.1 ppm. Conductivity was measured in umhos with a YSI Model 33 S-C-T conductivity meter. Conductivities were standardized to 25°C prior to data analysis. The pH meter was calibrated with pH 7 and pH 10 standard solutions on a daily basis as per the manufacturers' standard procedure. The dissolved oxygen meter was calibrated at each sample site to compensate for the effect of changes in elevation.

Water color was described as one of the following: light amber, dark amber, brown, dark brown, milky, clear, green, red, blue, or gray. Turbidity was assigned one of the following values: none, slight (some material visible in the water column), moderate (turbidity limits visibility into the water column to no more than 50 cm), or heavy (visibility limited to the top 5-10 cm).

The stream's width was measured at each subsample flag to the nearest 0.1 m. The total wetted distance perpendicular to the flow was measured including undercut areas. Any dry areas were subtracted from the width and any objects or boulders with significant flow under them were included in the width. Stream depths were measured along the width transect line to the nearest cm at the left bank, 1/4, 1/2 and 3/4 of the stream width.

Substrate type was determined at every meter along the transect line formed by the width measurement. During initial training a 0.06 m^2 quadrat frame was used with the left edge lined up on the meter mark, the dominant substrate type was determined as in Table 2 (from Platts et al. 1983). Substrate types were determined at all width transects. A subjective estimate of the percent embeddedness of the dominant substrate by sand and silt ($\leq$4.7 mm diameter, ratings 1 and 2) was made for each substrate sample.

Table 2.-Substrate types and sizes from Platts et al. (1983).

Substrate Type	Rating	Size
Silt and Fine Sand	1	<0.83 mm
Coarse Sand	2	0.83-4.7 mm
Gravel	3	4.7-76.0 mm
Cobble	4	76.0-304.0 mm
Small Boulders	5	305.0-609.0 mm
Large Boulders	6	>609.0 mm
Bedrock	7	--

Instream cover was quantified by identifying individual habitat pieces and assigning each piece to a habitat category. The criteria and types of categories where selected based on Bowlby and Roff (1986), Platts et al. (1983), Scarnecchia and Bergersen (1987) and Wesche et al. (1987). The categories used were: rock, undercut bank, overhanging plant material, logs (snags), deep water, turbulence, and artificial material. The length of each piece of habitat was measured along its long axis, and width was measured perpendicular to the long axis.

Stream structures must meet certain requirements to qualify as cover. All cover must have a minimum undercut/overhang of 9 cm and be in water having a minimum depth of 15 cm. Overhanging plants must be within 30 cm of the water surface. Deep water habitat must have a minimum depth of 45 cm, and turbulence must cause enough disturbance to hide a 20 cm fish in water at least 15 cm deep.

A crown densiometer was used to measure the canopy at five transects. Measurements were made at the water surface at mid-channel and the data expressed as a percentage.

Streams influenced by agricultural runoff were designated as "agricultural" based on information found on topographic maps, visual appearance of the site and knowledge of the area. This category included heavy fertilization by golf courses and some heavily maintained residential areas. Sample sites located below a dam or lake were recorded as such, so as to assess the impact of lake fish species which may be transitory within these areas.

At approximately 12:00 noon, air and water temperatures were measured to the nearest degree Celsius at the midpoint of the sample site. Maximum air and water temperatures were determined for as many sample sites as possible during summer heat waves.

The bedrock type for each sample site was determined from the DEP Natural Resources Center's Connecticut Natural Resources Atlas Series: Bedrock Geological Map.

Flow stability was rated on a four point scale: 0 = intermittent; 1 = fluctuating flows, possibly drying up once every five to ten years; 2 = fluctuating flows with no history of no-flow periods; 3 = flows do not fluctuate much more than 50% from average daily flows. Stability of flow for each stream was determined subjectively from visual observation and using any available historic information.

Average stream velocity and discharge were measured by one of two methods: 1) Marsh McBirney digital flow meter, or 2) a salt dilution technique. With the flow meter, flow was measured along a transect perpendicular to the direction of stream flow. Flow velocity, water depth and distance from the left bank were measured wherever depth or velocity visibly changed. The velocity reading was recorded to the nearest 0.01 m/sec, depth to the nearest cm and width to the nearest 0.1 m. The flow meter requires a minimum of 9 cm of depth to operate. The depths at which the velocity readings were taken follow suggested USGS guidelines: at 0.5 of the water column where total depth is 9-10 cm; and at 0.6 of the water column depth from the surface where total depth is 11-76 cm. For depths greater than 76 cm two readings were taken, one at 0.2 and one at 0.8 of the water depth. The calculations follow USGS guidelines as outlined in Platts et al. (1983).

The salt dilution method (Allen 1924, and John 1978) was used to estimate mean velocity and discharge wherever channel morphology and depth precluded use of the flow meter (i.e. shallow water, etc.). A 40-100 m reach of stream was selected, excluding large standing pools, and three baseline conductivity readings were taken. A measured quantity of brine solution was then added to the upstream end of the area. Concentration of the brine solution was approximately 226 grams of salt for each estimated cfs of flow volume. Conductivity was recorded at one minute intervals following the release of the brine. The time elapsed prior to the first change in conductivity from baseline was noted as was the time required to reach the highest conductivity reading.

2.4.3 Population estimation:

Fish population size was estimated at each sample site by either the Zippin removal method (Zippin 1958) or the Petersen mark-recapture method (Everhart and Youngs 1981). The Zippin method was used in all streams where it was possible to place block nets at the upstream and downstream ends of the sample site. In large streams where the stream's width (over 25 m wide) or large flow volume made it impossible to use block nets, mark-recapture was used (1988 only) or single-pass relative abundance data were collected. Mark recapture sampling was discontinued after the first year due to the excessive handling time required to mark such a large numbers and variety of fish. Many of the small cyprinid species were intolerant of this type of handling making accurate population estimation impossible.

Sampling was done with either Coffelt BP-4 dual electrode backpack electrofishing gear or a Coffelt VVP-2 stream shocker with 3 m electrodes. Prior to starting a shocking run the wind, weather, and precipitation were recorded along with output voltage, amperage, and pulse frequency. Each shocking pass consisted of one run upstream through the sample site. The length of time required for the first pass was recorded and subsequent passes were timed to maintain a consistent level of effort. One to four netters collected the stunned fish which were then transported to an adjacent stream section and processed. Inflated sample estimates caused by chance encounters with large numbers of young-of-the-year fish prompted us not to include centrarchids below 4.5 cm and cyprinids and catastomids below 3.5 cm in length in population calculations. Usually three passes were made for the Zippin method, but if after three passes the dominant species present had not declined at least 30% from the initial pass then a fourth or fifth pass was added as needed. At sites with very few fish (less than ten on the second pass), sometimes only two passes were adequate to calculate an accurate population estimate.

All fish collected on the first pass for mark-recapture sites were measured, marked (caudal fin clips), and enumerated by species. The fish were then released evenly throughout the sample area and any dead individuals collected and subtracted from the number of marked fish. A one hour readjustment period (Petersen and Cederholm 1984) was allowed prior to beginning the recapture pass. All fish caught during this pass were enumerated by species, and presence or absence of a fin clip was noted.

Fish were identified and the first 100 individuals of each species were measured to the nearest centimeter. All subsequent individuals were tallied by species. Scale samples were taken from all gamefish for the first two individuals measured in each 1 cm size class over 9 cm (brook trout, *Salvelinus fontinalis*; brown trout, *Salmo trutta*; rainbow trout, *Oncorhynchus mykiss*; Atlantic salmo, *Salmo salar*; largemouth bass, *Micropterus salmoides*; smallmouth bass, *Micropterus dolomieu*; rock bass, *Ambloplites rupestris*; chain pickerel, *Esox niger*; and sunfish, *Lepomis* spp.). Scale samples were taken from above the lateral line for all soft-rayed fish, and behind the point of the pectoral fin for spiny-rayed fish. These fish were measured to the nearest millimeter total length. Up to eight representative specimens of each species were preserved in 10% formalin for independent confirmation of identification by ichthyologist, Walter R. Whitworth, PhD., University of Connecticut, Department of Natural Resources.

The tabulated length frequency data for each trout population were used to separate young-of-the-year (YOY), Age 1, and adult fish. In many cases the separations in age groups were obvious from the size distribution. In cases where the size range seemed extreme, or where there was no clear split in age groups, scale samples were checked and fish were assigned to age groups proportional to the frequency distribution. In samples where stocked and wild trout could not be separated by obvious visible cues, scales were checked for hatchery or wild growth patterns. Age 1 and younger fish were assumed to be of wild origin unless available stocking information indicated otherwise.

All scales were mounted between two glass slides or acetate impressions were made on a roller press. Ages were determined by visual inspection of scale images from a trisimplex scale projector or microfiche reader.

Biomass estimates for each site were generated using the length frequency data and species specific length/weight relationships. The length/weight relationships were developed using the weight, in grams, of fish from several sample sites. In cases where the specimens were small (less than 8 cm), group weights of fish within a centimeter class were used to produce an average centimeter class weight for that species.

Crayfish and mussel/clam abundance was determined by visual observation during sampling procedures. The site was rated on a three point scale: 0 = not present; 1 = present in low numbers; 2 = abundant.

2.5 Laboratory Procedures:

Water samples were brought back to the lab to measure alkalinity. A potentiometric titration (APHA 1971) was used to analyze the three samples of water from each site. A 100 ml sample was measured in a graduated cylinder and added to a beaker which had been rinsed with sample water. A digital microburette with 0.02 N HCl was used to titrate to pH 4.5 and pH 4.2 end points. If less than 1.0 ml total titrant was used, the process was repeated using a 200 ml sample. All glassware was rinsed twice with distilled water and then with a small amount of the sample water. Alkalinity was calculated using the following formula:

$$\text{Alk} = \frac{(2C-D) * N * 50{,}000}{\text{Vol}} \tag{1}$$

where
Alk = Alkalinity (mg/ml as $CaCO_3$)
C = 4.2 pH titration volume
D = 4.5 pH titration volume
N = 0.02 titrant Normality
Vol = sample volume in ml

2.6 Calculations:

Means and standard deviations were calculated for pH, conductivity, D.O., and alkalinity.

The total length for each cover category (CL_j) was summed for all individual pieces of cover (L_i) for each site where j is the number of cover categories. A total length for all cover categories (TCL) was summed from the separate cover categories. A percent stream length as cover (PSL) was calculated from Equation 4. The area of each piece of cover (A_i) was calculated from the width times the length measurements. A percent stream area as cover (PSA) for each category and total cover area (TAC) were calculated by Equations 6 and 7. Total sample site area was the average width times the sample length:

$$CL_j = \sum L_i \tag{2}$$

$$TCL = \sum CL_j \tag{3}$$

$$PSL = \frac{TCL}{\text{Site length}} * 100 \tag{4}$$

$$CA_j = \sum A_i \tag{5}$$

$$TAC = \sum CA_j \tag{6}$$

$$PSA = \frac{TAC}{\text{Total sample site area}} * 100 \tag{7}$$

Calculation of population size (N) and probability of capture (p) for the Zippin method followed the Maximum Weighted Likelihood Estimate (MWLE) of Carle and Stubb (1978) (Equations 8-11).

$$T_i = \sum C_i \tag{8}$$

where C_i = catch for pass 'i'

$$X = \sum (K-i)C_i \qquad (9)$$

where K = total number of passes

The Maximum Weighted Likelihood Method Equality (Equation 10) is an iterative solution where population size (N) was incremented until the solution of the equation was equal to or just less than one:

$$1.0 \geq \frac{(N+1)}{(N-T+1)} \sum_{i} \frac{(KN-X-T+(K-i)}{(KN-X+(K-i)} \qquad (10)$$

Probability of capture (p) was calculated to insure that an adequate reduction of the sampled population was accomplished. The minimum desired p-value for the total population was 0.3. The probability of capture was determined as follows:

$$p = T/(KN-X) \qquad (11)$$

The variance of the estimate of population size (N) was determined as in Zippin (1958):

$$\mathrm{Var}(N) = \left(\frac{\frac{(N(N-T)T}{(Kp)^2}}{(T^2-N(N-T)\quad(1-p)} \right)^{1/2} \qquad (12)$$

The population size and variance for mark and recapture data were calculated with a Chapman version of a Petersen estimate (Equation 13, Everhart and Youngs 1981).

$$N = \frac{(M+1)(C+1)}{(R+1)} \qquad (13)$$

where M = Number of marked fish released from first pass
C = Number of fish captured on second pass
R = Number of marked fish recaptured on second pass

The variance of the estimate of population size (N) was determined by:

$$Var(N) = \frac{(M+1)^2(C+1)(C-R)}{(R+1)^2(R+2)} \quad (14)$$

The length/weight relationship for each species was calculated using a log-log regression (Ricker 1975) of weight in grams by length in millimeters. The length frequency data from each site with over 100 individuals were expanded proportionally to reflect the total number of individuals estimated for each species. The lengths were then converted to biomass values by centimeter class using the length/weight relationships, and summed for a total biomass by species. These biomass values were divided by the surface area of the sample site to generate biomass estimates in kg/ha for each species.

Growth for all trout species was calculated from scale aging analyses, expressed as back calculated length at age. Growth rates of other species of game fish were determined where appreciable numbers of individuals were collected.

The discharge volume calculations followed USGS recommendations outlined in Platts et al. (1983). The calculation of mean velocity using the salt method was as in Equation 15. The stream discharge volume for the salt method was calculated by taking the cross sectional area from the width-depth information and multiplying by the average stream velocity. This gave the discharge at that stream transect. A mean discharge volume for all transects in the salt sample length was used as the estimate of the stream discharge volume.

$$Vel = \frac{Length}{Peak * 60 \text{ sec/min}} \quad (15)$$

where Vel = Mean velocity of section
Length = length of salt discharge section

A mean and standard deviation were calculated for stream width and depth. Substrate data were tallied by type and a mean value for embeddedness was calculated for each substrate type. The length was calculated for each section of pool and riffle and then summed. A pool-length-to-riffle-length ratio (Platts et al. 1983) was calculated.

2.7 Creel Survey:

Creel surveys were conducted on a set of streams to supply information on the level of angler effort, and catch, and to provide socioeconomic data on stream fishermen. The streams selected were representative of a variety of different size streams, stocking regimes and management regulations.

2.7.1 Sampling design:

A stratified, random sampling design (non-uniform probability) was used for all streams and stream segments (Malvestuto et al. 1978 and 1983). Strata were non-overlapping. Two sampling periods were defined: period 1 (Opening Day to June 15) and period 2 (June 16 to October 15). A five stratum design was used for period 1 (Table 3) because of the variability in effort associated with stocking events (Thorpe et al. 1944, Butler and Borgensen 1965). Stocked (S) and nonstocked (NS)

Table 3.-Stratification of angler creel surveys.

Stratum	Description
1. Opening Day	Third Saturday in April
2. S-WE	Stocked weekend/holidays
3. NS-WE	Nonstocked weekend/holidays
4. S-WD	Stocked weekdays
5. NS-WD	Nonstocked weekdays

periods as well as weekday (WD) and weekend/holiday (WE/H) were defined as primary sample units for period 1. The stocked period was defined as the first two weeks after Opening Day and a four day period after an in-season trout stocking. Sample times (i.e. hours within a day) were defined as secondary sample units.

Because fishing effort was highly variable along a stream length, it was possible to divide streams into separate areas defined by high use (bridge-pools and easily accessible areas) and low use (areas between bridge-pools with poor access). High use areas were identified during preseason site examinations. Several bridge-pool combinations were included in each creel survey section. Estimates of effort in low use areas, collected shortly after Opening Day, were compared with high use area effort estimates collected during the same time period. Expansion values, produced from these comparisons, were used to generate effort and catch estimates for the entire stream.

To conserve manpower, three to four streams within close geographic proximity were creeled together as a single route. Creel routes were located in separate geographic locations in order to cover the drainage area. A starting time was assigned to the creel set based on sample probabilities (Tables 4 and 5). The order in which the streams were creeled was randomly assigned prior to the start of the sample.

Opening Day was treated as an individual stratum because fishing pressure on that day differs from all other days of the year. A minimum of 3 samples were collected from each stream on Opening Day. Sample probabilities (Table 4) for Opening Day sample times were derived from Farmington River creel surveys (Hyatt 1986).

Table 4.-Opening Day sampling unit probabilities, derived from Farmington River creel data (Hyatt 1986).

Time of Day	Probability of Time Block
6:00	0.26
7:00	0.09
8:00	0.08
9:00	0.08
10:00	0.07
11:00	0.06
12:00	0.07
13:00	0.07
14:00	0.06
15:00	0.06
16:00	0.05
17:00	0.05

A total of 7 to 60 samples were scheduled for each stream based on variance estimates of angling effort from previously sampled streams. Equal probability was used for each hour within WE/H samples. Non-equal weighted probabilities were used for WD samples to account for increased fishing effort in late afternoon (Table 5). Period 2 was creel sampled on a "spot check" basis to determine if any angler effort was expended during summer through early fall. Samples were assigned by use of a four digit random numbers table until the correct number of samples for each stratum was reached.

For small streams stocked with yearling brook trout, where large sample sizes were needed to reduce variance, a creel set included two creels on the same stream. This optimized manpower utilization when scheduling large and small streams that had different sample size requirements.

Table 5.-Sample probabilities by starting time of a three stream creel set and sample probabilities for the different areas to be subsampled by stratum.

Strata Subsample Units	Weekdays	Weekends/Holidays
Time:		
6:00	0.04	0.091
7:00	0.04	0.091
8:00	0.04	0.091
9:00	0.04	0.091
10:00	0.04	0.091
11:00	0.04	0.091
12:00	0.04	0.091
13:00	0.04	0.091
14:00	0.04	0.091
15:00	0.04	0.091
16:00	0.60	0.091

2.7.2 Site selection:

Creel sites were selected based on information generated from stream cataloging procedures discussed previously. Final site selections were made by visual inspections of individual streams, and were based on the following criteria: 1) angler accessibility (i.e. roads, trails, postings, etc.) and 2) length of accessible stream area. Stream sections that were representative of the "typical" accessibility of stocked streams in that area were used. As large an area as possible was creeled on each stream. On some small yearling brook trout stocked streams the creeled areas were less than 1 km in length.

2.7.3 Angler survey methods:

A roving creel clerk (Malvestuto et al. 1978) began at one end of a survey site and proceeded through the entire creel site.

Clerks performed counts of all anglers and interviewed as many anglers as possible within the allotted time frame of one hour per site.

Three forms were used during creel sampling. An angler count form was used to gather angler effort data. A "long" interview form was used to generate fishing effort, catch, and economic data. A "short" form was used to gather information on fishing effort and catch. Only two long interviews were conducted during a sample to increase speed.

2.7.4 Data analysis:

Calculations followed the methods of Malvestuto et al. (1980), and Hyatt (1986). Estimates of total angler hours per kilometer were calculated. Total angler days were presented as a range calculated by dividing the total angler hours by 1) the average trip length estimated from Farmington River creel data (4.2 hr), and 2) a shorter trip duration (2.0 hr) which may be more typical of trips to smaller sized streams. When calculating mean daily fixed cost, the value used for number of trips per angler per year (13.6) was less than the value used by Hyatt (1986) (20), and reflects a more recent survey (1991 National Hunting and Fishing Survey; USF&WS., 1991). This new survey required anglers to recall their fishing activities over a shorter period of time, which probably resulted in more accurate data.

2.8 Model Development:

Much of the statistical analysis required to develop and test models capable of predicting the abundance of stream fish populations was delayed until the final year of data collection was complete. Reassessment of three trout models: Wild, Non-trout, Habitat and Fertility (WNHF) (Engstrom-Heg 1990); and two Habitat Quality Index (HQI) Models (Binns and Eiserman 1979, Binns 1982) was conducted with a more complete data set than was available earlier (Hagstrom et al. 1990 and 1991). To ensure as complete a data set as possible, maximum water temperatures and chemical or physical data that were dubious or missing were collected or recollected at previously sampled sites during the summer of 1995.

Evaluation and development of trout carrying capacity models required selecting a subset of streams that were close to carrying capacity. Ideally, in this subset, populations would be limited by habitat rather than by fishing mortality, reproductive failure, or episodic events. Also, preliminary analyses indicated that brook trout and brown trout populations may respond differently to different habitat features. It was therefore necessary to group the trout populations by species, and by evidence of significant outside influences.

2.9 Wild Trout Stream Classification:

All streams with wild trout were classified into one of seven groups, depending on trout species present, age structure, and number of individuals (Table 6). The classification yielded Type-1, Type-2, and trace trout populations of brook trout, brown trout, and both species together (sympatric). Type-1 streams (Brook-1, Brown-1, Brook/Brown-1) had abundant young-of-year, balanced age structure, high densities, and little or no fishing pressure. Type-2 streams (Brook-2, Brown-2, Brook/Brown-2) had high densities, but were deficient in one or more of the other Type-1 criteria. Trace populations (Trace) had only a few individuals of one or both species. Type-1 streams were assumed to be at or near carrying capacity, and were thus most useful for evaluation and development of carrying capacity models.

2.10 Information Dissemination:

An informative public document is planned for development during 1997-1998. The existing database was planned as a dynamic information source that will be expanded with future data collections. The development of a user friendly access point to the databases using ARC/INFO, ARCVIEW software is planned.

Table 6.-Classification of wild trout populations based on species present, balance and stability of the age structure, and overall abundance.

Type	Description
TYPE-1	
Brook-1:	Primarily wild brook trout, although a few stocked trout or individuals of other salmonid species may be present. Brook trout parr abundant, significantly outnumbering older age groups. Yearlings common, and present in most or all suitable habitat. Age 2 and older trout often present. Evidence of fishing pressure minimal or lacking entirely.
Brown-1:	Primarily wild brown trout, although a few stocked trout or individuals of other salmonid species may be present. Brown trout parr abundant, significantly outnumbering older age groups. Yearlings common, and present in most or all suitable habitat. At least a few larger fish present that are likely to be age 2 or older. Evidence of fishing pressure minimal or lacking entirely.
Brook/Brown-1:	Primarily sympatric wild brook trout and wild brown trout, although a few stocked trout may be present. Brook trout and brown trout parr both abundant, significantly outnumbering older age groups. Yearlings of both species common, and present in most or all suitable habitat. Usually a few larger fish of each species present that are likely to be age 2 or older. Evidence of fishing pressure minimal or lacking entirely.
TYPE-2	
Brook-2:	Primarily wild brook trout, although a few stocked trout or individuals of other salmonid species may be present. Brook trout common to abundant, however one or more of the criteria for the Brook-1 category is violated.
Brown-2:	Primarily wild brown trout, although a few stocked trout or individuals of other salmonid species may be present. Brown trout common to abundant, however one or more of the criteria for the Brown-1 category is violated.
Brook/Brown-2:	Primarily sympatric wild brook trout and wild brown trout, although a few stocked trout or individuals of other salmonid species may be present. Brook trout and brown trout common to abundant, however one or more of the criteria for the Brook/Brown-1 category is violated for both species
TRACE	
Trace:	Very low numbers of wild brook trout or wild brown trout or both species.

3.0 Results:

3.1 Stream/Drainage Summary:

The stream resources of Connecticut are dominated by three major basins (Connecticut River, Housatonic River and Thames River) that contain 76.7% of the total length of streams in the state (Table 1). Stream sections with gradients of 0-3% were classified as meadow habitat and were the most frequently encountered gradient category 52%(41-71%) in all basins (Table 7). The meadow gradient includes the "Trout Zone" as defined by Huet (1949) and used in New York State's WNHF Model, and the habitat assessment portion of the CROTS (Catch-Rate-Oriented-Trout-Stocking system) stocking model (Engstrom-Heg 1979 and 1990). The drainages which are located in the eastern and western highlands have significant percentages of upland and plunge pool habitats. Approximately 9.5% (4.8-14%) of the total stream lengths in all basins consisted of impoundments (natural and man-made). Higher percentages of impoundments generally occurred in areas with more developed drinking water supply systems.

We estimated that a minimum of 14.4% (2,556 km) of all Connecticut streams are intermittent (no flow one year in five). This estimate was based on our subjective interpretation of topographic maps and on field observations which most often did not coincide with annual low flows. A second estimate of intermittent streams was made using drainage maps from the Natural Resources Center and USGS map data. These maps divide the state into drainage polygons, with the smallest drainage unit containing first order streams. It was assumed that all other streams in the polygon were intermittent. This results in a maximum estimate of approximately 6,118 km (34.5%) of intermittent streams..

For all subsequent calculations requiring estimates of total stream length per stream order we elected to use the maximum estimate of intermittent streams. As a result all estimates of statewide fish populations should be viewed as conservative.

Table 7.-Percentages of habitat grouping based on gradient by Connecticut drainage basins.

Habitat Type/ Gradient	Pawcatuck River Basin	Eastern Coastal Basin	Thames River Basin	Connecticut River Basin	Central Coastal Basin	Housatonic River Basin	Western Coastal Basin	Hudson River Basin	Average of all Basins
Meadow 0-3%	71.1	59.7	48.7	56.0	59.0	46.2	54.0	41.0	52.0
Channelized Meadow 0-3%	1.8	3.5	1.7	1.5	6.0	4.7	5.0	0	3.5
Upland 3-8%	3.7	3.1	7.6	19.6	8.4	27.0	14.2	36.6	16.8
Channelized Upland 3-8%	0.2	0.1	0.1	0.7	0.2	0.2	0.2	0	0.3
Plunge Pool >8%	1.0	0.3	0.5	3.8	0.9	7.5	2.7	11.1	3.5
Impounded sections 0%	14.0	4.8	10.7	6.6	8.9	9.5	13.5	7.7	9.5
Intermittent sections	8.2	15.6	30.1	11.2	11.7	6.0	7.7	4.0	14.4

A total of 98.3 km of stream were sampled, or roughly 0.9% of the total length of perennial streams. Connecticut streams and rivers ranged from first to sixth order (Table 8). While we were able to obtain fish population estimates in first through fourth order streams (Table 9), the majority of samples (80.2%) were from first and second order streams. It was impossible to sample the sixth order streams using our techniques because of their large size. We were able to obtain some samples suitable for determining the relative abundance of species for some fifth order streams.

Table 8.-Estimated percentages and kilometers of Connecticut streams by stream order.

Stream Order	All Streams (Km)	Percentage	Perennial Streams[1]
Intermittent and 1st	13,819	78.0	7,082
2nd	2,045	11.5	1,820
3rd	1,061	6.0	902
4th	469	2.7	469
5th	180	1.0	180
6th	148	0.8	148

[1] Does not include impoundments or intermittent streams.

Not all drainages were sampled with equal intensity. As crews gained experience, it was possible to increase efficiency and to streamline sampling. As a result, more data were collected from drainages sampled in the later years of the project (Housatonic River and Thames River basins) (Table 1), and maps depicting species occurrence can be misleading. A better gauge of relative distribution is the percent occurrence in the drainages as presented in Table 10.

Table 9.-The number of sites and streams sampled with trout present or trout reproduction[1] by stream order. Percentage in ().

Stream Order	Number of Sample Sites (Streams)	Number of Sites With Trout Present	Number of Streams With Trout Present	Number of Sites With Trout Reproduction	Number of Streams With Trout Reproduction
1	455 (448)	280 (61.5%)	275 (61.4%)	259 (56.9%)	256 (57.1%)
2	331 (287)	248 (74.9%)	219 (76.3%)	217 (65.6%)	198 (69.0%)
3	148 (112)	106 (71.6%)	85 (75.9%)	69 (46.6%)	59 (52.7%)
4	40 (19)	21 (52.5%)	14 (73.7%)	12 (30.0%)	11 (57.9%)
5	4 (3)	0	0	0	0
6	0				

---

[1] Age 0 or age 1 trout present in sample.

Table 10.-Frequency and percentage of occurrence of species by drainage. Samples were collected in Connecticut from 1988-1994. Width of streams in which species occurred are categorized by: A = 0-5 m, B = 5-10 m, C => 10 m. Basins are defined as: 1 = Pawcatuck River Basin (13 samples), 2 = Eastern Coastal Basin (39 samples), 3 = Thames River Basin (250 samples), 4 = Connecticut River Basin (191 samples), 5 = Central Coastal Basin (62 samples), 6 = Housatonic River Basin (275 samples), 7 = Western Coastal Basin (60 samples), 8 = Hudson River Basin (6 samples).

Species	Basin 1	2	3	4	5	6	7	8	Species Total
Anguilla rostrata (American eel)	12 92.3% A,B,C	38 97.4% A,B	91 36.4% A,B,C	146 76.4% A,B,C	47 75.8% A,B,C	22 8.0% A,B,C	51 85.0% A,B,C	--- --- ---	407 45.4% A,B,C
Menidia beryllina (Inland silverside)	--- --- ---	--- --- ---	--- --- ---	--- --- ---	--- --- ---	--- --- ---	1 1.7% B	--- --- ---	1 0.1% B
Catostomus catostomus (Longnose sucker)	--- --- ---	--- --- ---	--- --- ---	--- --- ---	--- --- ---	1 2.4% C	--- --- ---	--- --- ---	1 0.1% C
Catostomus commersoni (White sucker)	9 69.2% A,B,C	10 25.6% A,B	175 70.0% A,B,C	133 69.6% A,B,C	41 66.1% A,B,C	160 58.2% A,B,C	43 71.7% A,B,C	4 66.7% A,C	575 64.2% A,B,C
Erimyzon oblongus (Creek chubsucker)	1 7.7% B	3 7.7% A	14 5.6% A,B,C	8 4.2% A,B	2 3.2% B,C	4 1.5% A	1 1.7% C	--- --- ---	33 3.7% A,B,C
Ambloplites rupestris (Rock bass)	--- --- ---	--- --- ---	6 2.4% B,C	17 8.9% A,B,C	4 6.5% B,C	25 9.1% A,B,C	4 6.7% C	1 16.7% C	57 6.4% A,B,C
Enneacanthus obesus (Banded sunfish)	2 15.4% A,B	--- --- ---	2 0.8% A	--- --- ---	--- --- ---	--- --- ---	--- --- ---	--- --- ---	4 0.4% A,B
Lepomis auritus (Redbreast sunfish)	3 23.1% B,C	1 2.6% B	53 21.2% A,B,C	24 12.6% A,B,C	16 25.8% A,B,C	36 13.1% A,B,C	28 46.7% A,B,C	1 16.7% A	162 18.1% A,B,C
Lepomis cyanellus (Green sunfish)	--- --- ---	--- --- ---	36 14.4% A,B,C	--- --- ---	--- --- ---	1 0.4% A B,C	4 6.7% A,B,C	--- --- ---	41 4.6% A,B,C
Lepomis gibbosus (Pumpkinseed)	9 69.2% A,B,C	14 35.9% A,B	114 45.6% A,B,C	93 48.7% A,B,C	29 46.8% A,B,C	120 3.6% A,B,C	34 56.7% A,B,C	2 33.3% A	415 46.3% A,B,C
Lepomis macrochirus (Bluegill)	3 23.1% B,C	10 25.6% A,B	75 30.0% A,B,C	88 46.1% A,B,C	27 43.6% A,B,C	86 31.3% A,B,C	22 36.7% A,B,C	4 66.7% A,C	315 35.2% A,B,C
Micropterus dolomieu (Smallmouth bass)	--- --- ---	--- --- ---	25 10.0% A,B,C	12 6.3% A,B,C	--- --- ---	18 6.5% A,B,C	3 5.0% B,C	--- --- ---	58 6.5% A,B,C
Micropterus salmoides (Largemouth bass)	3 23.1% B,C	11 28.2% A,B	92 36.8% A,B,C	70 36.6% A,B,C	27 43.6% A,B,C	79 28.7% A,B,C	39 65.0% A,B,C	4 66.7% A,C	325 36.3% A,B,C
Pomoxis nigromaculatus (Black crappie)	--- --- ---	1 2.6% B	5 2.0% B,C	3 1.6% A,C	2 3.2% C	2 0.7% B	4 6.7% B,C	--- --- ---	17 1.9% A,B,C
Alosa pseudoharengus (Alewife)	--- --- ---	1 2.6% A	--- --- ---	1 0.5% B	--- --- ---	--- --- ---	--- --- ---	--- --- ---	2 0.2% A,B
Alosa sapidissima (American shad)	--- --- ---	--- --- ---	--- --- ---	1 0.5% C	--- --- ---	--- --- ---	--- --- ---	--- --- ---	1 0.1% C
Dorosoma cepedianum (Gizzard shad)	--- --- ---	--- --- ---	--- --- ---	--- --- ---	1 1.6% C	--- --- ---	--- --- ---	--- --- ---	1 0.1% C

Table 10.-(cont.)

	Basin								Species Total
Species	1	2	3	4	5	6	7	8	
Cottus cognatus (Slimy sculpin)	--- --- ---	--- --- ---	3 1.2% A,B	8 4.2% A,B,C	--- --- ---	6 2.2% A,B	--- --- ---	--- --- ---	17 1.9% A,B,C
Carassius auratus (Goldfish)	--- --- ---	--- --- ---	--- --- ---	2 1.0% A	3 4.8% A,B	--- --- ---	3 5.0% A,B	1 16.7% C	9 1.0% A,B,C
Cyprinus carpio (Common carp)	--- --- ---	--- --- ---	4 1.6% A	7 3.6% A,B,C	4 6.5% B,C	--- --- ---	--- --- ---	--- --- ---	15 1.7% A,B,C
Exoglossum maxillingua (Cutlips minnow)	--- --- ---	--- --- ---	--- --- ---	1 0.5% A	--- --- ---	23 8.4% A,B,C	14 23.3% A,B,C	3 50.0% A	41 4.6% A,B,C
Luxilus cornutus (Common shiner)	3 23.1% B	2 5.1% A	87 34.8% A,B,C	57 29.8% A,B,C	12 19.3% A,B,C	88 32.0% A,B,C	16 26.7% A,B,C	2 33.3% A	267 39.8% A,B,C
Notemigonus crysoleucas (Golden shiner)	8 61.5% A,B,C	7 17.9% A	87 34.8% A,B,C	54 28.3% A,B,C	13 21.0% A,B,C	78 28.4% A,B,C	11 18.3% A,B,C	3 50.0% A,C	261 29.1% A,B,C
Notropis bifrenatus (Bridled shiner)	--- --- ---	1 2.6% B	1 0.4% B	--- --- ---	1 1.6% A	3 1.1% A,B	--- --- ---	--- --- ---	6 0.7% A,B
Notropis hudsonius (Spottail shiner)	--- --- ---	--- --- ---	16 6.4% A,B,C	14 7.3% A,B,C	2 3.2% B,C	7 2.6% B,C	--- --- ---	--- --- ---	39 4.4% A,B,C
Pimephales notatus (Bluntnose minnow)	--- --- ---	--- --- ---	--- --- ---	--- --- ---	--- --- ---	3 1.1% B,C	--- --- ---	--- --- ---	3 0.3% B,C
Pimephales promelas (Fathead minnow)	--- --- ---	--- --- ---	2 0.8% B,C	--- --- ---	1 1.6% C	19 6.9% A,B,C	--- --- ---	--- --- ---	22 2.5% A,B,C
Rhinichthys atratulus (Blacknose dace)	3 23.1% A,B	8 20.5% A,B	172 68.8% A,B,C	134 70.2% A,B,C	39 62.9% A,B,C	238 86.6% A,B,C	49 81.7% A,B,C	4 67.0% A,C	647 72.2% A,B,C
Rhinichthys cataractae (Longnose dace)	8 61.5% A,B,C	3 7.7% A,B	56 22.4% A,B,C	62 32.5% A,B,C	21 33.9% A,B,C	111 40.4% A,B,C	9 15.0% B,C	2 33.3% A,C	272 30.4% A,B,C
Semotilus atromaculatus (Creek chub)	--- --- ---	--- --- ---	9 3.6% A,B,C	34 17.8% A,B,C	7 11.3% A,B,C	180 65.5% A,B,C	25 41.7% A,B,C	4 66.7% A	259 28.9% A,B,C
Semotilus corporalis (Fallfish)	4 30.8% B,C	2 5.1% A	126 50.4% A,B,C	71 37.2% A,B,C	16 25.8% A,B,C	43 15.6% A,B,C	9 15.0% A,B,C	1 16.7% A	272 30.4% A,B,C
Fundulus diaphanus (Banded killifish)	--- --- ---	2 5.1% A	2 0.8% A,C	7 3.7% A,B,C	4 6.4% A,B	6 2.2% A,B,C	1 1.7% A,B,C	--- --- ---	22 2.5% A,B,C
Fundulus heteroclitus (Mummichog)	--- --- ---	--- --- ---	2 0.8% A	--- --- ---	1 1.6% A	--- --- ---	2 3.3% B	--- --- ---	5 0.6% A,B
Fundulus majalis (Striped killifish)	--- --- ---	--- --- ---	--- --- ---	--- --- ---	2 3.2% A,B	--- --- ---	--- --- ---	--- --- ---	2 0.2% A,B

Table 10.-(cont.)

	Basin								
Species	1	2	3	4	5	6	7	8	Species Total
Esox americanus (Redfin pickerel)	8 61.5% A,B,C	11 28.2% A,B	7 2.8% A,B,C	51 26.7% A,B,C	19 30.6% A,B,C	15 5.4% A,B	6 10.0% A,B,C	2 33.3% A,B	119 13.3% A,B,C
Esox lucius (Northern pike)	--- --- ---	--- --- ---	4 1.6% B,C	2 1.0% B,C	--- --- ---	--- --- ---	--- --- ---	--- --- ---	6 0.7% B,C
Esox niger (Chain pickerel)	9 69.2% A,B,C	16 41.0% A,B	111 44.4% A,B,C	23 12.0% A,B,C	14 22.6% A,B,C	17 6.2% A,B	14 23.3% A,B,C	--- --- ---	204 22.8% A,B,C
Lota lota (Burbot)	--- --- ---	--- --- ---	--- --- ---	1 0.5% B	--- --- ---	2 0.7% B	--- --- ---	--- --- ---	3 0.3% B
Apeltes quadracus (Fourspine stickleback)	--- --- ---	1 2.6% A	1 0.4% A	1 0.5% B	4 6.4% A,B,C	--- --- ---	--- --- ---	--- --- ---	7 0.8% A,B,C
Gasterosteus aculeatus (Threespine stickleback)	--- --- ---	1 2.6% A	--- --- ---	--- --- ---	--- --- ---	--- --- ---	--- --- ---	--- --- ---	1 0.1% A
Pungitius pungitius (Ninespine stickleback)	--- --- ---	5 12.8% A	--- --- ---	--- --- ---	5 8.1% A,B	--- --- ---	--- --- ---	--- --- ---	10 1.1% A,B
Ameiurus catus (White catfish)	2 15.4% C	--- --- ---	1 0.4% C	--- --- ---	1 1.6% B	1 0.4% C	--- --- ---	--- --- ---	5 0.6% B,C
Ameiurus natalis (Yellow bullhead)	--- --- ---	--- --- ---	21 8.4% A,B,C	--- --- ---	--- --- ---	--- --- ---	--- --- ---	--- --- ---	21 2.3% A,B,C
Ameiurus nebulosus (Brown bullhead)	6 46.1% A,B	8 20.5% A	71 28.4% A,B,C	43 22.5% A,B,C	23 37.1% A,B,C	64 23.3% A,B,C	11 18.3% A,B,C	--- --- ---	226 25.2% A,B,C
Morone americanus (White perch)	--- --- ---	--- --- ---	--- --- ---	--- --- ---	1 1.6% C	1 0.4% C	1 1.7% B	--- --- ---	3 0.3% B,C
Morone saxatilis (Striped bass)	--- --- ---	--- --- ---	1 0.4% C	--- --- ---	1 1.6% C	1 0.4% C	2 3.3% B	--- --- ---	5 0.6% B,C
Etheostoma fusiforme (Swamp darter)	2 15.4% A	--- --- ---	6 2.4% A,B	--- --- ---	--- --- ---	--- --- ---	--- --- ---	--- --- ---	8 0.9% A,B
Etheostoma olmstedi (Tessellated darter)	8 61.5% A,B,C	19 48.7% A,B	105 42.0% A,B,C	86 45.0% A,B,C	24 38.7% A,B,C	91 33.1% A,B,C	25 41.7% A,B,C	2 33.3% A	360 40.2% A,B,C
Perca flavescens (Yellow perch)	1 7.7% B	6 15.4% A,B	58 23.2% A,B,C	26 13.6% A,B,C	12 19.3% A,B,C	21 7.6% A,B,C	6 10.0% A,B,C	--- --- ---	130 14.5% A,B,C
Petromyzon marinus (Sea lamprey)	--- --- ---	--- --- ---	--- --- ---	23 12.0% A,B,C	6 9.7% A,B,C	--- --- ---	1 1.7% C	--- --- ---	30 3.3% A,B,C

Table 10.-(cont.)

	Basin								
Species	1	2	3	4	5	6	7	8	Species Total
Oncorhynchus mykiss (Rainbow trout)	4 30.8% B,C	2 5.1% A,B	11 4.4% B,C	10 5.2% A,B,C	3 4.8% B,C	18 6.5% A,B,C	3 5.0% C	--- --- ---	51 5.7% A,B,C
Salmo salar (American salmon)	2 15.4% C	--- --- ---	1 0.4% B	17 8.9% A,B,C	--- --- ---	--- --- ---	--- --- ---	--- --- ---	20 2.2% A,B,C
Salmo trutta (Brown trout)	4 30.8% B,C	8 20.5% A,B	65 26.0% A,B,C	79 41.4% A,B,C	21 33.9% A,B,C	120 43.6% A,B,C	21 35.0% A,B,C	1 16.7% A	319 35.6% A,B,C
Salvelinus fontinalis (Brook trout)	8 61.5% A,B	30 76.9% A,B	159 63.6% A,B,C	99 51.8% A,B,C	27 43.5% A,B,C	195 70.9% A,B,C	13 21.7% A,B,C	5 83.3% A	536 59.8% A,B,C
Trinectes maculatus (Hogchoker)	--- --- ---	--- --- ---	--- --- ---	--- --- ---	1 1.6% B	--- --- ---	--- --- ---	--- --- ---	1 0.1% B
Umbra limi (Central mudminnow)	--- --- ---	--- --- ---	--- --- ---	5 2.6% A,B	--- --- ---	--- --- ---	--- --- ---	--- --- ---	5 0.6% A,B

3.1.1 Physical parameters:

Several physical parameters showed some regional trends. Low values for pH (<4.5) occurred in the tannic, marsh-fed streams near the eastern border of Connecticut and in two small streams on the western edge of the Housatonic River. Conductivity was higher in portions of the Housatonic River Basin because layers of marble substrate greatly increase conductivity and alkalinity.

The potential for Connecticut streams to be influenced by acid rain is governed by the neutralizing capacity of the stream water. A measure of this buffering capacity is alkalinity. An alkalinity value below 5 mg/l ($CaCO_3$ eq) was determined to be the level at which acid rain could potentially have negative impacts (Bureau of Water Management, 1991). Fifty-one (6.4%) of the streams sampled fell into this group. These sites were often associated with gneiss or schist deposits, bedrock with little buffering capacity, or with acid swamps (Figure 4).

3.1.2 Invertebrates:

A total of 4,141 invertebrate samples were collected from 855 of the sample sites. Invertebrates from seven phyla, 17 orders and 74 families were identified (Appendix D). No great differences were seen in number of invertebrate families, number/m^2 or grams/m^2 between sites with trout present and those sites without trout (Table 11). There was a very wide range in the number of invertebrate families at sites with or without trout present. All samples (sorted, labeled and preserved) are stored at the University of Connecticut and are available for detailed examination in the future.

3.2 Fish Species Information:

A total of 56 fish species from 18 families were collected during the course of this study (979 sites) (Table 10). Cyprinids were the most common taxa with 13 species. Species that often dominated the biomass were white suckers and American eels. The most common species collected were blacknose dace, white sucker and brook trout. Nine species of centrarchids were found, many of which were only transient individuals in smaller streams. Nine species of marine visitors or amphidromous species were only occasionally sampled because site selection placed only a few sites at the head of tide.

3.2.1 Trout:

Of the 800 streams sampled, 668 were inhabited by trout. Three species of trout were found to be present and reproducing in Connecticut streams (brook trout, *Salvelinus fontinalis*, native; brown trout, *Salmo trutta*, introduced; rainbow trout, *Oncorhynchus mykiss*, introduced). Streams with either age 0 or age 1 trout were considered to be supporting trout reproduction (495 streams, Table 12). The wild trout stream classifications yielded 106 Type-1 streams, 94 Type-2 streams and 383 Trace streams (Table 13, Figure 5).

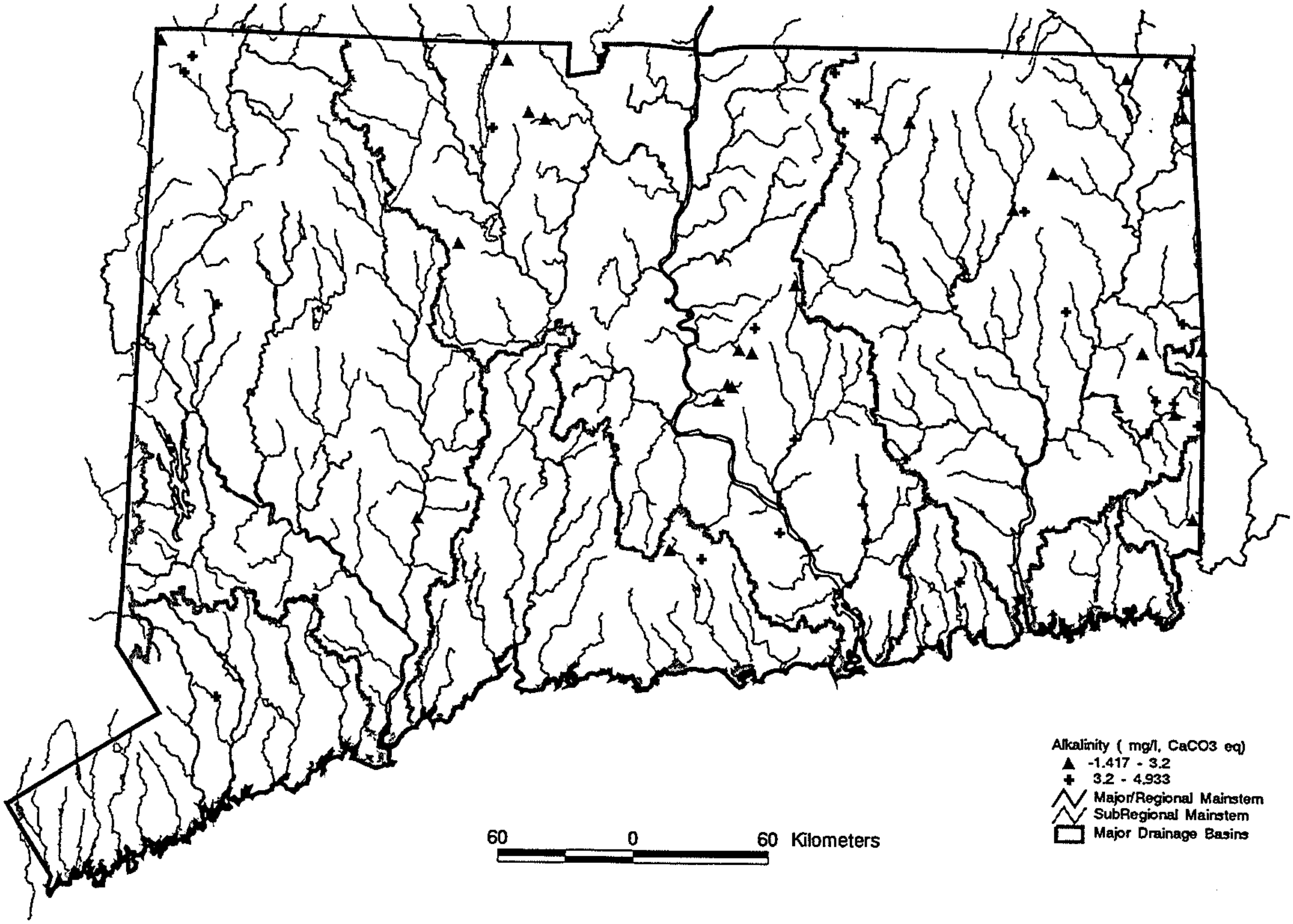


Figure 4. Potentially acid sensitive sample sites.

Table 11.-Summary of invertebrate sampling data from 1988-1994 samples. Means ± standard deviation and range ( ) were calculated for number of invertebrate families, average weight and average number of individuals per square meter for three groups of streams.

Variable Name	Non-trout Stream	Trout Present in Stream	Trout Reproducing in Stream
Sample Size (N)	262	591	506
Number of Families	15 ± 6 (1-20)	18 ± 4 (3-32)	19 ± 4 (4-32)
Individual/m^2	1,258 ± 1,597	1,104 ± 946	1,091 ± 839
Weight g/m^2	15.3 ± 22.1	16.3 ± 15.7	16.0 ± 14.8
Individual. Weight. >1.0 mg			
Number of Families	6 ± 2 (1-14)	7 ± 3 (1-16)	7 ± 3 (1-16)
Individual/m^2	398 ± 805	362 ± 422	365 ± 423
Weight g/m^2	14.5 ± 22.3	14.6 ± 15.6	14.3 ± 14.5

Trout of hatchery origin comprised 14.6% of all trout sampled, and 34.1% of all sites sampled (344 sites). Hatchery brown trout were sampled in a larger percentage (82.5%) than had been stocked (approximately 60% brown trout). Stocked brown trout also made up a significant part of the total number of harvestable size trout (35%) still available during mid-summer.

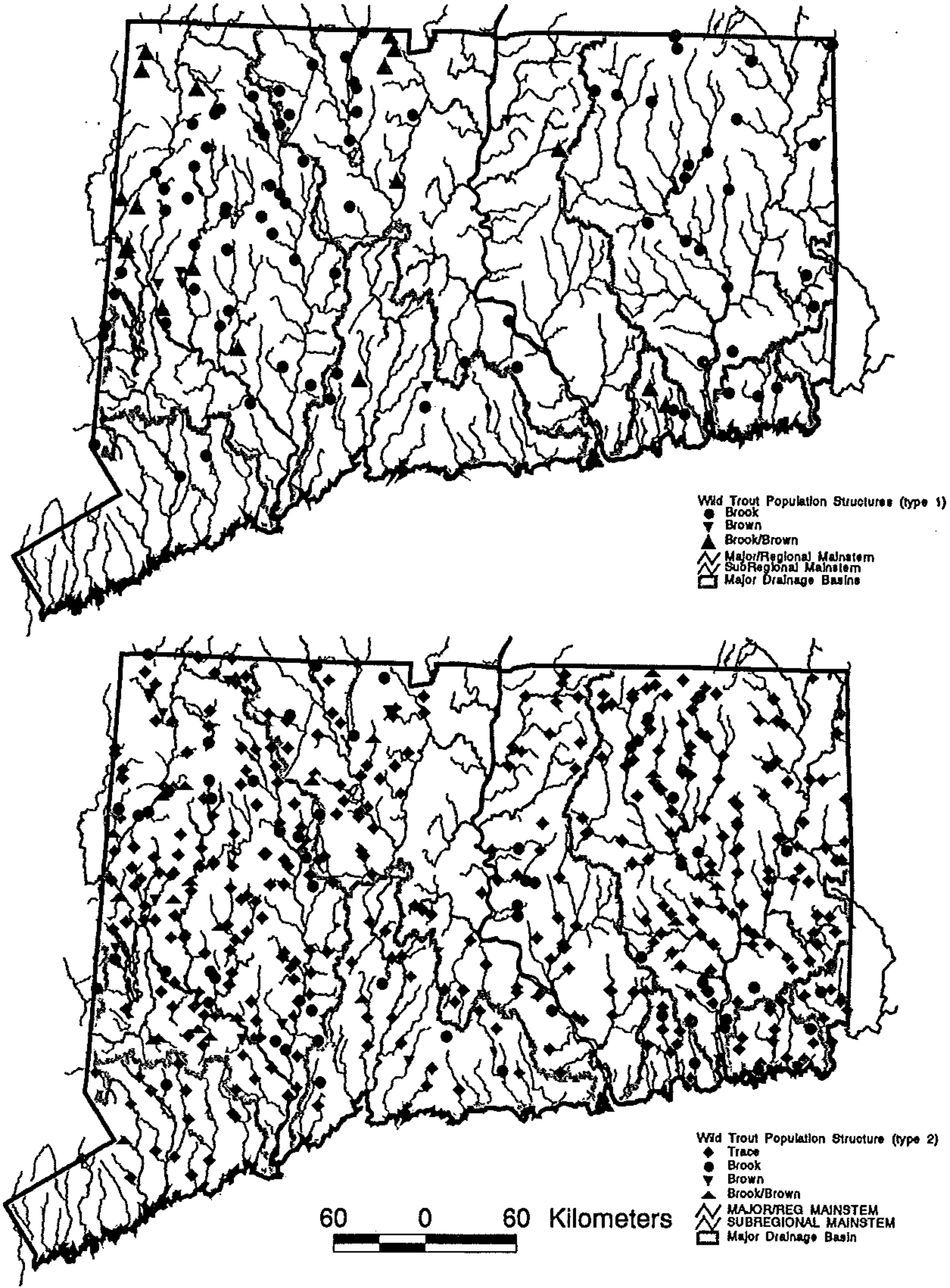


Figure 5. Distribution of trout population structure.

Table 12.-Number of streams sampled in Connecticut with trout presence or reproduction, by species.

Species	Streams With Trout Present	Streams With Trout Reproduction
Brook Trout	472	432
Brown Trout	505	203
Rainbow Trout	41	5
Any trout	668	495

Table 13.-Frequency of wild trout population classes.

Classification[1]	Frequency
Type-1	
Brook-1	83
Brown-1	5
Brook/Brown-1	18
Type-2	
Brook-2	61
Brown-2	10
Brook/Brown-2	23
Trace	383
Stocked Trout only	85
Total	668

[1] see Table 6 for classification definitions.

3.2.2 Wild trout:

Many wild trout populations were sampled. Drainages in the less developed portions of the state had the most common occurrence of age 0 and age 1 wild trout (Figure 6). Brook trout, the most common wild trout, were found primarily in smaller, headwater streams. Reproduction of brook trout was lacking near heavily developed areas of Hartford, New Haven and lower Fairfield counties, (Figures 7 and 8). Brown trout and

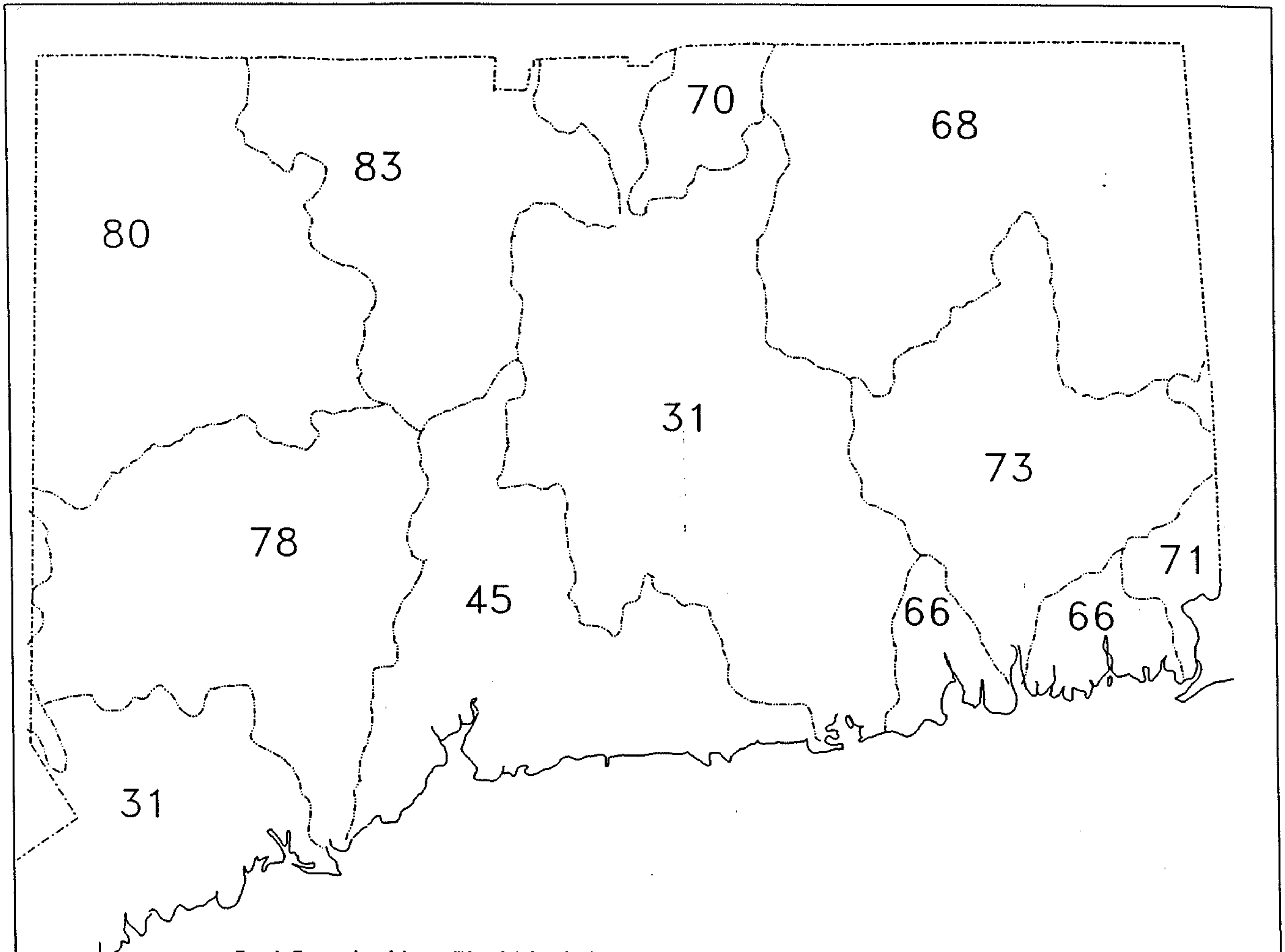


Figure 6.–The percentage of streams within each drainage that have age 0 or age 1 trout.

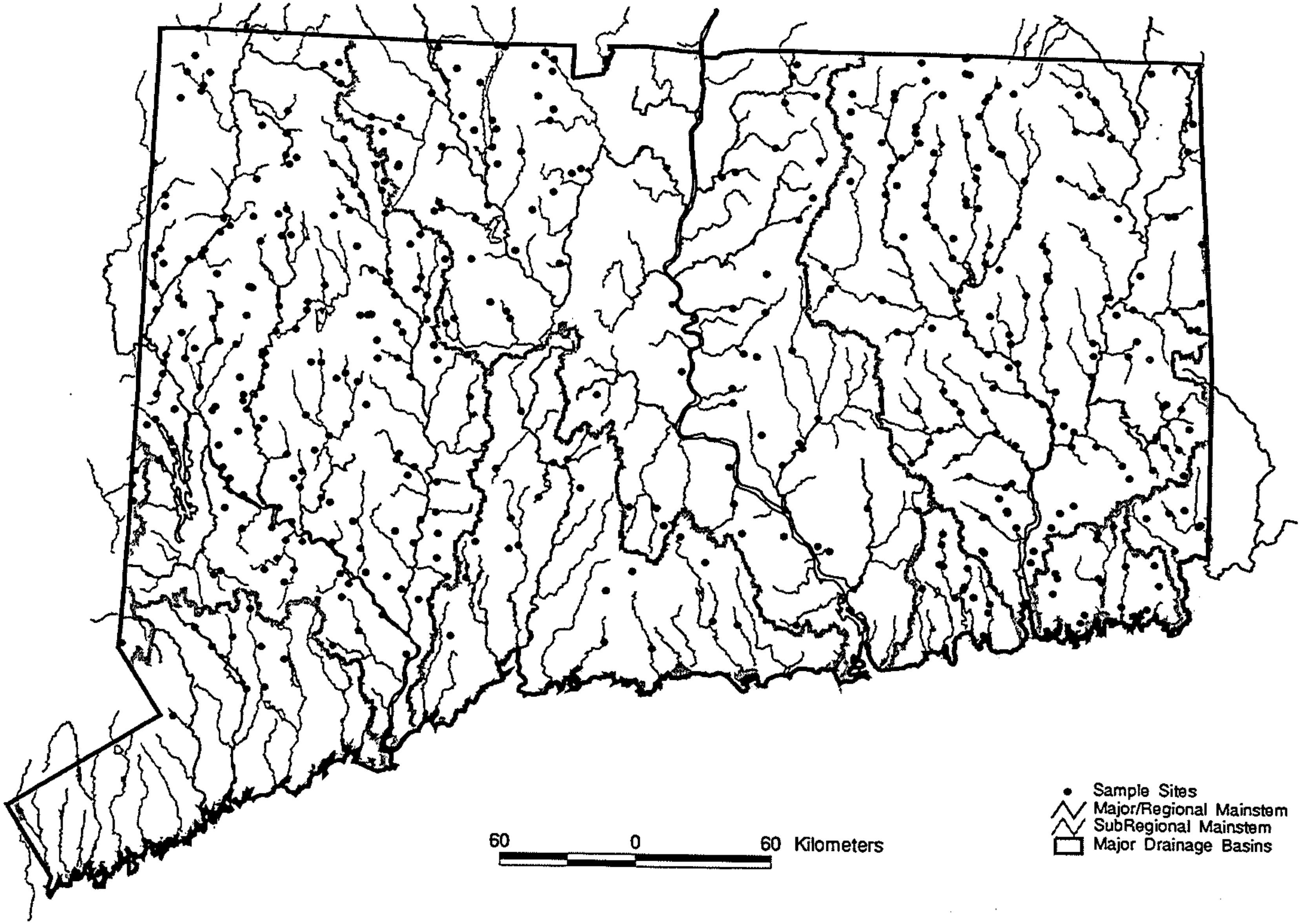


Figure 7. Sample sites with age 0 or age 1 wild brook trout present.

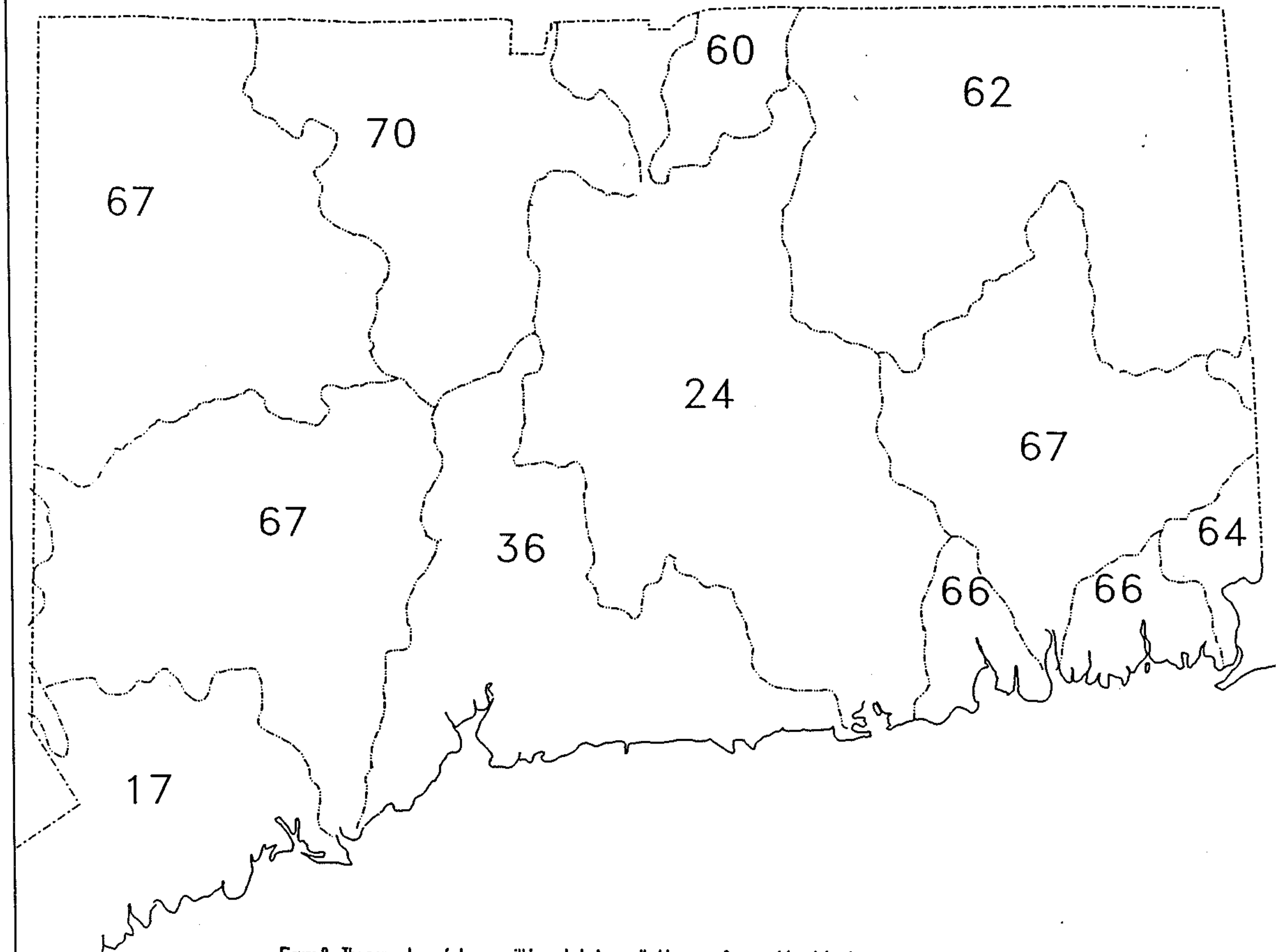


Figure 8.–The percentage of streams within each drainage that have age 0 or age 1 brook trout.

rainbow trout found in the streams were often stocked fish from the spring. The presence of age 0 and age 1 brown trout indicated that reproduction was widespread, with a higher percentage occurring in streams in the Northwest portion of the state (Figures 9 and 10). Rainbow trout reproduction was limited. Only five streams had evidence of rainbow trout spawning: Wewaka Brook, Hubbard Brook, Guinea Brook, Kent Falls Brook, and the Pootatuck River. All are located in the western part of the state.

It is estimated that there are approximately 6,500 kilometers of stream in Connecticut with at least some wild trout present. This number was calculated by expanding from the kilometers of stream by stream order (Table 8) and by the percent occurrence of each trout stream classification (Table 14), and were corrected for impoundments and intermittent streams (see comments on intermittent streams in 3.1). The largest portion of Brook-1 streams were first order streams, while Brown-1 streams were mostly second order streams. The difference in use of streams is further emphasized by the difference in the percentages of streams with trout reproduction versus the size of the streams (Figure 11). The streams most commonly found to have brook trout reproduction were less than 7 m wide, while brown trout reproduction was most commonly found in streams 5 m wide and greater. The average width of first order streams was 2.9 m, second order streams averaged 5 m and third order streams averaged 9 m wide. Apparently brown trout do better in the larger first order or higher order streams.

Distribution of adult trout was similar to juveniles, with 84% of all spawning age brook trout (age 1 and greater males and greater than age 1 females) occurring in first order streams and 54% of all spawning age brown trout in second and third order streams. Mean mid-summer densities of trout per kilometer of stream order were expanded by total kilometers of a stream order to produce rough estimates of the total number of wild trout (Table 15) and harvestable size (over 15 cm) wild trout (Table 16) in Connecticut.

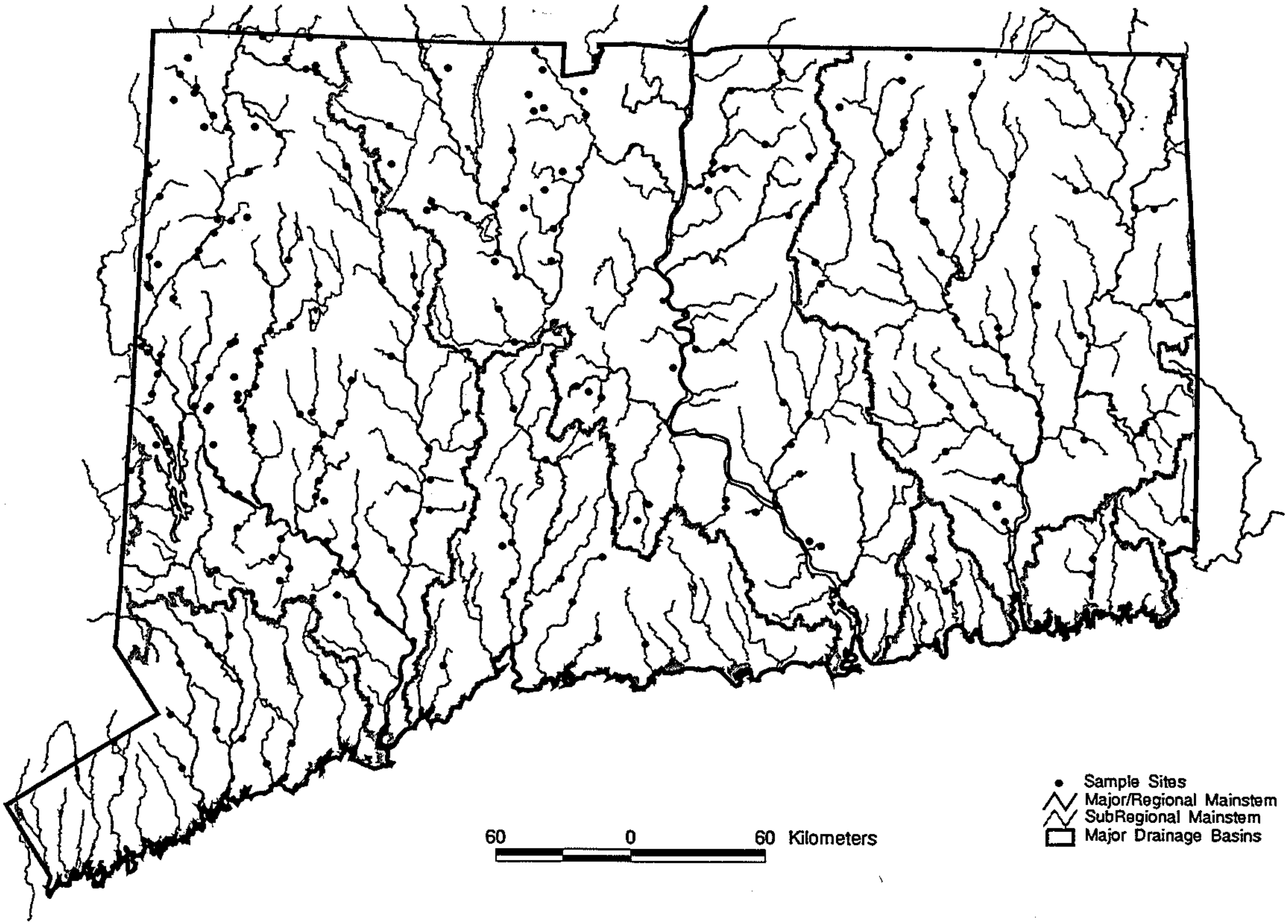


Figure 9. Sample sites with age 0 or age 1 wild brown trout present.

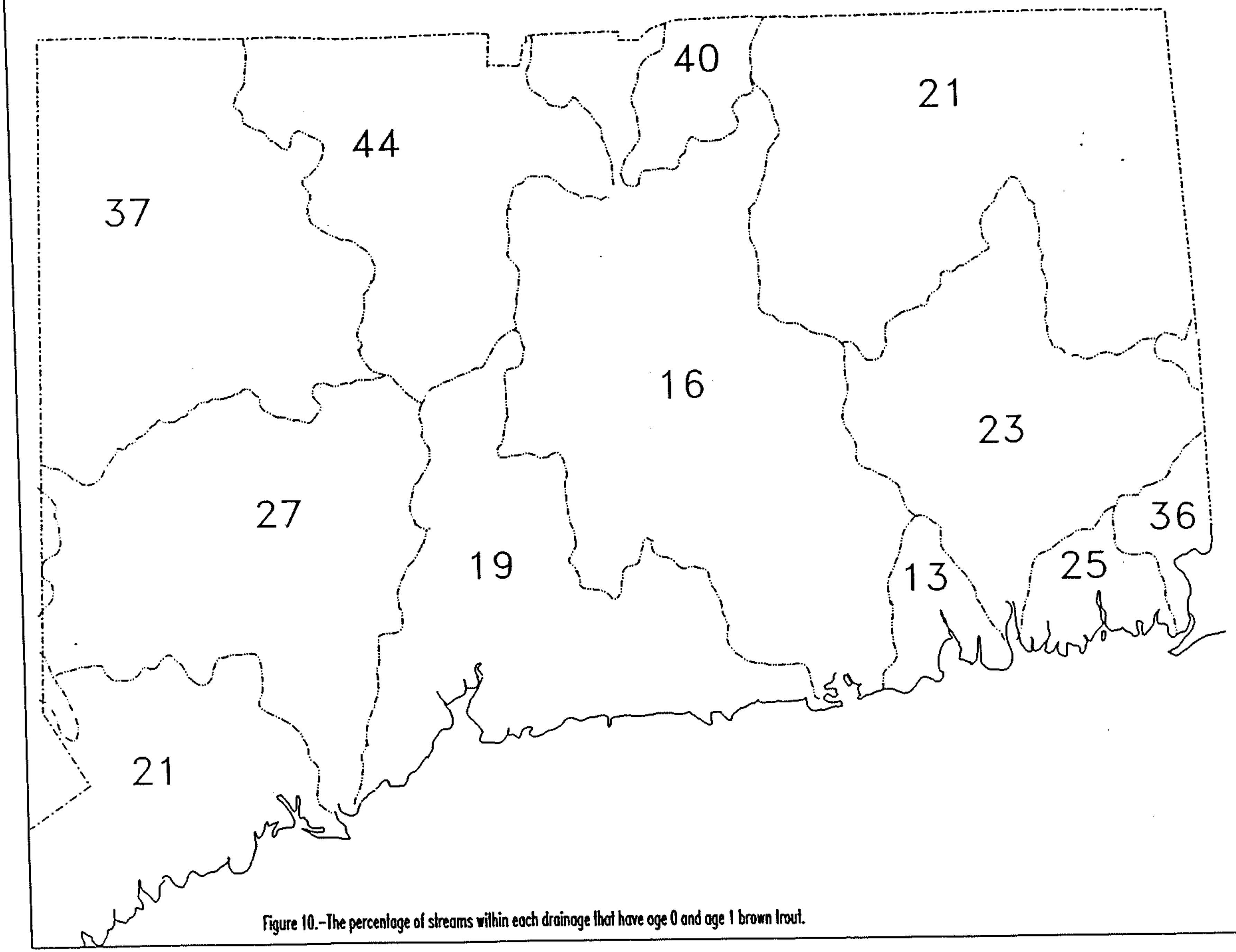


Figure 10.–The percentage of streams within each drainage that have age 0 and age 1 brown trout.

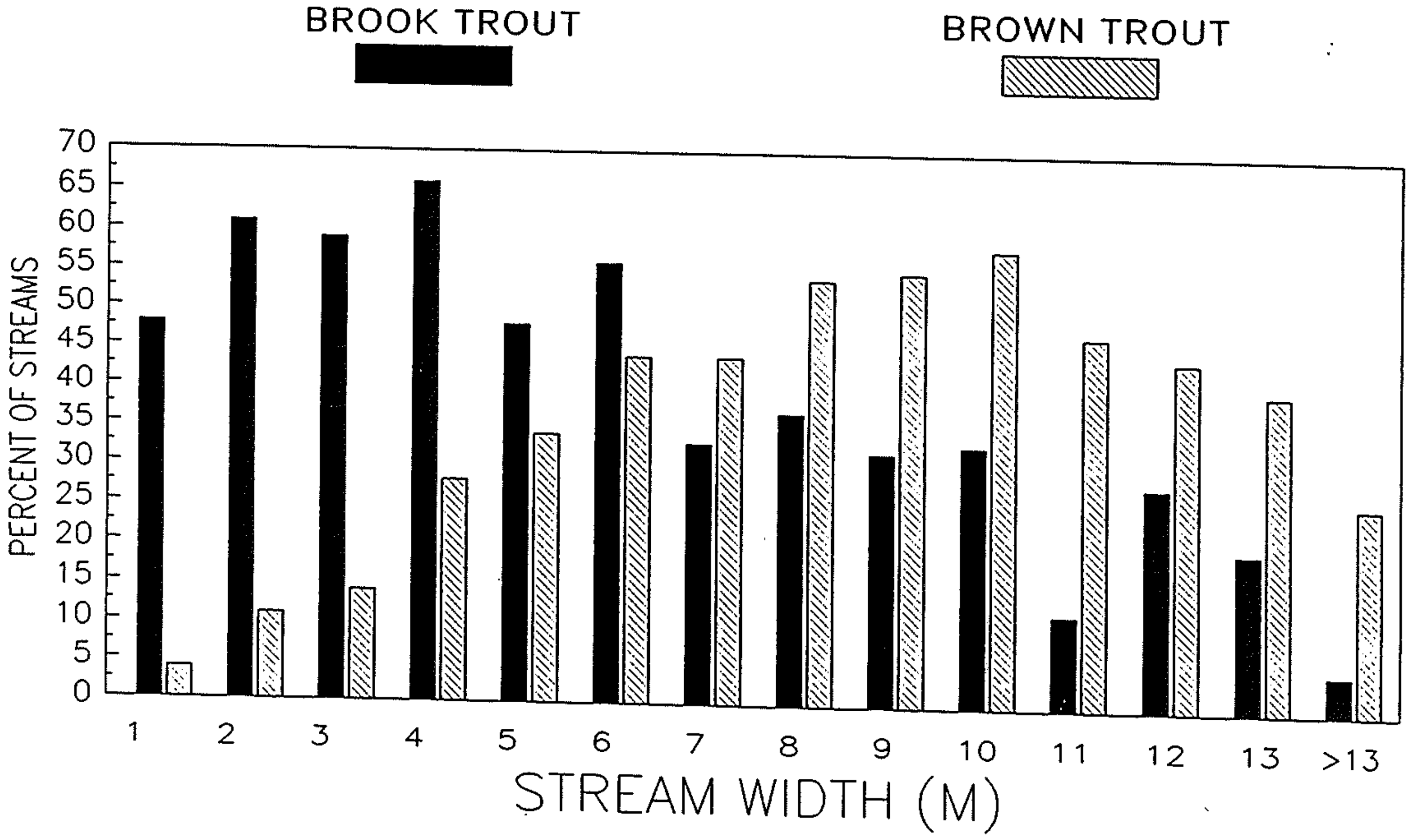


Figure 11.—Percentage of streams with either age 0 or age 1 brook trout or brown trout present versus stream width.

Table 14.-Kilometers of streams with wild trout presence by stream classification and stream order. Numbers do not include intermittent streams. The percentage of streams is in ().

	Type-1			Type-2			**Trace**
Stream order	Brook Trout	Brown Trout	Mixed Trout	Brook Trout	Brown Trout	Mixed Trout	Wild Trout
1	1,051 (13.8%)	15 (0.2%)	84 (1.1%)	601 (7.9%)	31 (0.4%)	99 (1.3%)	2,726 (35.8%)
2	104 (5.7%)	33 (1.8%)	60 (3.3%)	114 (6.3%)	22 (1.2%)	71 (3.9%)	874 (48.0%)
3	6 (0.7%)		6 (0.7%)	25 (2.7%)	25 (2.7%)	25 (2.7%)	389 (43.2%)
4							146 (35.0%)
Total	1,161	48	150	740	78	195	4,135

Table 15.-Expanded estimate of number of wild brook trout and wild brown trout by age and stream order.

Age	Stream Order	Brook Trout	Brown Trout	Total
0	1	1,463,046	109,376	1,572,422
	2	206,052	102,386	308,438
	3	27,745	31,314	59,059
	4	641	2,774	3,415
	All	1,697,484	245,850	1,943,334
1	1	586,103	35,038	621,141
	2	90,504	28,732	119,236
	3	16,322	9,613	25,935
	4	418	1,017	1,435
	All	693,347	74,400	767,747
2	1	132,511	7,362	139,873
	2	18,271	7,345	25,616
	3	3,834	2,341	6,175
	4	181	139	320
	All	154,797	17,187	171,984
3	1	10,310	1,534	11,844
	2	833	2,254	3,087
	3	320	613	933
	4	0	209	209
	All	11,463	4,610	16,073
4	1	0	430	430
	2	0	462	462
	3	0	168	168
	4	0	56	56
	All	0	1,116	1,116
All	All	2,557,091	343,163	2,900,254

Table 16.-Estimated mid-summer number and percentage of harvestable wild brook trout and wild brown trout (TL > 15 cm) by age and stream order. Percentages are of the total number of harvestable wild trout.

Age	Stream Order	Brook Trout Number	Brook Trout Percentage	Brown Trout Number	Brown Trout Percentage	Total Number	Total Percentage
1[1]	1	205,136	43.74	17,519	3.74	222,655	47.47
	2	31,671	6.75	14,366	3.06	46,042	9.82
	3	5,510	1.22	4,807	1.02	10,517	2.24
	4	146	0.03	509	0.11	655	0.14
	All	242,668	51.74	48,258	7.93	279,869	59.67
2	1	132,511	28.25	7,362	1.57	139,873	29.82
	2	18,271	3.90	7,345	1.57	25,616	5.46
	3	3,834	0.82	2,341	0.65	6,175	1.32
	4	181	0.04	139	0.03	319	0.07
	All	154,797	33.00	17,187	3.66	171,984	36.67
3	1	10,310	2.20	1,534	0.33	11,844	2.53
	2	833	0.18	2,254	0.48	3,087	0.66
	3	320	0.07	613	0.13	933	0.20
	4	0	0.00	209	0.04	209	0.04
	All	16,586	2.51	4,610	0.98	16,073	3.43
4	1	0	0.00	430	0.09	430	0.09
	2	0	0.00	462	0.10	462	0.10
	3	0	0.00	168	0.04	168	0.04
	4	0	0.00	56	0.01	56	0.01
	All	0	0.00	1,116	0.24	1,116	0.24
All	All	408,928	87.18	60,114	12.82	469,042	

[1] Values for age 1 trout were calculated using 0.35*(number of age 1 brook trout) and 0.5*(number of age 1 brown trout).

3.2.2.1 Wild trout growth:

Age and growth estimates were determined for 3,745 wild brook trout from 446 sites, 1,618 wild brown trout from 207 sites, and 14 wild rainbow trout from 3 sites. Average length at annulus formation was calculated for each species at each site. Data for brook trout are summarized in Table 17 and Figure 12, and data for brown trout are in Table 17 and Figure 13. These data reveal greater longevity and greater size attained by wild brown trout compared to brook trout, resulting from faster growth rates and lower mortality rates of brown trout.

The average of brown trout growth rates in Connecticut was about the same as the "moderate growth" rate defined by Neuman (1985) (Table 17). Based on comparisons of brown trout length-at-capture data from New Hampshire, Pennsylvania, and New York (Carlander 1969) with our length-at-age data, it appears that

Table 17.-Mean of wild brook trout and wild brown trout length at age (mm total length) for sites sampled 1988 through 1995 and selected comparison values. Lengths were back-calculated from scale measurements. Range in().

Species/Source	Age 1 (mm)	Age 2 (mm)	Age 3 (mm)
Brown trout			
Connecticut River Drainages, Conn.	98 (73-131)	177 (146-207)	246 (197-280)
Farmington River	86 (74-92)	153 (133-181)	222 (210-235)
Central Coastal Streams	98 (63-136)	200 (185-219)	238 (-)
Western Coastal Streams	109 (83-146)	227 (218-237)	308 (-)
Lower Housatonic and Adjacent Hudson River Drainages	110 (77-149)	201 (145-242)	266 (183-292)
Upper Housatonic River Drainage	94 (57-155)	193 (132-250)	259 (168-330)
Eastern Coastal and Pawactuck River Drainages	104 (90-144)	198 (174-226)	268 (234-335)
Lower Thames River Drainage	104 (92-144)	210 (174-250)	277 (244-297)
Upper Thames River Drainage	91 (59-132)	188 (147-232)	256 (169-316)
"Slow Growth"[1]	73 (60-81)	126 (120-138)	172 (161-194)
"Moderate Growth"[1]	99 (76-165)	191 (149-272)	249 (206-295)
"Fast Growth"[1]	110 (94-122)	231 (224-240)	335 (325-345)

Species	Age 1	Age 2	Age 3	Age 4	Age 5
Brown Trout					
All Drainages	101 (57-155)	196 (126-312)	267 (168-387)	331 (225-403)	404 (329-486)

---

[1] Mean data from streams characterized as having slow (N=5), moderate (N=11), and fast (N=3) growth rates by Newman (1985).

Table 17.-(Conti.)

Source	Age 1 (mm)	Age 2 (mm)	Age 3 (mm)
Brook trout			
Connecticut River Drainages, Conn. (15 streams)	103 (68-141)	182 (116-255)	248 (223-299)
Farmington River	89 (71-104)	136 (115-161)	191 (183-199)
Central Coastal Streams	104 (79-128)	175 (144-221)	---
Western Coastal Streams and Adjacent Hudson River Drainages	113 (91-145)	198 (166-238)	---
Lower Housatonic and Adjacent Hudson River Drainages	97 (74-128)	162 (121-203)	210 (141-236)
Upper Housatonic River Drainage	88 (63-130)	146 (112-206)	187 (140-223)
Eastern Coastal and Pawcatuck River Drainages	99 (80-117)	159 (129-195)	244 (215-264)
Lower Thames River Drainage	97 (73-133)	157 (123-189)	193 (176-217)
Upper Thames River Drainage	88 (64-113)	142 (107-204)	185 (144-213)
All Drainages	95 (63-145)	156 (107-255)	206 (140-299)
NY Streams[2]	109 (74-287)	152 (66-287)	175 (102-381)
PA Streams[2] (12 streams)	102 (81-119)	135 (119-142)	163 (150-211)
NH Streams[2] (11 streams)	107-130 (76-188)	152-196 (127-272)	198-246 (165-335)

---

[2] From Carlander (1969), These data include measured lengths at age and are not directly comparable to back-calculated lengths.

brook trout growth rates in Connecticut streams are about the same as in nearby states. Difference in growth rates between basins is discussed in prior reports (Hagstrom et al. 1992, 1993, 1994).

Growth rates of brown trout and brook trout differed between and within basins. Generally, growth rates were slower in areas of higher elevation (Farmington River, upper Housatonic River Drainage and upper Thames Drainage) and faster in areas at lower elevations or close to the coast. Cooler water temperatures at the higher elevations are probably the cause of this slower growth. This pattern was consistent across age classes for both species.

Also apparent is the wide range of variation in length-at-age of each species among sites. The relationship between length-at-age and physical, chemical, biotic, and thermal variables at each site was examined in an effort to gain insight into the reasons for this variation. Growth rate is a critical factor in determining the ability of a particular stream to produce significant numbers of large fish. The ability to predict growth rates will allow us to identify streams with the best potential for wild trout production. Correlation analysis was used to identify the variables that were directly or indirectly related to growth rate.

Correlations between brook trout length-at-age and several other variables were significant (Table 18). The best correlations ($-0.3<R>0.30$) of physical variables were with conductivity, pH, alkalinity, mean width, mean depth, maximum pool length, water temperature, gradient, elevation, and stream order. Correlation coefficients were generally low, however, with a great deal of unexplained scatter. Stepwise multiple regression techniques reduced scatter, providing four-variable models with improved R^2 values ranging from 0.32 for age 2 brook trout to 0.59 for age 3. Many of the significant variables

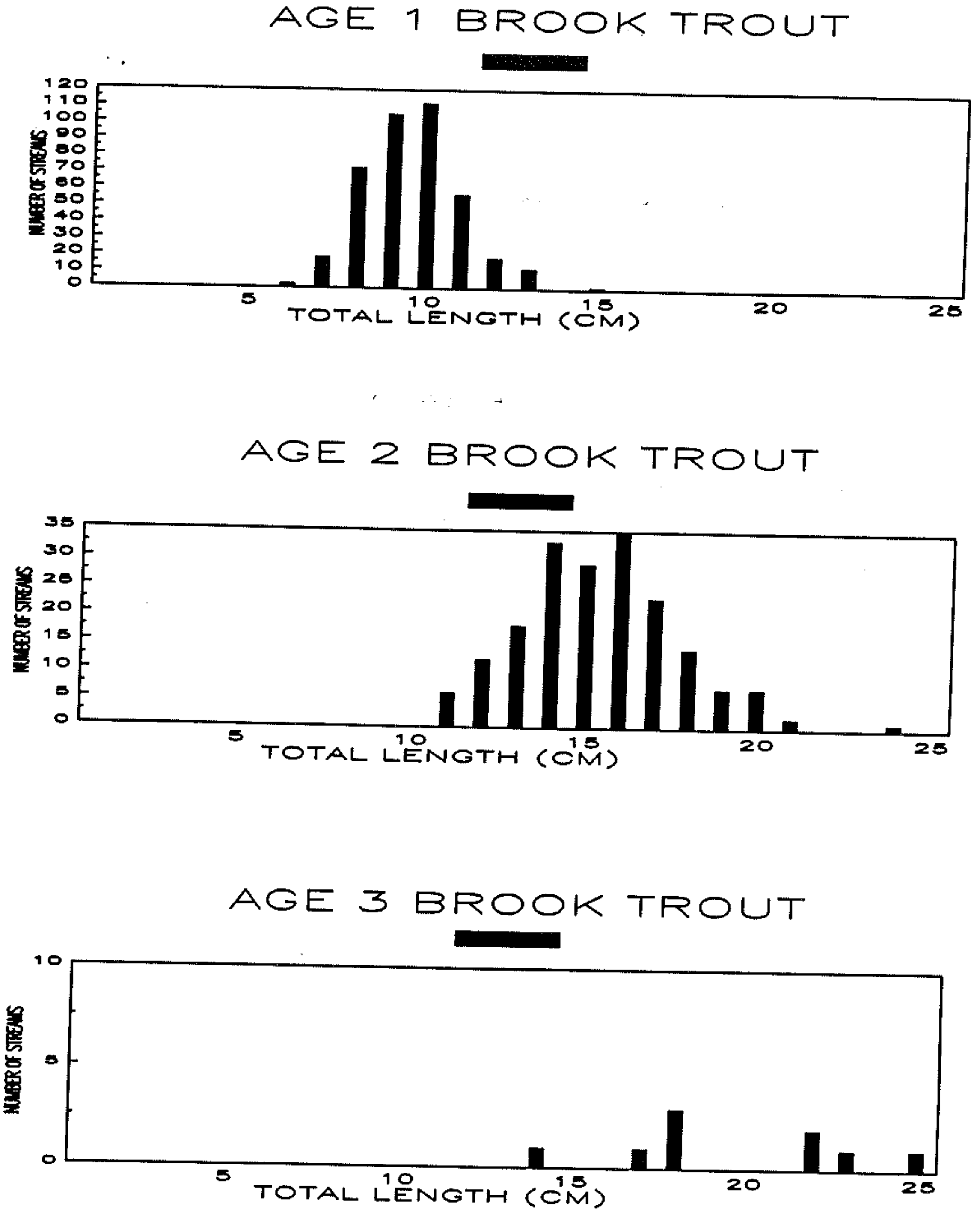
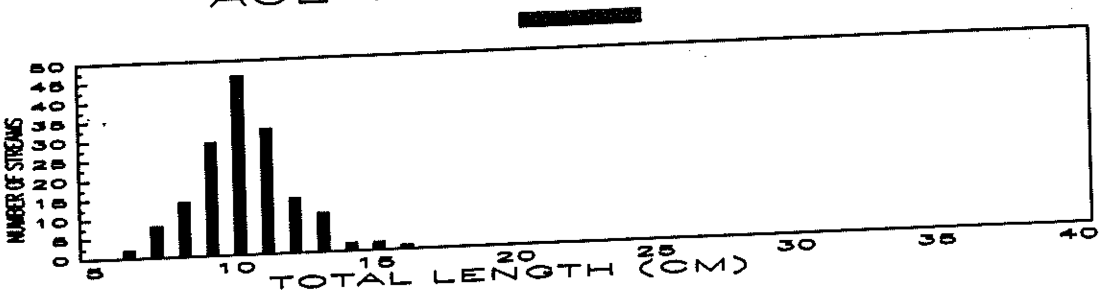
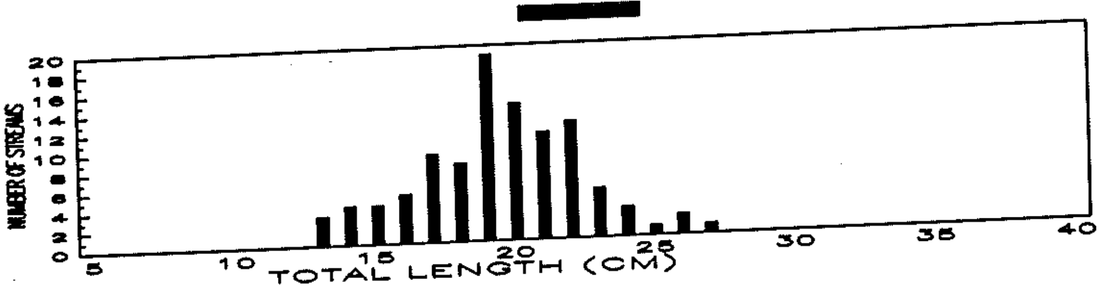


Figure 12.-Frequency of Connecticut streams with specific back-calculated mean lengths at age (cm) for brook trout.

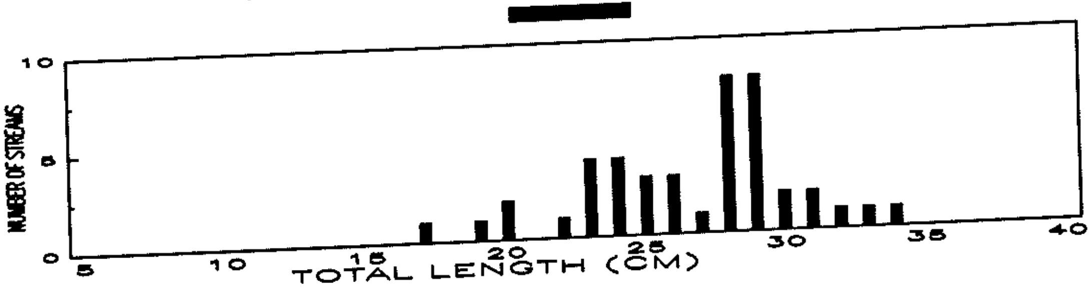
AGE 1 BROWN TROUT



AGE 2 BROWN TROUT



AGE 3 BROWN TROUT



AGE 4 BROWN TROUT

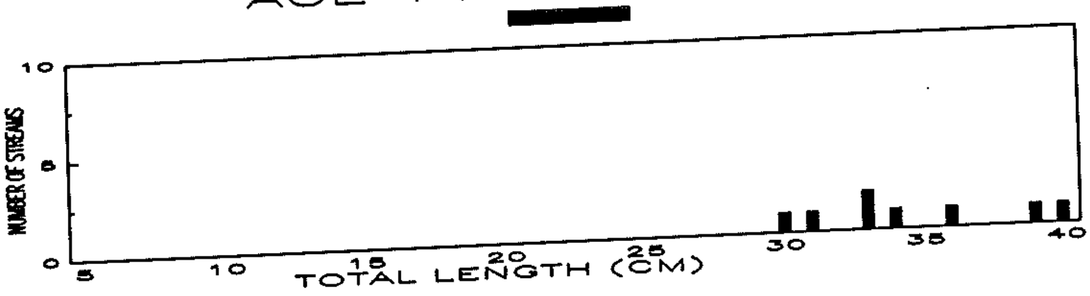


Figure 13.-Frequency of Connecticut streams with specific back-calculated mean lengths at age (cm) for brown trout.

Table 18.-Correlation coefficients (r) for significant correlations of brook trout length at age vs. stream and fish population variables from Connecticut streams sampled from 1988-1995.

Parameter	Age 1	Age 2	Age 3
Number/ha Age 0	-0.23***	-0.21**	NS
Number/ha Age 1	-0.33***	-0.27***	NS
Number/ha Age 2	-0.26***	-0.34***	NS
Number/km Age 0	-0.24***	-0.19**	NS
Number/km Age 1	-0.28***	-0.21**	NS
Number/km Age 2	-0.19***	-0.26***	NS
Conductivity	0.36***	0.32***	0.37*
pH	0.18**	0.23**	0.45**
Alkalinity	0.24***	0.29***	0.36*
Mean Width	0.34***	0.30***	0.38*
Mean Depth	0.32***	0.32***	NS
Maximum Depth	0.29***	0.21**	NS
% Substrate Coarse Sand	NS	0.17**	NS
% Substrate Gravel	0.11*	0.13*	NS
% Substrate Small Boulders	-0.14**	-0.20**	NS
% Substrate Large Boulders	-0.18**	-0.24***	NS
Velocity	0.12*	0.15*	NS
Maximum Pool Length	0.30***	0.32***	NS
Maximum Water Temperature	0.17*	0.28*	NS
Water Temperature	0.23***	0.25***	0.46**
Gradient	-0.27***	-0.25***	-0.34*
Elevation	-0.43***	-0.42***	-0.24*
Mean Embeddedness Gravel	NS	-0.16*	NS
Mean Embeddedness Cobble	0.16**	0.25***	NS
Dominant Substrate Type	-0.11*	-0.17**	NS
Stream Order	0.32***	0.28***	0.36*
Percentage of Sample Area as Cover	0.25***	0.26***	NS
Percentage of Sample Length as Cover	0.21***	0.26***	NS
Overhead Canopy	-0.21***	-0.21**	NS
Subjective Fishing Pressure	0.30***	0.21**	NS
Kilograms/ha Age 0	-0.10*	NS	NS
Forage Fish	0.12*	0.17**	NS

Table 18.-(cont.)

Parameter	Age 1	Age 2	Age 3
Weight of Non-trout Species	0.25***	0.27***	NS
Cross Sectional Area of Sample Site	0.30***	0.30***	NS
Kilograms/ha of Trout	-0.10*	NS	NS

* $0.01 < P \leq 0.05$, ** $0.0001 < P \leq 0.01$, *** $P \leq 0.0001$, NS Not Significant

correlated with each other so that cause and effect relationships were unclear. A general trend of increasing values was seen for conductivity, pH, alkalinity, mean width, mean depth, maximum depth, cross sectional area, maximum pool length, adult trout cover, maximum summer water temperature, temperature on the fish sampling date, forage fish abundance, standing crop of non-trout species, and estimated fishing pressure as stream size increased. Brook trout length-at-age also increased as these variables increased. Conversely, brook trout density and standing crop, substrate size, percent canopy cover, gradient, and elevation, all tended to decrease as stream size increased. Brook trout length-at-age also tended to be inversely related to these variables. It is not clear which variable or combination of these variables actually had a direct effect on brook trout growth. Indeed the parameters with the most direct effect on growth may not have been directly measured at all, but may be correlated with parameters that we measured. Bioenergetics models (e.g. Winberg 1956, Fry 1957, Brett et al. 1969, Kerr 1971) generally use food supply and water temperature as the most important determinants of net production and growth. Thus it appears that variables that measure aspects of temperature and food would have the most direct effect on growth. Surprisingly, correlation analyses failed to show a direct relationship between food supply (density and number of families of aquatic invertebrates) and trout growth. This may have been due to differences in availability of invertebrates to trout, or forage fish and terrestrial invertebrates may have contributed significantly to the food supply. It is also possible that the effects of differences in food supply were overshadowed by differences in temperature, or that deficiencies in invertebrate sampling design produced the inconclusive results. Other variables may influence growth by affecting temperature and food. For example, more canopy may reduce water temperatures, and higher alkalinity may increase food production. Apparently the intuitive link between trout growth, production, and food supply is elusive, as other researchers have failed in attempts to quantify this relationship (Allan 1982, Healey 1984). These interactions are undoubtedly complex, and sorting out all of these relationships is beyond the scope of this report.

Brown trout length-at-age correlations showed trends similar to those of brook trout. However, with a smaller sample size fewer significant relationships were detected (Table 19).

Comparisons of length-at-age with trout density and standing crop indicate density dependent growth, with trout exhibiting slower growth under more crowded conditions. This conclusion may be erroneous, however, as both slower growth and higher density occur in smaller streams, where a host of other variables may be less conducive to growth. Furthermore, others have demonstrated convincingly that changes in trout density in a given stream have no detectable effect on growth rate (Clark et al. 1980, Bachman 1984, Elliott 1994).

3.2.2.2 Range of trout occurrence:

The presence of wild trout is dependent on the ability of the individual within the population to survive in the local environment. Factors that affect a population include food availability, shelter (cover), water quality, predation, and space, or in the case of fish, flow volume. Parameters can operate in both a density dependent manner (number of individuals is directly related to parameter values and change as a function of that parameter) or in a density independent manner (all individuals are affected equally and these effects limit the occurrence of trout). Many physical parameters have density independent effects outside of certain ranges (i.e. a pH below

Table 19.-Correlation coefficients (r) for significant correlations of brown trout length at age vs. stream and fish population variables from Connecticut streams sampled from 1988-1995.

Parameter	Age 1	Age 2	Age 3	Age 4
Number/ha Age 1	-0.17*	-0.24*	-0.29*	NS
Number/ha Age 2	NS	-0.21*	NS	NS
Number/ha Age 3	NS	-0.20*	NS	-0.45*
Number/ha Age 4	NS	NS	NS	-0.57**
Mean Width	NS	NS	0.46**	NS
Mean Depth	NS	NS	0.38**	NS
% Substrate Large Boulders	NS	NS	-0.31*	-0.44*
% Substrate Bedrock	0.16**	NS	NS	NS
Stream Discharge Volume	NS	NS	0.35*	NS
Maximum Pool Length	NS	NS	-0.32*	NS
Maximum Water Temp.	NS	NS	0.44*	NS
Water Temperature	0.23**	NS	NS	NS
Elevation	NS	-0.22*	-0.33**	-0.49*
Mean Embeddedness Cobble	NS	NS	NS	0.55*
Maximum Depth	0.22**	0.31**	0.53***	NS
Stream Order	NS	NS	0.48**	NS
% of Sample Area as Cover	NS	NS	0.27*	NS
% of Sample Length as Cover	NS	NS	0.29*	NS
Overhead Canopy	NS	NS	-0.28*	NS
Forage Fish	0.20**	NS	NS	NS
Cross Sectional Area of Sample Site	NS	NS	0.43**	NS

* $0.01 < P \leq 0.05$, ** $0.0001 < P \leq 0.01$, *** $0.0001 \leq P$, NS Not Significant

5.0 is limiting to brown trout, but a pH above 5.0 has a density dependent effect). Table 20 lists means and ranges of many physical parameters measured at each site where Type-1 trout exist, as well as for streams with Trace trout populations. We assumed that for Type-1 trout populations the impacts of fishing mortality will not obscure the relationships between trout population parameters and physical variables. The ranges shown in Table 20 probably represent the extremes where trout populations are found in Connecticut streams. Streams with water quality parameters outside these ranges are unlikely to have viable trout populations.

3.2.2.3 Mortality:

Natural and fishing mortality rates determine the ability of a wild trout population to maintain itself and support recreational fishing. Age specific population estimates were generated from length frequency information of individual depletion passes and back-calculated scale aging. In some cases where scales were not collected, visual determinations of ages were made from the length frequencies. Mortality rates for the entire population and between age groups were calculated using a Heinke estimate and simple proportion (Ricker 1975) (Table 21). Age 0 fish were not included in calculations using the Heinke method so that we could produce mortality estimates which are representative of the fishable segment of the populations.

Regardless of sympatry or allopatry, brook trout and brown trout populations do not differ in average annual mortality rates through age 2. The only statistically significant difference in mortality rates between sympatric and allopatric populations was between age 2-3 brook trout. Differences in mortality rates between brown trout and brook trout were only statistically different between age 2 and age 3 in sympatric populations. Few brook trout were surviving to age 3 in any of the 15 sympatric populations and there was a 95% mortality rate in the allopatric populations. Brook trout past age 2 are rarely found in Connecticut streams.

The average annual mortality rates calculated from Type-1 Connecticut streams are most comparable to trout populations under heavy fishing pressure. When compared to mortality rates from Hunts Creek and the Au Sable River, Michigan (Shetter,

Table 20.-The mean and range of physical parameters over which different classifications of trout populations occurred. N = Number of observations.

		Type-1 Populations			Type-2 and Trace Populations		
Variable	Species	N	Mean(Range)	SD	N	Mean(Range)	SD[1]
Dissolved Oxygen (mg/L)	BK[2]	91	9.5(6.0-11.5)	1.1	315	9.2(4.8-15.8)	1.2
	BN	21	9.7(8.5-11.1)	0.6	147	9.2(6.0-15.8)	0.9
pH	BK	91	6.8(5.3-8.1)	0.5	314	6.9(4.7-9.0)	0.6
	BN	21	7.3(5.7-8.4)	0.6	147	7.2(5.2-8.3)	0.5
Conductivity (umHos)	BK	91	115.6(22.0-453.2)	72.4	318	132.0(25.0-456.6)	76.0
	BN	21	175.2(31.3-324.0)	77.9	145	167.9(34.6-453.3)	82.7
Alkalinity (mg/L as $CaCO_3$)	BK	88	26.3(0.03-203.2)	28.4	311	28.1(0.03-186.7)	28.2
	BN	21	50.8(3.9-98.4)	29.3	144	41.8(1.9-212.8)	39.1
Mean Width of Sample Area (m)	BK	92	2.9(0.6-6.6)	1.3	319	4.3(0.6-20.7)	2.6
	BN	21	4.0(2.2-6.0)	1.0	150	7.7(1.2-82.6)	7.9
Mean Depth of Sample Area (cm)	BK	92	10.4(2.1-30.9)	5.3	319	13.9(1.6-68.6)	8.5
	BN	21	14.9(7.3-28.6)	5.8	150	18.0(2.8-64.2)	9.8
Velocity (cm/s)	BK	90	0.1(0.01-0.3)	0.1	312	0.1(0.0-0.5)	0.1
	BN	21	0.2(0.09-0.3)	0.1	144	0.2(0.0-0.5)	0.1
Discharge (m^3/s)	BK	90	0.1(0.0-1.0)	0.2	312	0.2(0.0-2.8)	0.4
	BN	21	0.1(0.0-1.0)	0.2	144	0.5(0.0-8.0)	1.0
Length of Longest Riffle in Sample Area (m)	BK	92	20.8(0.0-120.0)	16.8	318	21.1(0.0-140.0)	16.5
	BN	21	33.4(5.0-120.0)	25.0	148	33.0(0.0-300.0)	35.9
Length of Longest Pool in Sample ARea (m)	BK	92	15.0(3.0-67.0)	10.8	318	27.5(0.0-150.0)	25.4
	BN	21	17.2(7.0-41.0)	10.4	148	33.7(0.0-200.0)	30.7
Pool to Riffle Ratio	BK	92	2.2(0.05-100.0)	10.4	314	5.5(0.0-100.0)	4.1
	BN	21	0.9(0.05-3.5)	0.8	145	4.4(0.0-100.0)	5.6
Maximum Water Temperature (°C)	BK	25	20.9(17.0-27.0)	2.7	101	22.4(16.0-32.0)	2.9
	BN	10	22.5(17.0-26.0)	2.9	54	23.0(16.0-30.0)	2.6
Water Temperature on Sample Date (°C)	BK	92	16.4(9.0-22.0)	2.5	318	18.2(7.5-27.0)	2.7
	BK	21	17.3(15.0-22.0)	2.3	146	18.7(11.0-27.0)	2.7
Gradient (%)	BK	91	2.8(0.04-17.5)	2.8	317	2.2(0.0-15.2)	2.5
	BN	21	1.9(0.5-4.6)	1.2	146	1.8(0.08-14.2	2.2
Mean Embeddedness Gravel (%)	BK	74	34.1(0.0-100.0)	23.4	283	35.9(0.0-95.0)	23.1
	BN	17	35.2(4.1-57.5)	15.6	139	38.6(0.0-106.7)	22.1
Mean Embeddedness Cobble (%)	BK	88	26.0(0.0-66.2)	13.8	297	28.4(0.0-95.0)	16.7
	BN	21	33.8(12.1-66.2)	15.6	145	29.7(0.0-110.0)	15.7
Maximum Depth of Sample Area (cm)	BK	79	50.0(15.0-115.0)	20.0	274	60.8(10.0-200.0)	31.8
	BN	17	63.8(30.0-115.0)	21.5	130	77.1(14.0-200.0)	35.8
Dominant Substrate Type	BK	92	4.0(1.0-7.0)	1.1	319	3.9(1.0-73.0)	1.2
	BN	21	3.9(3.0-6.0)	0.8	149	4.1(1.0-7.0)	1.0
Abundance of Invertebrates (num./m^2)	BK	90	110.3(9.9-500.5)	79.6	365	110.0(6.14-812.8)	86.7
	BN	23	132.0(9.9-812.8)	158.3	215	102.1(6.7-654.4)	76.9
Number of Invertebrate Taxa in Sample	BK	90	20.0(6.0-29.0)	4.4	365	18.3(4.0-31.0)	4.8
	BN	23	19.3(6.0-26.0)	4.8	215	17.3(2.0-30.0)	4.8
Standing Crop All Species	BK	101	91.6(0.0-300.5)	58.3	393	82.5(0.0-1002.5)	112.2
	BN	23	143.7(0.0-520.7)	115.1	232	125.3(0.0-1002.5)	158.0

Table 20.-(Cont.) N = Number of observations.

Variable	Species	N	Type-1 Populations Mean(Range)	SD	N	Type-2 and Trace Populations Mean(Range)	SD[1]
Number of Fish Species in Sample	BK	101	4.8(1.0-17.0)	3.6	333	7.5(0.0-21.0)	4.4
	BN	23	7.7(3.0-17.0)	3.8	232	10.6(0.0-21.0)	4.4
Percent Total Sample Area as Cover	BK	101	3.8(0.0-28.5)	4.6	391	7.0(0.0-82.9)	10.8
	BN	23	4.9(3.0-19.2)	4.3	234	9.5(0.0-86.9)	14.0
Percent Total Sample Length as Cover	BK	101	18.7(0.0-88.6)	18.5	391	28.7(0.0-297.5)	36.0
	BN	23	25.9(1.1-85.8)	20.0	234	41.7(0.0-262.5)	45.9
Canopy (%)	BK	101	88.1(5.0-100.0)	20.1	392	85.0(0.0-100.0)	20.0
	BN	23	81.9(19.0-100.0)	20.9	230	76.0(0.0-100.0)	24.4

[1] SD = Standard deviation.
[2] BK = Brook trout, BN = Brown trout.

Table 21.-Average annual percent mortality and standard deviations of Type-1 trout populations by species for age 1+ and older trout and for individual age classes.

Species	Mortality Age 1 and older[1]	Mortality by Age Class Age 0-1	Age 1-2	Age 2-3
Allopatric populations:				
Brook Trout (N)	83.5%±16.0[3] 83	66.6%±17.2 74	80.1%±22.4 80	95.5%±15.1 63
Brown Trout (N)	78.3%±14.1 5	66.2%±30.4 5	74.0%±26.8 4	86.3%±13.0 5
Sympatric populations:				
Brook Trout (N)	79.0%±20.8 18	57.7%±25.0 18	79.5%±17.8 18	100.0%±0.0* 15
Brown Trout (N)	74.9%±19.1 18	66.1%±26.2 14	78.0%±17.4 18	76.9%±35.0** 13

[1] Heinke estimate-does not include age 0 trout.

* Statistically different (alpha = 0.05) from brook trout in allopatric populations.

** Statistically different (alpha = 0.05) from brook trout in sympatric populations.

1968), brook trout in Connecticut streams showed comparable survival from age 0 to age 1, but had higher average mortality rates in older age classes than those found in Hunts Creek. Mortality in the older age classes of brook trout was similar to values from the more heavily fished Au Sable River. For brown trout age 0 to age 1 mortality was comparable to the Au Sable River, but average mortality rates between older age classes were 15-25% higher in Connecticut streams.

The effect of recreational fishing on annual mortality rates of wild trout appears to be related to fishing pressure. A comparison of estimates of fishing pressure with annual mortality rates for 45 selected Type-1 and Type-2 streams showed that annual mortality rates for age 1 and up wild brown trout were always greater than 70% in streams with more than 350 hours of angler effort per kilometer (Figure 14). The higher angler effort values were on larger streams, which attract more attention from anglers.

A factor that can confound mortality estimates is emigration or immigration of individuals. Evaluation of scatter plots of the largest individual in a sample versus mean width and mean depth of a site indicates that brown trout >30 cm total length (TL) (about age 2 to age 4) were not typically found in sites with a mean width of less than 4 m and mean depth of less than 8 cm (Figure 15). This tends to indicate that larger fish can not remain in these smaller streams and would explain why older brown trout (Age 3 and 4) are rarely found in streams less than 3.2 m wide. Age 3 and 4 brown trout make up 23% of the brown trout biomass in Type-1 streams over 3.2 m wide (average 65 total kg/ha).

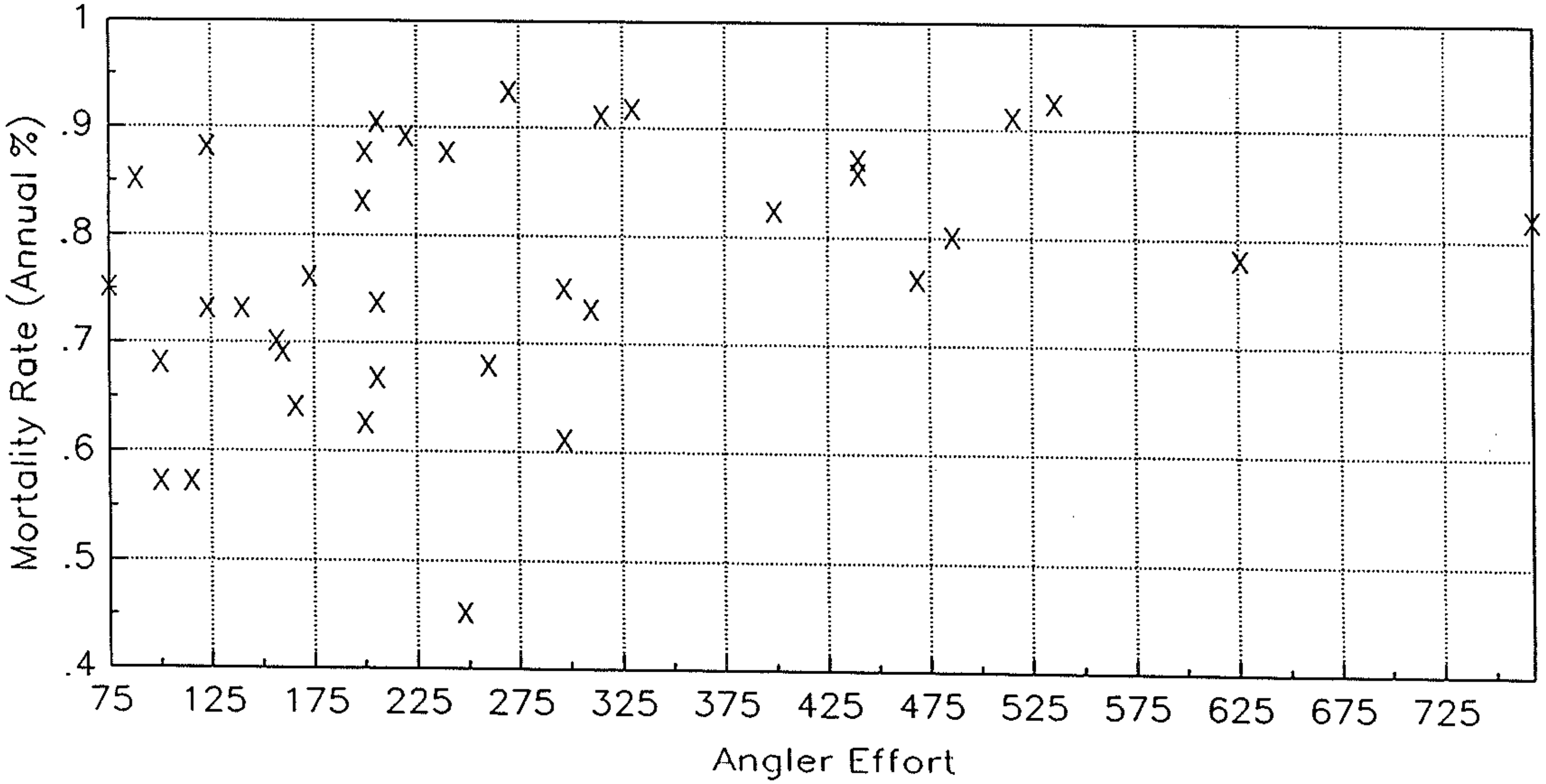


Figure 14.—Mortality rates of Brown trout versus fishing pressure (angler hours/km) in Type—1 and Type—2 Connecticut Streams.

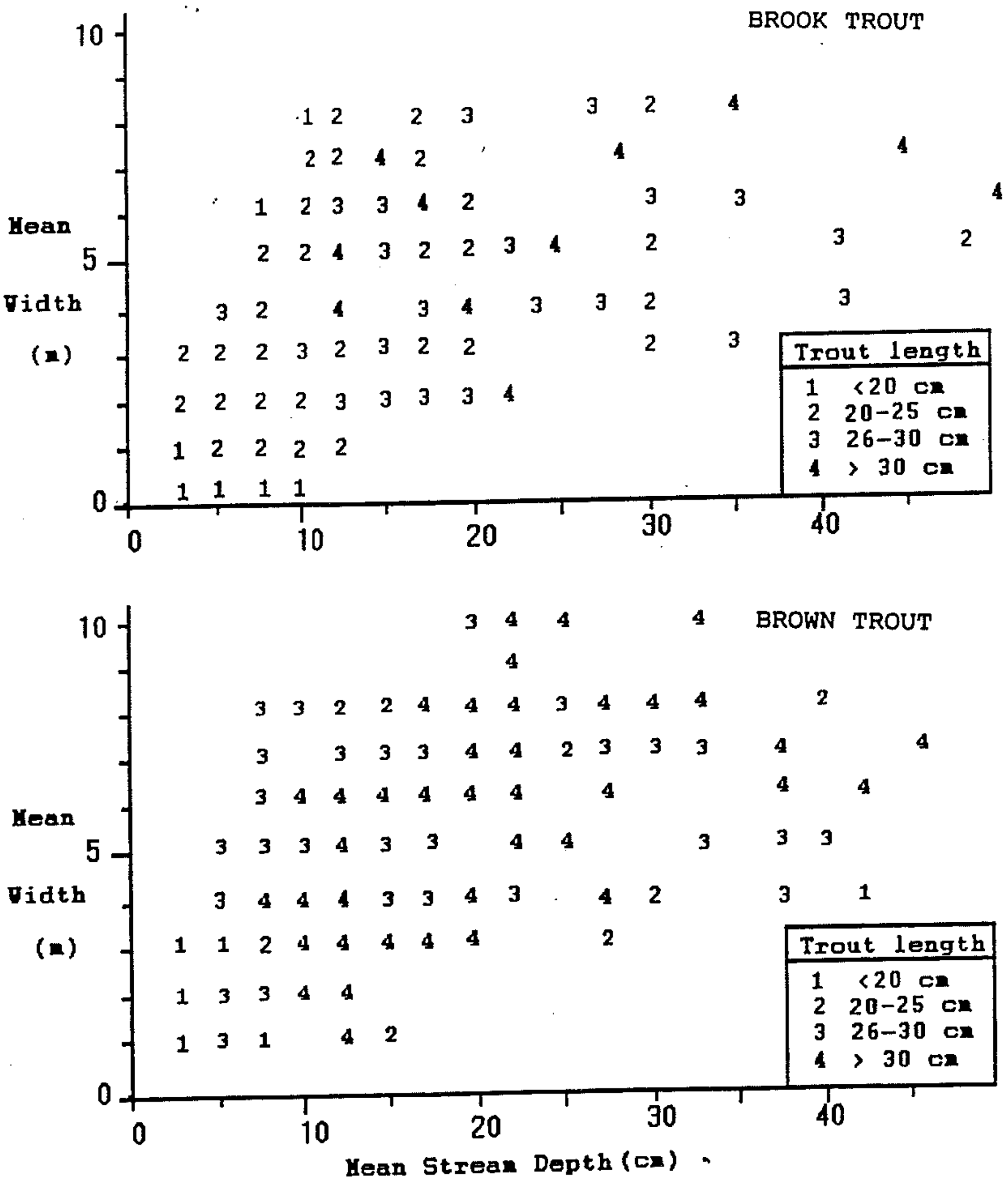


Figure 15.-The maximum size of trout sampled in Connecticut streams of different widths and depths.

The movement of trout downstream as they age, seeking larger streams with more cover and cross sectional area, could have caused us to overestimate mortality in smaller streams, when in reality it is not mortality but emigration that is occurring. No attempt was made to control for this and it should be recognized that the high inverse correlation between physical variables that increase in a downstream direction and mortality (see Sec. 5.2.1 correlation analysis) may be at least partly due to emigration.

3.2.2.4 Biomass of trout:

The biomass of trout (kilograms of trout/hectare) in Connecticut streams was not significantly different between basins for those streams containing trout. The average biomass of trout in the Connecticut River valley (excluding the Farmington River and Scantic River regional basins) was lower than the biomass in other basins, as was the biomass of trout in the Western and Central coastal basins (Figure 16). Areas of higher standing crop for brown trout and brook trout are found in the Housatonic Valley, parts of the Farmington River, and in the southeastern portion of the state for brook trout (Figure 17 and 18).

The majority of trout streams sampled (59%) had less than 20 kg/ha of wild trout present (Figure 19). The higher biomasses of trout encountered were in streams which acted as a thermal refuge for a lake or river (maximum biomass, 512 kg/ha). The biomass of all trout (wild and stocked) averaged 29.9 kg/ha for streams with trout (Table 22). Wild rainbow trout did not contribute significantly to the overall trout biomass, averaging 5.9 kg/ha at only 2 sites and being composed of age 0 and age 1 trout. Stocked trout accounted for less than 12% (3.3 kg/ha) of the mid-summer trout biomass encountered in Connecticut streams.

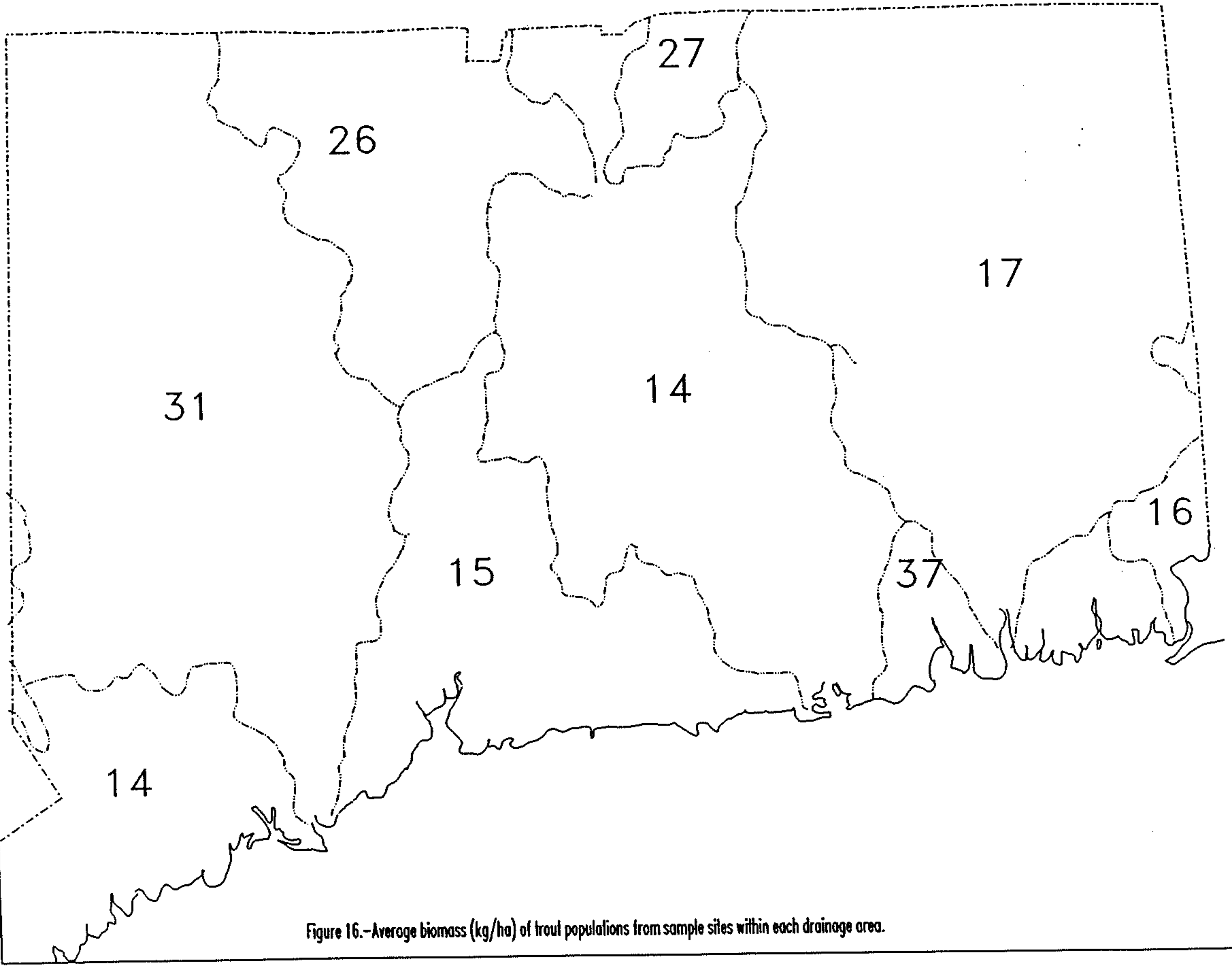


Figure 16.–Average biomass (kg/ha) of trout populations from sample sites within each drainage area.

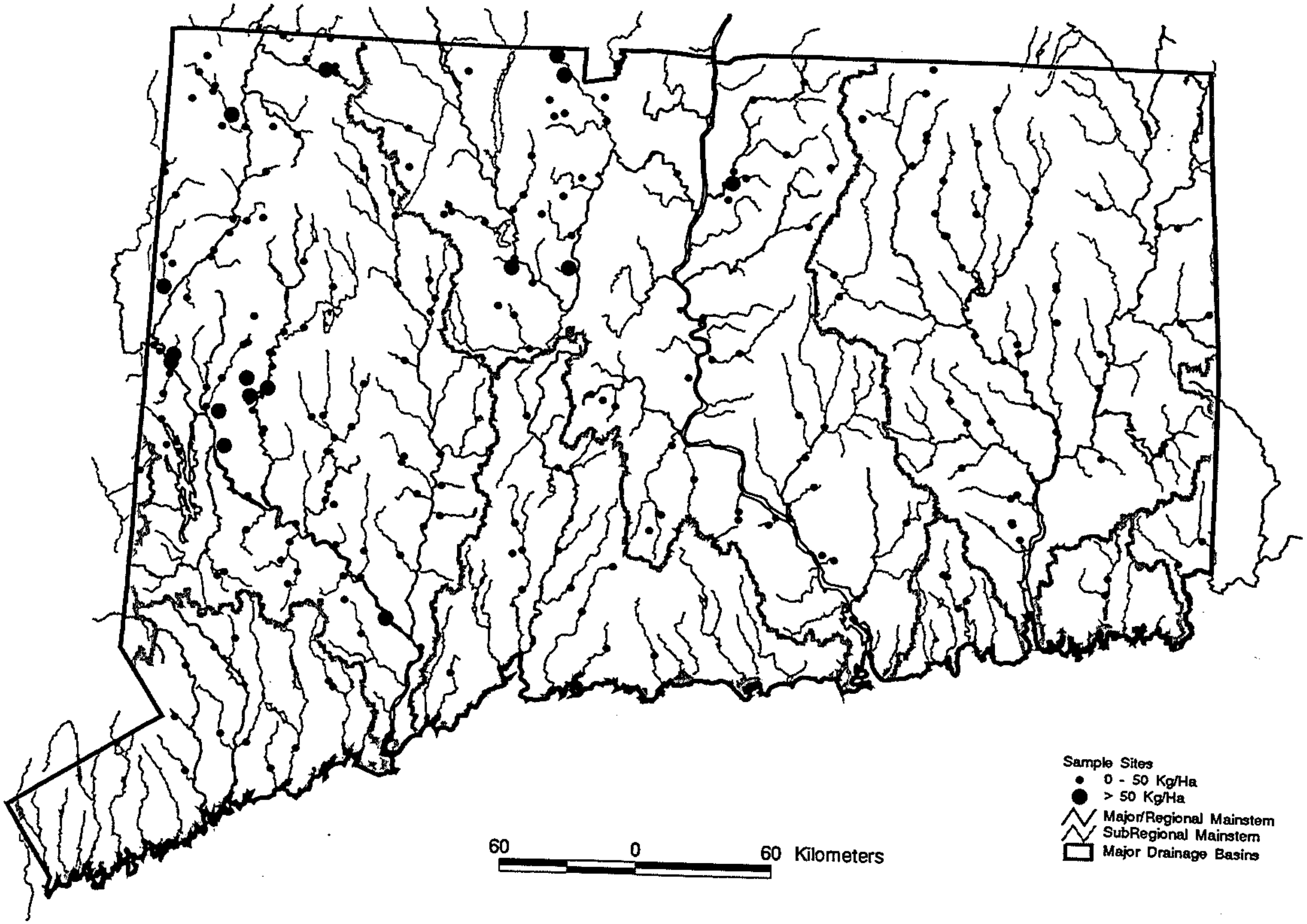


Figure 17. Brown trout standing crop in sample sites from Connecticut streams.

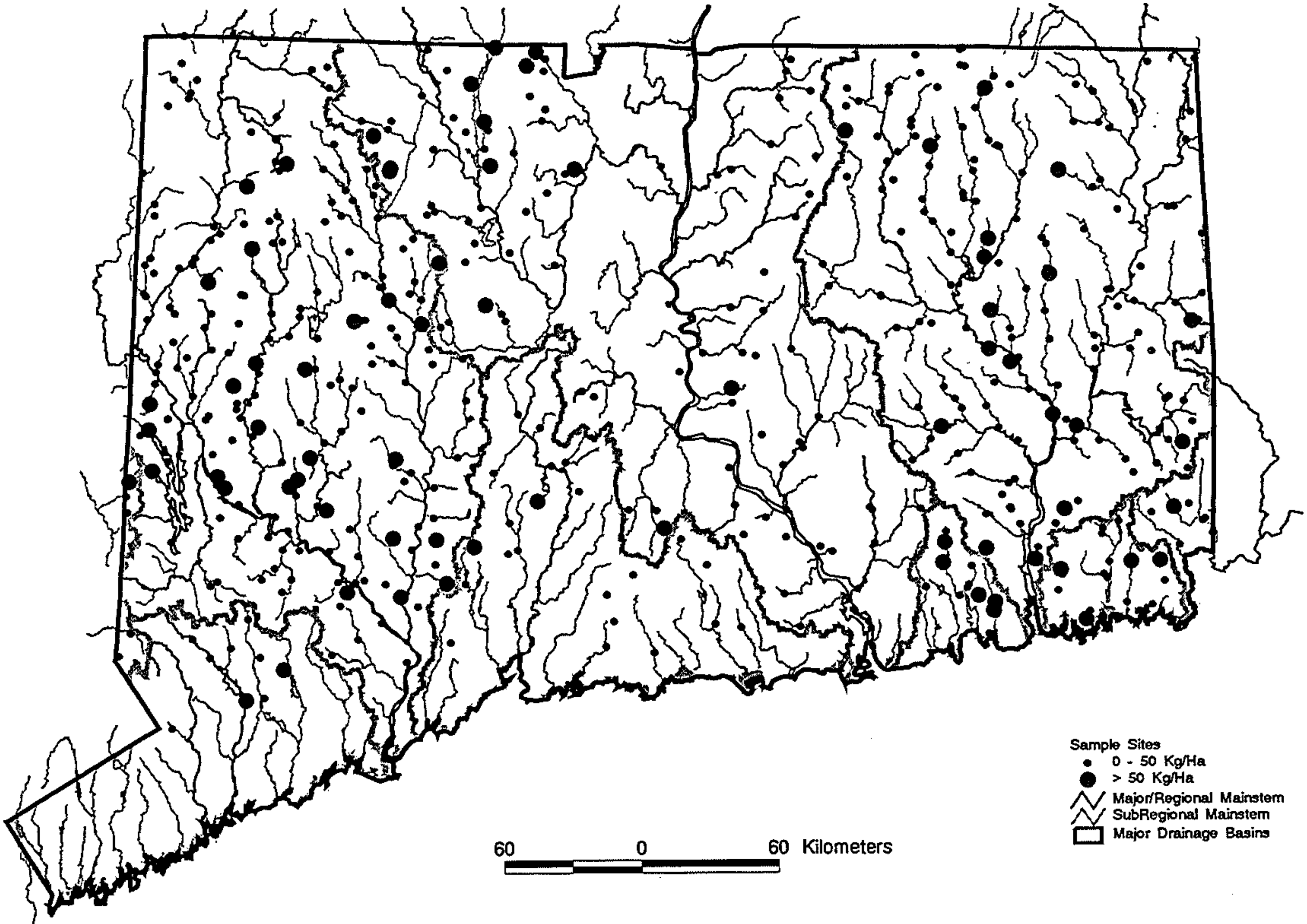


Figure 18. Brook trout standing crop in sample sites from Connecticut streams.

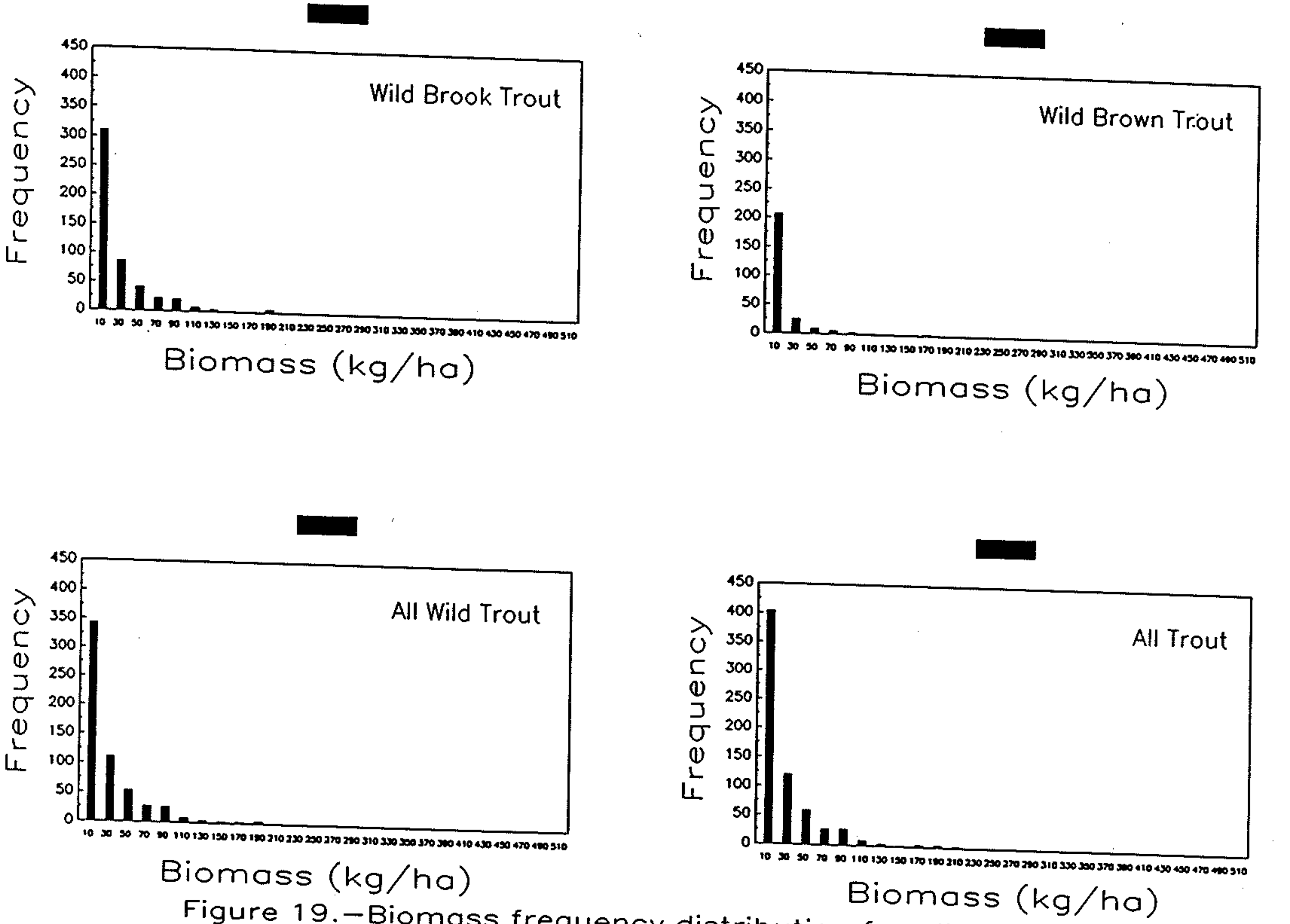


Figure 19.—Biomass frequency distribution for all trout, all wild trout, wild brook trout, and wild brown trout from stre amsurvey sites.

Table 22.-Biomass in kilograms per hectare (mean ± standard deviation/range/number of observations) of trout by age, stream classification, and species.

		Stream Classification			
Species	Age	Brook-1	Brown-1	Brook/Brown-1	All Trout Populations
Wild Brook Trout	0	12.7±17.5 1.2-15.5 83	----- ----- -----	3.2±3.9 0.06-16.2 18	3.8±9.2 0.0-155.0 495
	1	30.3±17.4 5.3-80.8 83	----- ----- -----	20.3±36.4 0.37-163.0 18	13.4±22.8 0.0-306.0 495
	2	14.9±15.2 0.0-54.8 63	----- ----- -----	7.9±7.55 0.0-27.8 18	7.1±13.6 0.0-111.3 495
	3	0.9±4.02 0.0-34.6 88	----- ----- -----	----- ----- -----	0.6±4.5 0.0-81.8 495
	All	58.8±31.3 8.8-184.0 83	----- ----- -----	31.2±44.0 1.2-200.3 18	24.96±36.0 0.0-375.0 495
Wild Brown Trout	0	----- ----- -----	8.9±6.01 2.1-17.2 5	5.3±5.6 0.2-19.9 18	0.6±2.5 0.0-27.0 583
	1	----- ----- -----	29.3±10.0 13.3-44.9 5	21.9±19.5 2.6-78.0 18	2.2±6.8 0.0-27.0 583
	2	----- ----- -----	24.5±26.7 3.5-25.9 5	17.1±18.6 0.0-74.25 18	1.6±6.1 0.0-75.9 583
	3	----- ----- -----	8.85±13.7 0.0-35.98 5	10.2±15.97 0.0-49.0 18	0.7±4.4 0.0-49.0 583
	4	----- ----- -----	1.99±3.99 0.0-9.97 5	2.5±5.2 0.0-17.2 18	0.2±2.2 0.0-44.9 583
	All	----- ----- -----	73.6±46.0 34.8-163.0 5	56.9±44.0 5.2-167.0 18	5.5±16.7 0.0-167.0 583
Wild Rainbow Trout	All	----- ----- -----	----- ----- -----	----- ----- -----	5.50±0.0 3.18-8.15 2
Wild[1] Trout	All	58.9±31.2 8.8-184.0 83	75.9±47.1 36.1-167.0 5	88.2±54.8 25.9-211.05 18	26.65±37.6 0.00-37.5 583
All[2] Trout	All	59.1±31.6 8.8-184.0 83	77.6±48.7 36.1-172.0 5	90.3±55.0 25.9-211.0 18	29.98±45.0 0.00-512.0 583

[1] Wild brook trout and wild brown trout combined.
[2] All brook trout and brown trout (wild and stocked).

3.2.2.5 Brook trout-brown trout interactions:

The biomass averages by age class for each species were essentially the same for both sympatric and allopatric populations. The only significant difference ($p \leq 0.05$) was the larger biomass of age 0 brook trout in allopatric brook trout populations.

A scatter plot of brown trout biomass versus brook trout biomass from the sites with sympatric populations (Figure 20) suggests a competitive interaction between the two species. Similar patterns exist for number of trout per hectare and number of trout per kilometer. Several authors have speculated on possible displacement or replacement relationships between brook trout and brown trout (Fausch 1989, Sorensen et al. 1995, and Waters 1983). However, it is also possible that this relationship may be an artifact generated by slight differences in habitat preference.

To test for possible habitat differences, sympatric populations were classified based on the dominant species biomass, or were placed in a third class if the species' biomasses were relatively equal. An analysis of variance with Duncan's multiple range tests was used to determine if any of the measured habitat variables were closely associated with difference in species biomass. There were significant differences in the ranges of three habitat variables (water temperature, mean width, and mean depth) between brook trout dominated and brown trout dominated streams. This indicates that the differences seen in sympatric populations were a result of differences in habitat preference rather than of competitive exclusion. Waters (1983) speculated on the displacement of brook trout by brown trout because of habitat availability changes caused by flooding and siltation events.

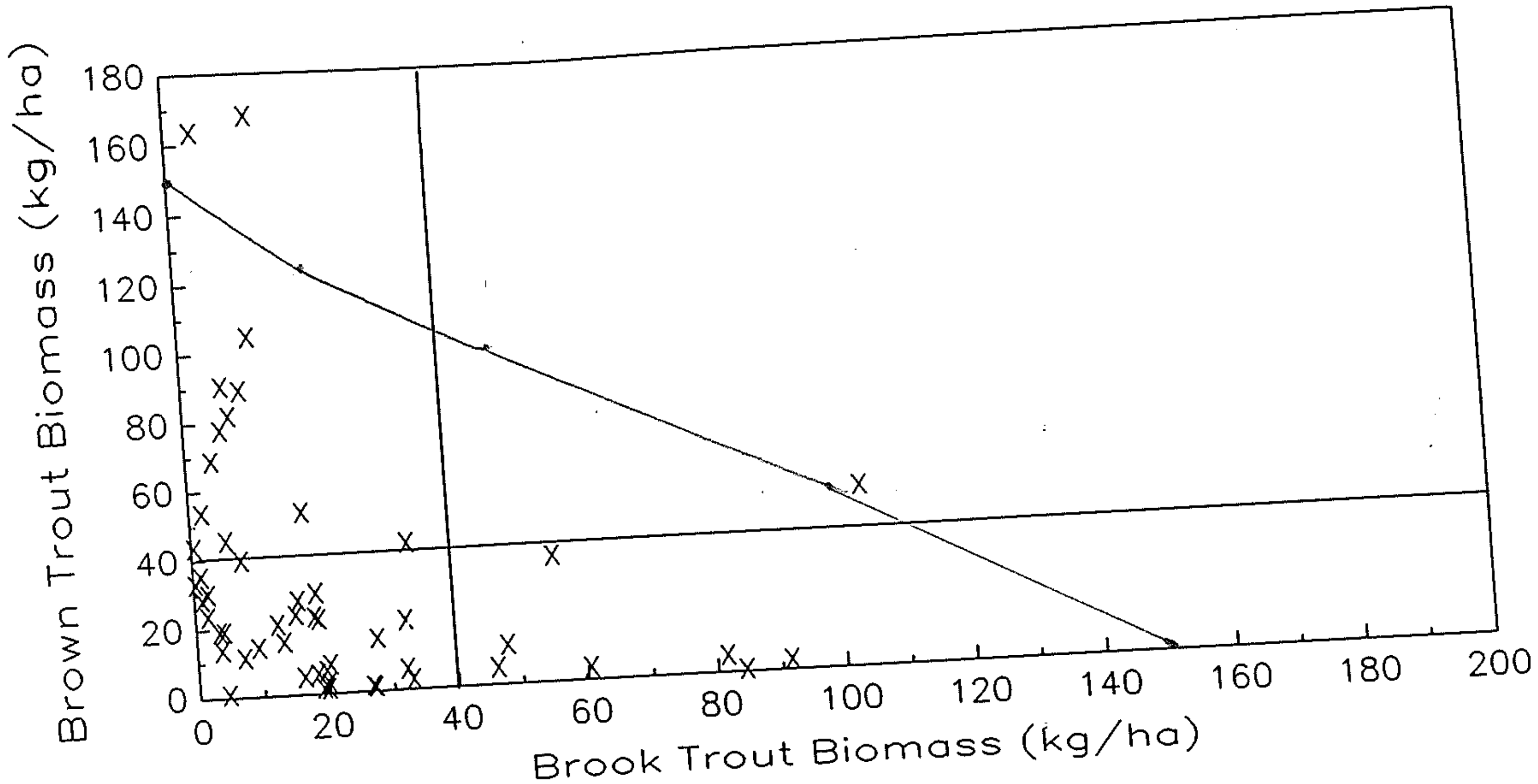


Figure 20.—A scatter plot of brook trout versus brown trout biomass using sample sites with sympatric populations

3.3 Smallmouth Bass:

Age and growth estimates were determined for 927 smallmouth bass from 65 stream sites throughout the state. Several of these smallmouth bass samples were collected from sites on small streams that were near reservoirs or larger rivers. Other samples were represented by only a few individuals, or a single year class. Samples such as these did not appear to be representative of isolated resident populations, and were eliminated from further analyses. Samples from adjacent sites on the same stream, or from the same site in different years were combined to increase sample size. Sites from the same stream that were separated by significant distances reflected different stream conditions, and were not combined. This resulted in sets of data for 34 distinct stream populations of smallmouth bass from 21 streams. For the most part, these were the larger warmer streams in the state (Figure 21). Data from these 34 populations were analyzed in more detail.

Means and ranges of length-at-age are presented in Table 25. It is apparent that growth rates of stream dwelling smallmouth bass are slower, and longevity is greater than for brook trout and brown trout (Table 17). On average, stream smallmouth bass do not reach "quality" size (280 mm) until age 6 (Table 25). As a result, these larger, older individuals were rare with less than half of the populations producing detectable numbers of fish age 6 or greater.

Length-at-age ranged widely from population to population. For sites where physical and chemical data were collected, correlation analyses were conducted to identify attributes associated with faster or slower growth. For one or more age groups, length-at-age was positively correlated with conductivity, stream width, cross sectional area, water temperature, velocity, discharge, maximum riffle length, and percent type 3 (gravel) substrate. Negatively correlated variables were number of invertebrate families present, percent canopy cover, and percent type 1 (fine sand) and type 2 (coarse sand) substrate. In general, growth was faster in warmer, larger streams or stream sections.

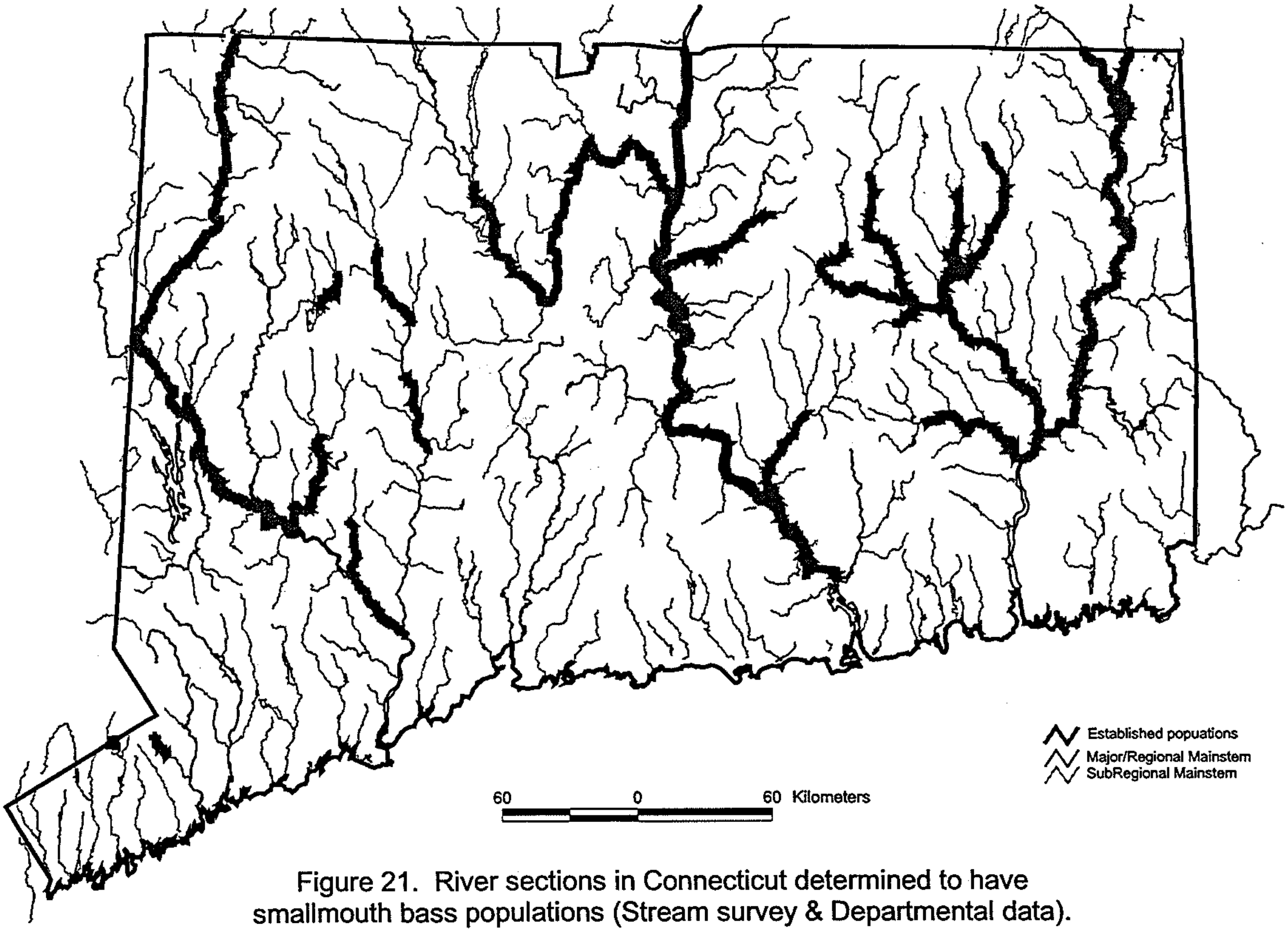


Figure 21. River sections in Connecticut determined to have smallmouth bass populations (Stream survey & Departmental data).

Table 25.-Mean length-at-age and range (mm TL) of smallmouth bass from 34 stream sites with resident smallmouth bass populations.

	AGE										
	1	2	3	4	5	6	7	8	9	10	11
Mean Length	84	141	187	229	257	284	318	323	327	337	346
Range	71-100	120-171	157-215	182-314	218-286	228-309	304-337	311-337	325-328	---	---
Number of Populations	34	33	33	26	18	16	8	3	2	1	1

Standing crop (kg/ha) of smallmouth bass was not significantly correlated with length-at-age for any age class. Hence, contrary to what Jacobs et al. (1996) found in Connecticut Lakes, growth of smallmouth bass in streams may not be related to density. In fact, in a given stream, growth was slowest in years of poor recruitment when densities were lowest, and dominant year classes demonstrated rapid growth at high densities during their first year, and average growth thereafter. This absence of density dependent growth for stream dwelling smallmouth bass has been suggested by others (Paragamian and Wiley 1987, McClendon and Rabeni 1987), and may have important implications for smallmouth bass management. Specifically, overpopulation and stunting may not be an important consideration in streams, as environmental variables may have overriding effects on growth, and competition for the food supply may not be important. Thus, thinning of abundant smaller sized fish may not increase the growth rate, and may not be an appropriate management strategy for stream-dwelling smallmouth bass. These results are similar to studies done on brown trout where growth in streams is generally density independent (Clark 1980) whereas growth in lakes is often strongly density dependent.

3.4 Natural Hybridization:

Tiger trout (brook trout X brown trout) occurred at eight sample sites. Representatives for both types of crosses were seen. At both Burton Brook and Stony Brook-Fall Brook, two tiger trout were taken. Of the 32,938 trout handled during this study, 0.033% (10) were naturally occurring tiger trout. At most sites wild brook trout and brown trout were present, however some of these hybrids may be the result of stocked brown trout spawning with native wild brook trout.

Hybrid sunfish were collected at widely scattered locations throughout the state. The greatest concentration of hybrid sunfish occurred in the Thames River Basin, with hybrids between green sunfish and other species being most common.

3.5 Other Species:

Species previously documented from Connecticut streams that were not confirmed at the original sample locations were pearl dace (*Semotilus margarita*) and the stoneroller (*Campostoma anomalum*, for previous documentation see Whitworth et al. 1968).

One new fish species was encountered, the longnose sucker, *Catostomus catostomus*. This species, often found in cold clear water, is well documented from drainages in Massachusetts and Eastern New York.

3.6 Species Distributions:

Many fish species are not uniformly distributed throughout the state. Natural barriers, post glacial reinvasion patterns, introductions by humans, life history patterns and specific habitat preferences have generated patchy distributions. Natural fall line barriers have prevented post glacial reinvasion of some species above Bulls Bridge on the Housatonic River, and beyond the fall line on the Natchaug River at Willimantic. Whitworth (1996) has presented a detailed discussion on recolonization of Connecticut by fish species following the last glacial period. There appears to be a reduced number of species in the portion of the Eastern Coastal Basin that is east of the Thames River. In part, this may be due to the lack of larger streams in this basin and that several of the largest streams are dammed for water supply reservoirs. For detailed distributions see maps and species descriptions in Appendix A.

3.7 Stream Carrying Capacity:

The maximum weight of fish that a stream can support for an extended period, i.e. the total biomass of all species, is its carrying capacity. It is assumed that most of the streams sampled are at or near carrying capacity. The average biomass for all sites sampled was 107.8 ± 172 kg/ha (range 0-2,342 kg/ha). The average biomass of streams with trout reproduction was 92.8 ± 116 kg/ha. Higher biomass values occurred in larger, warmer stream sites (Table 26). Species that are considered "stream species", species that spend most of their freshwater life cycle in streams, composed an average of 92.3% of all stream biomass sampled.

Species other than trout make up a significant portion of the total biomass in most streams. In Type-1 streams, allopatric brook trout comprised an average of 62% of the stream biomass, while allopatric brown trout accounted for 33%. In sympatric populations, brook and brown trout made up an average of 66% of the stream biomass.

Table 26.-Average, standard deviation and range of total fish biomass by stream order and trout reproduction status.

Stream Order	With Trout Reproduction Present (kg/ha)	With No Trout Reproduction (kg/ha)
1	72 ± 80 (0.78-581)	95 ± 175 (0-1,716)
2	102 ± 131 (0.37-1,002)	159 ± 286 (0.2-2,342)
3	115 ± 140 (22-823)	191 ± 267 (7.8-2,050)

Indexes of Biotic Integrity (IBI) use the species composition of a site to gauge the environmental health of an area. With this in mind, inquiries are often made about the

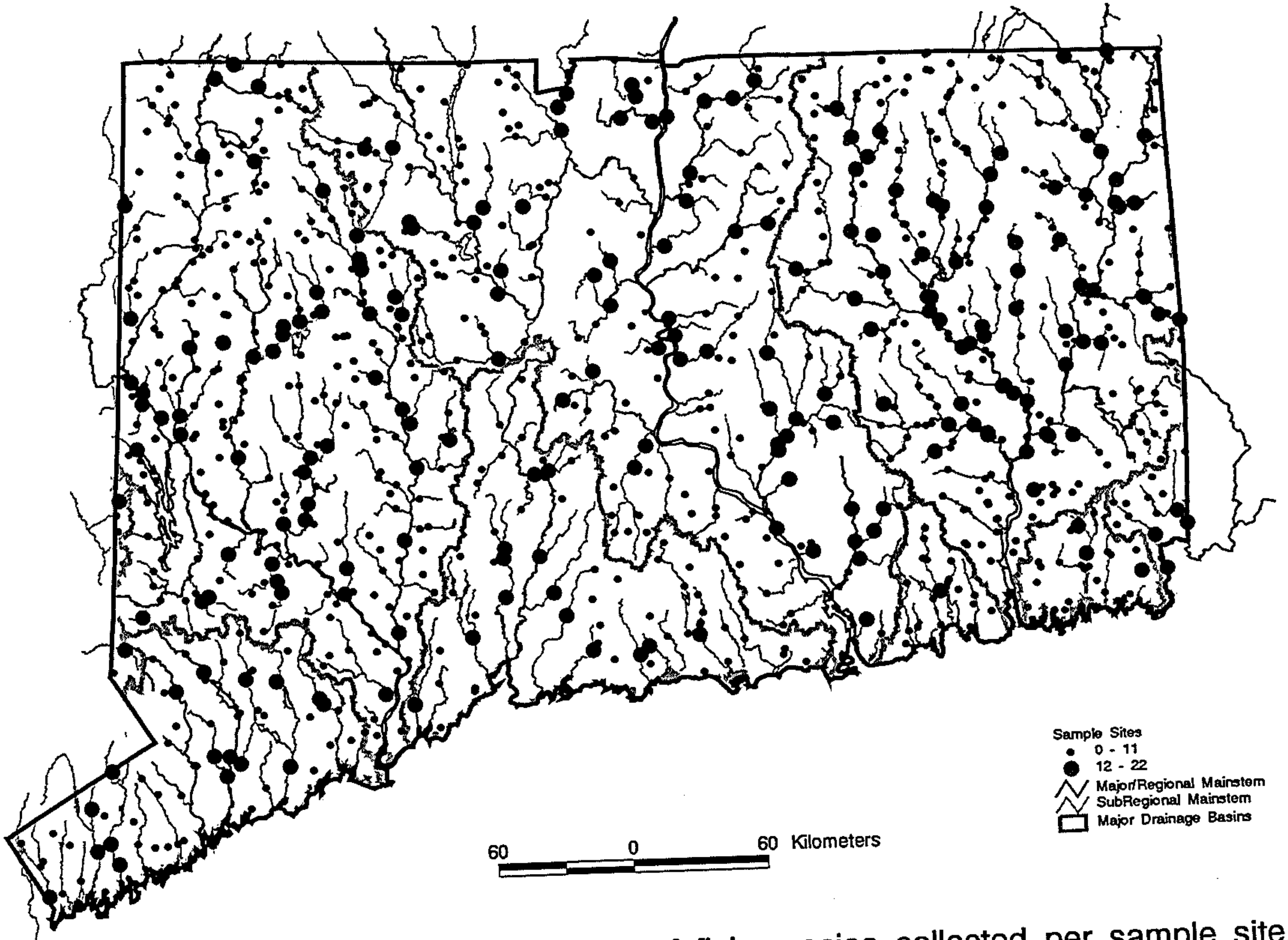


Figure 22. A distribution of number of fish species collected per sample site.

number and composition of species that could be expected in a stream (species diversity). The highest numbers of species are usually found in larger streams, and species diversity decreases toward the headwaters (Figure 22). Correlation and regression investigations of fish species diversity and physical stream parameters followed the same general approach used for investigation of trout population parameters. Lyons et al., 1996, suggested that cold water species complexes (summer high temperatures below 22°C) are healthiest at low diversity and warm water assembledges (over 24°C) are healthiest at high diversity. To accommodate this theory, regression analysis of species abundance was conducted on all streams to see if different relationships were apparent in cold (below 22°C), cool (22-24°C), and warm (over 24°C) streams.

These efforts produced a predictive model for all streams (Figure 23). The best predictor of species number in a stream was stream width. As seen in Figure 23, there is considerable variability around the line. No additional improvement in predictability could be obtained from the inclusion of any other parameter or interaction term. A third order polynomial relationship using only width produced the best predictive equation (Equation 16).

$$\text{Species count} = -0.01899 + 2.1305(\text{width}) - 0.0998(\text{width})^2 + 0.00154(\text{width})^3 \qquad r^2 = 42.2\% \qquad (16)$$

Repeating this analysis on the different temperature groups produced similar relationships and regression coefficients that were not significantly different and offered no better predictability. Analysis using only "stream" species, without "transitory" pond species, produced similar results and a slight improvement in predictability (Equation 17). Plots of this data produced graphs similar to Figure 23, but leveled off at a species count of 11 rather than 15 as in Figure 23.

$$\text{Species count} = 1.04 + 1.07(\text{width}) - 0.034(\text{width})^2 + 0.000277(\text{width})^3 \qquad r^2 = 50.8\% \qquad (17)$$

If the IBI assumptions of species diversity are correct for Connecticut, it can be assumed that a number of coldwater and/or warmwater streams have been negatively impacted because both had similar regression relationships. A combination of factors may have contributed to obscure differences between stream types. Impacted coldwater streams would have a greater number of species resulting in a regression line which is higher on the graph than expected; whereas, impacted warmwater streams would have fewer species resulting in a regression line which is lower than expected. Additional evaluation is needed to set species count criteria for evaluating impact to diversity in Connecticut streams.

An alternative approach is being examined using a carrying capacity function, which is simpler and more intuitively logical, but model development is incomplete at this time.

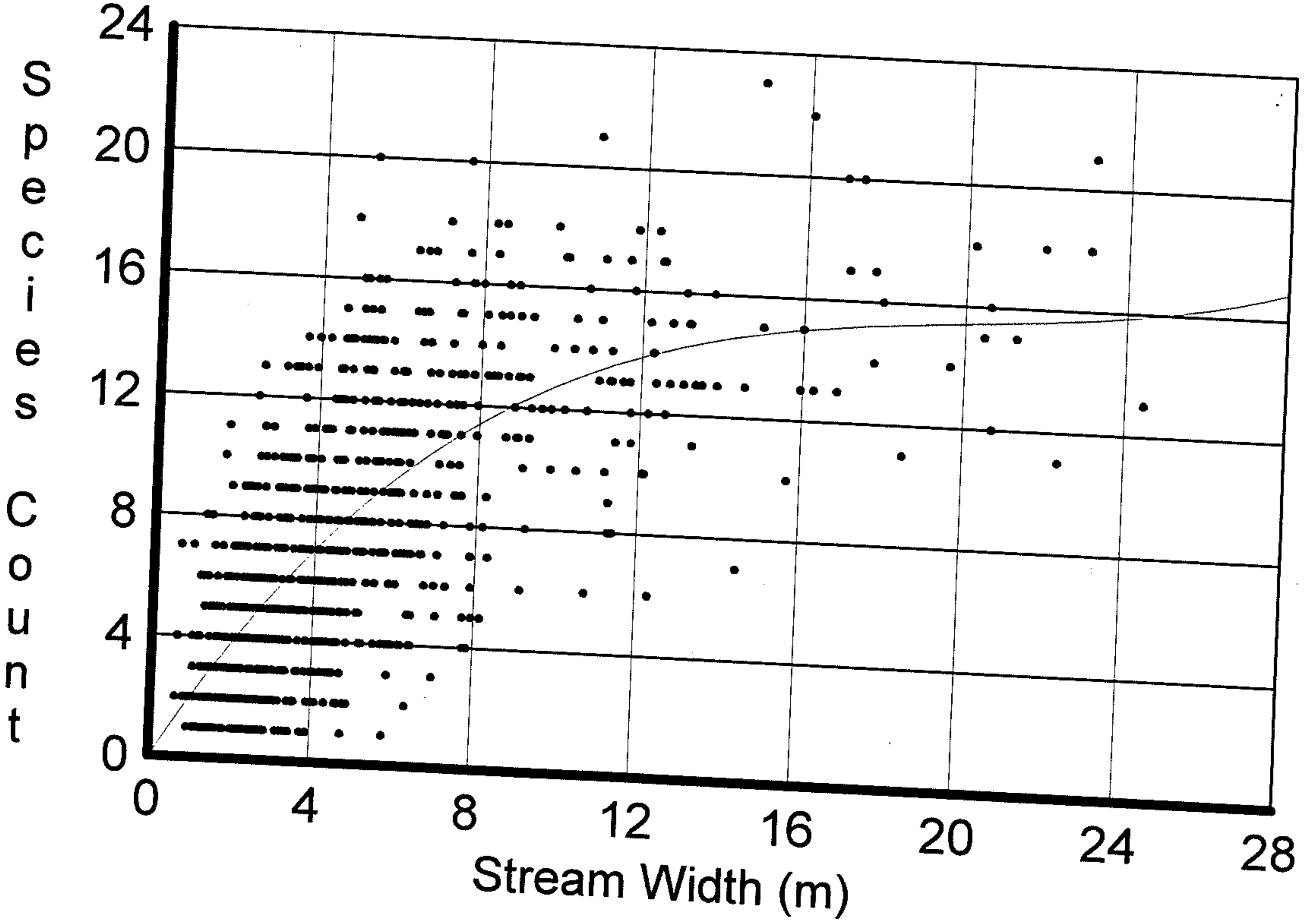


Figure 23.--Number of fish species versus stream width in Connecticut streams sampled 1988-1994.

4.0 Angler Survey Results:

Angler surveys were conducted at 85 sites on 53 streams (Figure 24). A total of 23,189 anglers were counted, of which 4,643 (20.0%) were interviewed. Prior to analysis, the sites were divided into different categories based on the type of regulation in effect, stocking history, or time period sampled. With the exception of yearling streams, which received yearling brook trout, all streams that were stocked received a mixture of brook trout, brown trout, and rainbow trout (230-305 mm).

4.1 Types of Stream Surveyed:

Nonstocked streams are not stocked by the DEP. They are subject to a spring closure from March 1 until the third Saturday of April. There is a daily limit of five trout and all legal methods of take are allowed. The Bulls Bridge area of the Housatonic River was initially included in this set, but does not match the profile, being a nonstocked section of a large river that is stocked upstream. It will be discussed separately.

Adult streams are stocked by the DEP with 9-12 inch adult size trout. These streams have a spring closure from March 1 until the third Saturday of April. There is a daily limit of five trout and all legal methods of take are allowed. Streams with stocked juvenile Atlantic salmon had nine inch minimum size limits.

Yearling streams are stocked with 6-9 inch yearling size brook trout. These streams have a spring closure from March 1 until the third Saturday of April. There is a daily limit of five trout and all legal methods of take are allowed.

Fly-Fishing-Only (FFO) areas are streams stocked by the DEP with adult size trout which have a daily limit of five trout, but have a fly-fishing-only gear restriction. These streams have a spring closure from March 1 until the third Saturday of April.

Trout Management Areas (TMA) are stream sections that are managed under catch-and-release regulations for all or part of the year. All five TMA streams sampled during this study are catch-and-release only from March 1 until the third Saturday of

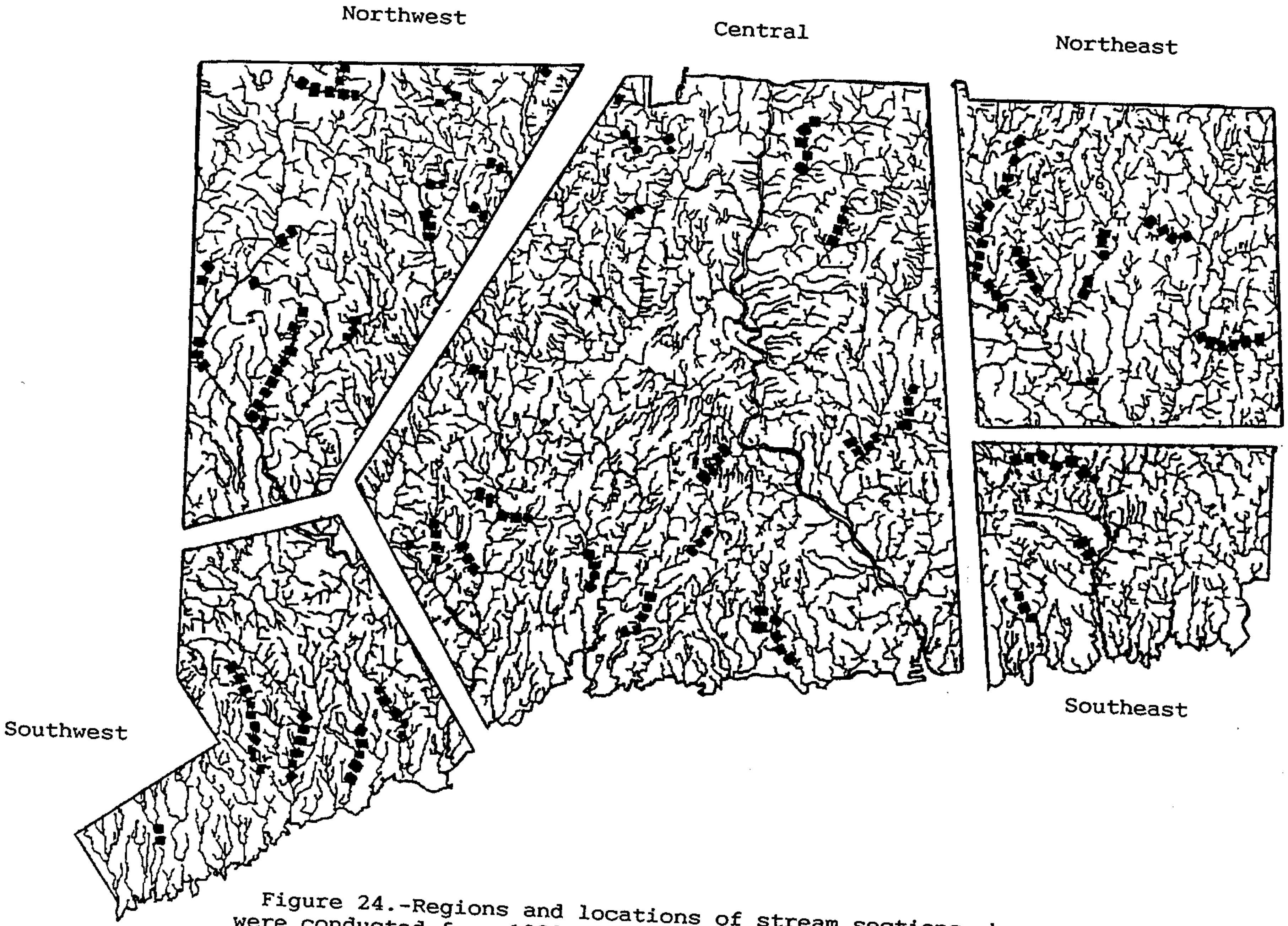


Figure 24.-Regions and locations of stream sections where angler surveys were conducted from 1988-1994.

April, and three TMA streams sampled had nine inch minimum size limits and variable creel limits of 0-5 trout per day for the remainder of the year. Streams that go to a five fish limit on the third Saturday of April were treated as adult streams if creeled after that date. In addition to the sample design previously described in the methods section (see page 20), TMA's were also sampled during the preseason (conducted March 1 through the third Saturday of April) and fall (after Labor Day through October 31). Analyses were also done separately based on additional gear restrictions in some of the TMA's. Three of the TMAs are fly-fishing-only (TMA-FFO) and four are open to all legal gear types (TMA-ALT).

No economic data were collected on fall angler surveys other than distance traveled and variable costs. To calculate economic expansions for the fall fishery it was assumed that fixed costs were similar to costs in the early spring. Due to the limited number of samples, all TMAs and FFO areas were combined for the final portion of the economic analysis.

4.2 Angler Effort:

The level of angler effort varied widely between streams surveyed and between types of streams (Table 27). Angler effort values ranged from an undetectable level in most nonstocked streams (lowest measurable value 8 hours/km) to a high of 7,576 hours/km in the Salmon River fly-fishing-only area during the period of opening day through June 15. Springtime angler effort is highly variable within stream types, ranging from 100 to 6,522 angler hours/km on adult stocked streams and from 378 to 7,576 angler hours/km on FFO areas.

The fact that effort was undetectable in most of the nonstocked streams does not mean there was no effort. Nonstocked stream sites chosen for surveys generally had wild trout and some evidence of angling activity (discarded bait containers, etc.). Between 1% to 7% of all possible sample blocks were surveyed on most nonstocked streams during these creels. If one sample block had contained an angler when sampling at the 1% level, a

Table 27-Average and standard deviations for selected creel statistics for 53 Connecticut streams creeled from Opening day through June 15, 1988 through 1994.

Averages of:	Adult	Fly-Fishing Only Areas	TMA-ALT[1]	TMA-FFO[2]	Yearling Stocked	Non-Stocked
Number of Streams	38	5	2	2	11	5
Kilometers of Stream Stocked	9.5±1.2	1.7±0.9	2.8±1.5	2.6±2.2	2.5±0.4	-----
Total Effort per Kilometer	1,283±270	2,613±3,027	824±591	876±183	152±36	-----
Total Catch per Kilometer	1,101±240	1,766±2,269	1,084±976	1,097±413	199±64	-----
Trout Catch per Unit Effort	0.742±0.057	0.700±0.312	1.313±0.082	1.225±0.590	1.095±0.255	-----
Percentage of Stocked Adult Trout Caught by Anglers	96.9±11.3	82.5±28.8	358.0±139.0	268.7±11.6	47.8±10.5	-----
Percentage of Anglers Practicing Catch and Release Fishing	28.6±2.8	65.0±34.3	83.0±24.0	99.5±0.4	36.6±8.6	-----
Percentage of Trout Catch Released	29.2±2.9	67.3±17.9	88.5±16.2	97.7±3.2	47.4±8.5	-----
Hours Effort per Trout Stocked	1.677±0.229	1.455±0.632	1.370±0.776	3.040±0.671	0.533±0.122	-----

[1] Trout Management Area-All Legal Techniques
[2] Trout Management-Fly-Fishing-Only

Table 28.-Averages and standard deviations for selected for creel statistics from streams surveyed during the preseason, March 1 through opening day, and fall creels, Sept 1- Oct 15.

Averages of:	Fall Creels	Preseason TMA	Preseason TMA-FFO
Number of Streams	6	6	4
Total Effort per Kilometer	578±224	737±356	231±66
Total Catch per Kilometer	361±108	680±430	27±17
Trout Catch per Unit Effort	0.891±0.225	0.594±0.247	0.483±0.060
Percentage of Stocked Trout Caught by Anglers	113.2±31.0	125.6±54.9	94.0±2.9
Percentage of Anglers Practicing Catch and Release Fishing	100.0±0.0	100.0±0.0	100.0±0.0
Percentage of Trout Catch Released	75.0±12.5	100.0±0.0	100.0±0.0
Hours Effort per Trout Stocked	0.633±0.235	1.254±0.370	0.776±0.166

calculation of angler effort would have generated an estimate of approximately 120 hours. With 7% of possible sample units used, the expanded effort from a single angler drops down to about 14 hours. It seems reasonable to assume that since we could easily miss one hour of angler effort on a nonstocked stream with wild trout, that a minimum angler effort estimate would be greater than 14 hours/km.

When angler effort/km was averaged for each stream type, there were large differences seen during the spring creel period. The highest angler effort was in FFO areas (2,613 hours/km) (Table 27), where the inclusion of the Salmon River FFO area greatly increased the average. Without this area the average effort/km for FFO drops to 1,374 hours/km, close to the average of adult streams. The average effort on yearling streams (151.8 angler hours/km) was almost an order of magnitude lower than the average of adult streams. Given the much smaller size and lower stocking densities of trout in these yearling streams, a lower level of angler effort was expected.

The Housatonic River at Bulls Bridge, while not stocked with trout by the DEP, has considerable spring angler effort (377 hours/km), directed primarily at trout (51%). Anglers targeting both trout and smallmouth bass made up 27% of the anglers. No other streams had any significant amounts of angler effort directed at non-trout species, however summer creels may have shown effort for non-trout species on some streams (i.e. Willimantic River).

The average spring angler effort (opening day through June 15) of TMAs was lower than on adult or FFO streams. However, if the early spring fishing is included then the total angler effort of TMAs is comparable to the Adult streams. Furthermore, data from Connecticut's two largest TMAs (Farmington River TMA and Housatonic River TMA) were not included in this comparison because slightly different sample designs were used in previous studies. Inclusion of data from these areas would greatly increase the average effort values for TMAs. Still, these studies have clearly demonstrated seasonal differences in angler activity on TMAs vs waters managed under statewide regulations (Orciari and Phillips 1985, Hyatt 1986). TMAs attract anglers year-round whereas fishing pressure in trout waters managed under statewide regulations drops off precipitously after mid-June. It appears that most Connecticut trout anglers prefer to fish waters where harvest is allowed so long as regular stocking is underway, but that they either stop trout fishing or fish in TMAs once stocking ends. From the standpoint of springtime angler utilization, the TMAs and Adult streams are equivalent but offer different experiences.

The TMAs are heavily used by both fly fishing and non-fly fishing anglers prior to the traditional Opening Day. Fly anglers accounted for 65% of the preseason effort on all areas sampled (TMA-ALT and TMA-FFO). Usage of TMA-ALT during the preseason was greatest by fly anglers (57%) (lure anglers, 37%; and bait anglers, 5.7%). Angler effort in the preseason was greater on the TMA-ALTs (8,451 hrs) than on TMA-FFO by 78% (1,878 hrs). This difference may be partly because early spring effort is dependent on temperature and weather conditions (Hagstrom, 1994) and the two most heavily used TMA-ALT areas are located along the coast where early spring conditions are more moderate (Hammonasset River and Mianus River). Furthermore, the popular TMA-FFO at Salmon River was closed in April during years covered by this study. Overall, early spring fishing accounted for 17.8% of the total usage of areas open in the early spring and 2.7% of the total effort measured from all streams.

Fall effort was measured only on the Hammonasset River TMA, Moosup River TMA, Salmon River TMA and Salmon River non-TMA sections (Table 28). Usage was high (578 angler hours/km) both on TMAs and in the one non-TMA area sampled. It was apparent that trout fishermen will utilize the streams at times other than spring if they believe there is a good chance of catching trout.

The gear type most commonly used changed with stream type. The dominant gear type for adult stocked streams was bait. As one would expect, fly fishermen dominate the angler effort in all TMA-FFO and FFO areas (Figure 25). A small percentage of anglers (>5%) in FFO areas were seen who were using illegal gear types. Most claimed to be unaware of the regulation or were confused as to the portion of stream they were fishing. Yearling streams are used primarily by bait anglers.

The National Survey of Fishing, Hunting and Wildlife Associated Recreation conducted in 1991 (USFWS 1991) estimated that approximately 5% of stream fishing in Connecticut was by nonresidents. Only 2.9% of the anglers interviewed were nonresidents. The density of nonresident anglers was higher in the TMA-FFO areas (6.4%, Table 29). Nonresident use of the Housatonic River at Bulls Bridge was the highest encountered: 33% of the 54 anglers interviewed were from New York, with 6 anglers targeting smallmouth bass or species other than trout. The high percentage of nonresidents in this area is most likely due to the close proximity to the New York State border.

We used our data to develop an equation to predict angler effort during the spring. A linear regression of trout stocked/km and angler effort/km had the best overall predictability (Figure 26, eq. 18). This is similar to the results of other studies of put-and-take trout fisheries (Bulter and Borgenson 1965).

Table 29.-Percentage of resident and nonresident anglers surveyed on Connecticut streams, categorized by stream type. N = number of interviews.

Stream Type	Resident N	Resident Percentage	Nonresident N	Nonresident Percentage	Total N
Adult	2,980	97.3	82	2.7	3,062
TMA-ALT	355	96.7	12	3.3	367
TMA-FFO	162	93.6	11	6.4	173
Fly-Fishing-Only	245	99.2	2	0.8	247
Preseason TMA	187	98.9	2	1.1	189
Yearling	269	100.0	0	---	269
Housatonic River (Nonstocked)	36	66.7	18	33.3	54
Totals:	4,234	97.1	127	2.9	4,361

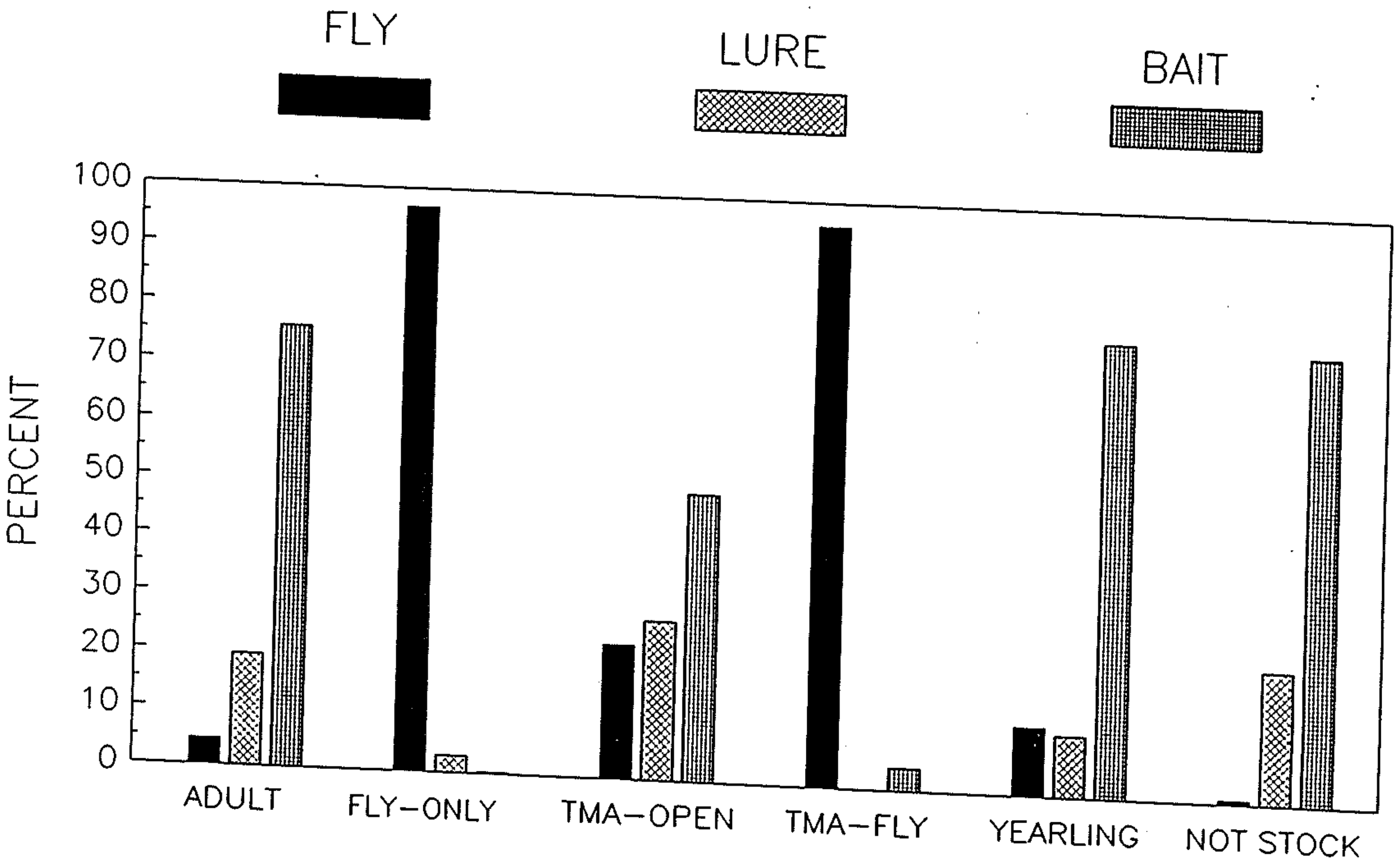


Figure 25.–The percentage of each gear type used by anglers on different types of Connecticut streams.

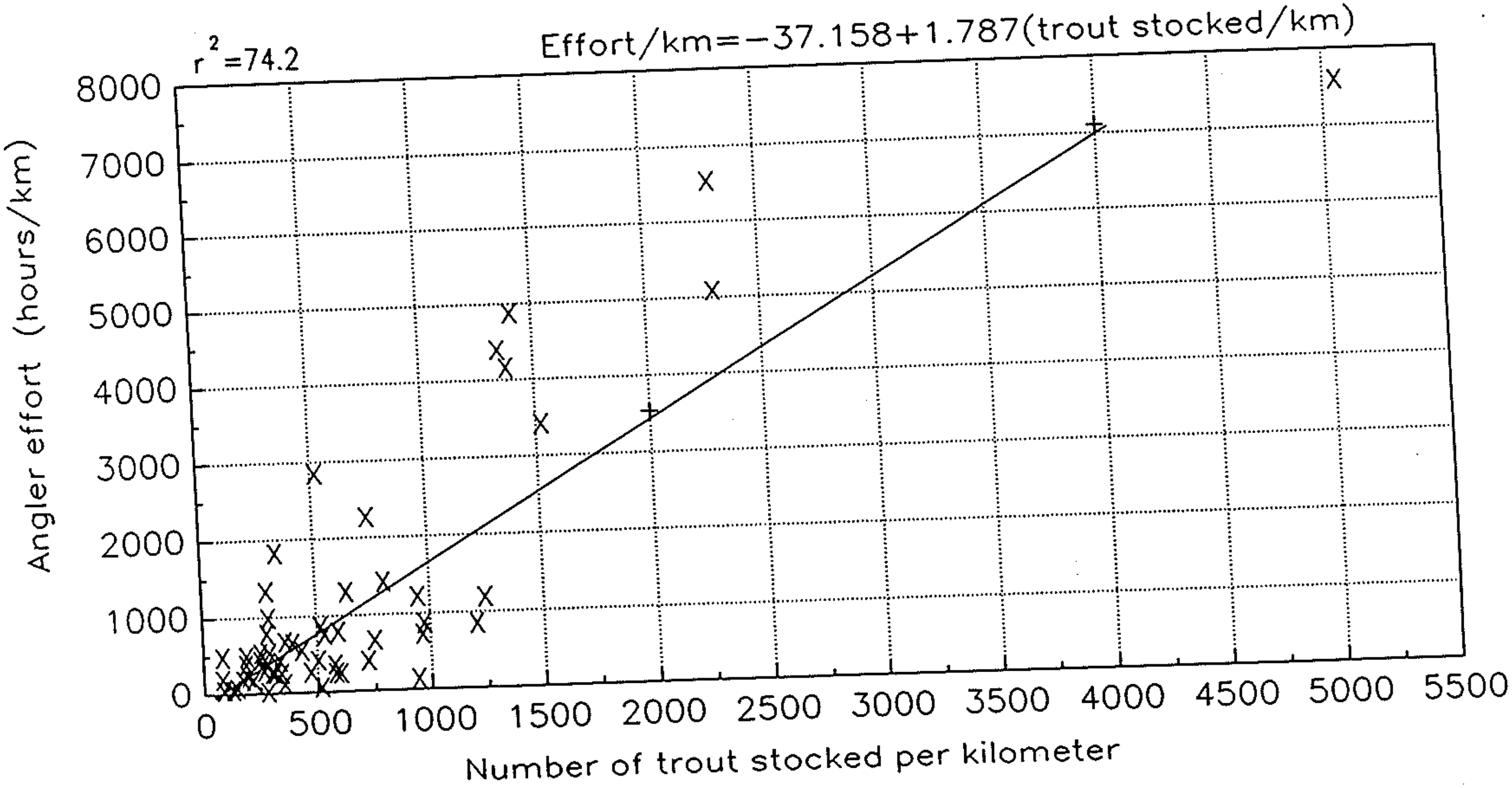


Figure 26.–Angler effort in hours per kilometer vs. number of trout stocked per kilometer in Connecticut streams creeled from 1988–1994.

$$\text{Angler effort/km} = -185.5+1.683(\text{Trout stocked/km}) \qquad (18)$$

$$r^2 = 0.74 \quad n=55$$

For New York streams, Zielinski et al. (1991) found a good correlation between angler hours/acre and town population density, percentage of stream with parallel roads, stream width and percentage of the stream with public fishing rights. He found little predictive value in the total number of trout stocked ($r^2 = 0.213$). However, using our data, stream width and distance to the nearest large town (pop. 50,000 or greater) did not produce a regression with as close a fit as eq. 18.

Number of trout stocked/km and angler effort/km were even more closely correlated in TMA and FFO areas (eq 19, $r^2 = 0.859$, n=12).

$$\text{Angler effort/km} = -406.8 + 1.539(\text{Trout stocked/km}) \qquad (19)$$

A logistic curve model that assumed maximum angler usage would not exceed 10,000 hours/km also had good predictability, for all stream types:

$$\text{Angler Effort} = \frac{10{,}000 \text{ hours}}{(1-0.0000789e^{(-0.000000018*\text{trout stocked/km})})}$$

$$r^2 = 0.842 \quad n = 55 \qquad (20)$$

We estimated that approximately 937,000 total angler hours are spent fishing on state stocked trout streams during the spring (March until mid-June). This estimate was calculated using Equation 18 and information on stocking densities for Connecticut streams.

Engstrom-Heg (1990), in his CROTS system, had proposed use of expansion values of 1.18 (pattern 2-little late season fishing) and 1.33 (pattern 1-fishing well into summer) for expanding spring effort data. For the one area for which we have good summer and fall effort data (Moosup River TMA, a pattern 1 area), the effort was equal to about 29% of the spring effort. This agrees well with Engstrom-Heg's expansion value. Using this information it would be reasonable to expand the previous angler hours estimate to 1,208,730 hours through the fall.

Estimates of average completed trip lengths varied from 3.1 to 4.2 hours for studies on TMAs and large rivers; Oricari and Phillips (1985), Barry (1986), and Hyatt (1994). More realistic estimates of average completed trip time would probably be closer to 2 hours/trip for smaller streams. An estimate of the total number of fishing trips on state stocked streams was calculated using this range of estimates of completed trip lengths (2-4.2 hours/trip). Based on this range of trip lengths, the total number of fishing trips on state stocked streams each year is between 287,793 and 604,365 trips.

State stocked streams account for a significant portion of angler trips on streams in Connecticut. USFWS's National Survey of Hunting and Fishing (1991) estimated a total of 1.16 million angler trips to fish Connecticut's river and streams. Angler trips to stocked streams annually account for up to approximately 52% of all stream angling trips. The balance of the trips not accounted for can be attributed to the following sources: summer non-trout fishing trips on stocked streams (not determined by this study), fishing trips for wild trout on nonstocked streams, fishing on private water without public access, and any fishing on rivers and streams for non-trout species on nonstocked streams. This last group would include: shad, herring, catfish, striped bass and bass fishing primarily on larger rivers, such as the Housatonic River, Thames River, and Connecticut River.

4.3 Catch:

The overall catch of the three trout species was proportional to their level of stocking. Brown trout dominated the catch (Table 27), and generally made up 60% of the trout caught. Total catch is a function of stocking levels and the percentage of catch-and-release fishing. Higher release rates usually result in higher catch. TMA-FFO areas, which averaged a 97% release rate for trout, had catches of 4,239 trout/km, but had an average stocking density of only 577 trout/km.

Wild trout were identified in the creel using marked stocked fish at three stream locations, and later based on fish appearance at four sites (Hagstrom et al. 1991, 1994). At three sites wild populations were evaluated before and after the spring fishing season; at the remaining four sites populations were evaluated after the spring season. Wild trout accounted for a small percentage of the catch on stocked streams (average 5.5%), with the exception of Merrick Brook (37.5%) which receives few stocked fish. The impact of fishing pressure on the wild trout population was substantial, with up to 66% of the harvestable size wild trout being taken during the spring (average 40.6%, Table 30). The impacts of this level of fishing mortality on the age and size distribution of a wild trout population are unclear because many of the lightly fished wild trout populations which were sampled had high mortality rates. Mortality rates between age 1 and age 2 averaged 66% annually for brown trout and 80% annually for brook trout. Engstrom-Heg (1990) cites an average annual natural mortality rate for older age wild brown trout of 32% in his CROTS stocking guidelines. Alexander (1991) presents mortality rates ranging from 50-80% for wild brown trout with approximately 30% being attributable to anglers. This leaves a 20% to 50% natural mortality rate. Still, many studies have indicated that exploitation rates of 30-40% are sufficient to affect fishing quality and population structure for wild brown trout by reducing age 3 fish in the population (Avery and Hunt 1981, and McFadden 1961). Since wild age 3 trout were infrequently encountered in stocked streams it is reasonable to assume that fishing is having an effect on population structure in some of these waters (i.e. those capable of supporting larger trout).

Table 30.-The percentage of wild trout in the creel and the percentage of the estimated wild trout population harvested from selected Connecticut streams surveyed in 1991 and 1994.

Stream Name	Percentage of Spring Trout Catch attributed to Wild Trout.	Percentage of Wild Trout Harvested in the Spring
Fenton River	3.9	31.9
Furnace Brook	4.7	40.0
Kent Falls Brook	6.4	66.0
Macedonia Brook	9.5	41.0
Mashamoquet Brook	4.2	39.8
Merrick Brook	37.5	42.5
Roaring Brook	4.5	23.1
Average	10.1	40.6

Of all the streams sampled only the portion of the Housatonic River at Bulls Bridge had a significant smallmouth bass catch in the spring period. Over 75% of the fish caught in this area were smallmouth bass, however this section of stream is not stocked so this percentage is not comparable to stocked streams. Smallmouth bass were also caught on the two sections of the Yantic River that were sampled, but these fish made up only 8-18% of the catch. In other creeled streams where smallmouth bass were present (Natchaug River, Salmon River, and Willimantic River), they were not observed or reported in the creel. However, it is likely that later in the summer they would have appeared in the catch.

4.4 Catch per Unit of Effort:

Catch per unit of effort (CPUE) (Table 27) is an index of fishing quality. Springtime catch rates from areas with a five trout creel limit average 0.78 trout/hour. Yearling streams averaged 1.09 trout/hour, but had lower levels of effort for the numbers of fish stocked. This resulted in more fish available per angler and better catch rates. Catch rates for TMA's were also over 1.0 (TMA-ALT, 1.31 trout/hour and TMA-FFO 1.23 trout/hour) presumably because of the high occurrence of catch and release fishing.

Early spring (March 1 to opening day) CPUEs ranged from 0.0 to a high value of 1.66 trout/hour for TMAs. CPUE values for TMA-ALT and TMA-FFO areas were not significantly different. The early spring TMA-ALT areas were closer to average spring adult stream values (averaging 0.594 trout/hour), but were still lower than spring TMA values. Two years of data were collected on the Moosup River TMA and Salmon River TMA for the early spring season because high flows and ice jams produced unusually low effort levels during the first year (1993). The CPUE during 1993 was near zero trout/hour (highest values 0.05 trout/hour). The two TMA's located close to the moderating influence of Long Island Sound (Mianus River and Hammonasset River) had high CPUEs and effort levels (see page 85) in the early spring, but the highest CPUE (1.66 trout/hour, Willimantic River TMA) was seen in a river with ice cover, high flows, and only low fishing pressure for the first two weeks of the early spring. It appears that cold and flows affect angler effort more than trout catchability.

Fall trout CPUE values for all stream types averaged 0.89 trout/hour. It was only possible to survey six sites in the fall, five of which were in TMAs that were under catch and release regulations. All the TMA sections had CPUE values that were 23-47% lower than in the spring. The CPUE on the one stream section with harvest permitted, a portion of the Salmon River outside the TMA, was at a low to moderate level (0.405

trout/hour, spring average 0.996 trout/hour). Overall, fall fishing provided an additional angling opportunity with a moderate to good level of success.

Catch rates of smallmouth bass were 0.9 fish/hour at the Bulls Bridge section of the Housatonic River. The CPUE rates were not as high as reported by Barry et al., 1986 (1.79 fish/hour) for this section of the Housatonic River during a comparable time period. Catch rate on the Yantic River were low at 0.04-0.08 fish/hour.

4.5 Catch-and-Release:

The percentage of anglers releasing trout was highest in catch-and-release areas (94%) and lowest in adult areas (29.7%, Table 27). A small percentage of anglers were encountered who claimed to be either unaware of the catch-and-release regulation or were confused as to which portion of stream they were fishing. In areas where harvest was allowed, an average of 68.3% of fly anglers released at least some of their fish. A smaller percentage of other angler types practiced catch-and-release fishing (Lure-37.6%, Bait-25.7%).

4.6 Return to the Angler:

The objective of most trout stocking programs is to produce a high rate of return on stocked trout to the angler (Butler and Borgenson 1965). The highest return was from trout stocked in the TMAs, where trout stocked in the early spring were caught an average of 3 or more times each during the early spring and spring trout season (Mianus River TMA-303%, Willimantic River TMA-455%, Hammonasset River TMA-357%, and Moosup River TMA-260%). If the high return rates of the TMAs were not factored in, then on average, anglers captured 81% of the trout that were stocked (Table 27 and Appendix C). The return rate was lowest on yearling brook trout streams where 47% of stocked trout were caught.

The average hours of angling per trout stocked is a good indication of the cost effectiveness of stocking an area. Values for Connecticut streams were 1.56 hours/trout in adult streams, 2.01 hours/trout in FFO streams, 2.84 hours/trout for TMAs, and 0.47 hours/trout in yearling streams.

4.7 Wild Trout Management Area:

In spring 1995, the first wild trout management area (WTMA) was established on the Tankerhoosen River in the Belding Properties (Vernon). Fishing in this area was restricted to catch-and-release using barbless single-hook artificial lures and flies. Prior to the WTMA, this property was under management by a fishing club. Primarily, they utilized a single small impoundment on the stream. Abundant wild brown trout and brook trout were present during population sampling in 1989 and 1993.

The WTMA had fishing effort from March to September 1994 of 177 angler hours/km with a catch of 128 trout/km. CPUE was near the average for Connecticut streams at 0.723 trout/hour. Population samples collected after the first season of fishing showed no noticeable changes in the structure of the wild trout population under this level of angler effort. Utilization of this WTMA was comparable to that of an average yearling stocked stream. More than half of the anglers interviewed had caught at least one fish.

4.8 Trip Satisfaction:

It is useful to have a criterion to judge whether anglers are happy with their angling success that is independent of anecdotal information. Anglers were asked to rate their fishing success by selecting one of six categories: excellent, good, average, poor, terrible and can't tell yet (CTY). We wanted the anglers to rate their **fishing success** rather than the quality of their trip. If anglers responded instead based on the quality of their trip then the trip rating would have been expected to be independent of the level of catch and/or the CPUE of trout. Fortunately a clear, consistent relationship was seen between the success rating and CPUE and catch.

Another concern was that more successful anglers would fish longer and therefore be more likely to be encountered and interviewed. If an avidity bias of this nature had occurred, then the ratings would change with the length of time the angler had fished. Analysis of Covariance showed that ratings (except (Can't tell yet, CTY) were independent of trip length at the time of interview (Table 31). This allowed us to determine the approximate catch rate at which the majority of anglers would be satisfied with the success of their trip (Table 31).

Table 31.-Mean CPUE and number of trout caught for each stream type by trip rating at the time of interview. N = number of interviews.

Stream Type	Trip Rating	CPUE	Number of Trout Caught	N
Adult	Excellent	2.4147	4.13	149
	Good	1.6146	2.19	443
	Average	0.7804	1.26	389
	Poor	0.2655	0.47	543
	Terrible	0.0685	0.14	264
Yearling	Excellent	2.8528	4.33	18
	Good	2.8731	3.13	62
	Average	2.4259	2.06	31
	Poor	0.3279	0.47	36
	Terrible	----	0.00	16
TMA-ALT	Excellent	4.2846	8.38	16
	Good	1.7027	4.16	37
	Average	0.8545	1.86	35
	Poor	0.1939	0.41	22
	Terrible	0.0693	0.15	13
Fly-Fishing-Only	Excellent	1.7117	6.22	9
	Good	1.4559	2.95	44
	Average	0.6826	1.57	51
	Poor	0.1981	0.49	55
	Terrible	0.0469	0.11	18

Three of the four stream types showed approximately the same levels of CPUE for each rating group, except "excellent". For the streams stocked with adult size trout, a general value of 0.77 trout/hour is the level at which 80% of anglers feel they have had at least "average" fishing success. Trips with a CPUE of less than 0.3 trout/hour could be classified as "unsatisfactory" because at this CPUE 70% of the anglers rated their trips terrible or poor. Since these CPUE values correlate well with average angler satisfaction, they should be considered when selecting management objectives for stocked streams.

4.9 Distance Traveled:

The distance traveled by anglers to fish can provide useful data on what areas would benefit from a new stocking. Using Analysis of Variance (ANOVA), differences in the mean distance traveled by anglers were tested between different types of streams and regions.

Yearling streams and adult streams, whose stocked areas were at least partially included in a state park, were used by anglers from a significantly wider distance (Table 32). Statistically significant differences were shown in the distances anglers traveled to fish adult streams between the Northwest and the Southwest regions. Anglers fishing streams in the Northwest region were willing to travel 14 km further on average than anglers fishing streams in the Southwest region. There were no significant differences between any of the other regions. The 90th percentile of cumulative frequency distributions of the distance traveled provided a good indication of the area from which these streams draw anglers (Table 32). Using this data in conjunction with the GIS system, it should be possible to construct coverages that will allow a comparison of angler demand and the availability of trout fishing resources provided by the state.

4.10 Economics:

All creel surveys were conducted between 1988-1994, and all dollar values are presented as 1991 dollar equivalents. Calculations used to place economic values on a per-kilometer basis required the use of a average angler trip length. As discussed earlier exact values are not available. A range of 2.0 to 4.2 hours per trip was used because these values reflect both small stream (2.0 hr/trips) and large stream usage (4.2 hr/trip).

Table 32.-Mean and 90th percentile of distance traveled by anglers to Connecticut streams. Data is subset by variables found significant using Analysis of Variance.

Stream Type	Mean Distance Traveled	90th Percentile of Distance Traveled
Yearling Streams:		
Associated With a State Park	17.6 km	30.0 km
Not Associated With a State Park	7.4 km	9.9 km
TMA and FFO:	20.3 km	38.5 km
Adult Streams:		
Associated With A State Park	20.5 km	36.8 km
Not Associated With a State Park	10.8 km	26.3 km
By Region		
NW	25.9 km*	51.7 km
NE	19.6 km	40.7 km
C	18.8 km	31.2 km
SE	13.4 km	35.5 km
SW	13.0 km*	24.6 km
All Regions	19.4 km	37.6 km

* Significantly different (P « 0.01)

4.10.1 Variable expenditures:

Variable expenditures include money spent for food, bait, tackle, lodging, and travel to and from the fishing site. Anglers spent about $9.32 on variable expenses. The average angler spent $3.85 on travel, 41.3% of the average per trip variable cost. Purchases included bait ($1.42 per trip, 15.1%), food ($1.01 per trip, 10.9%), lures/flies ($0.90 per trip, 9.7%) and $2.13 per trip (22.8%) in other costs. Other costs include combined costs of food, bait, tackle and other items (sunscreen, maps, etc.). This last category reflects data from anglers who could not or would not break down their trip costs.

Analysis of Variance (ANOVA) showed no significant differences in variable expenditures between angler gear types (fly, bait, lure) (Table 33). However, higher mean per trip variable costs were found for fly fishing anglers on TMA and FFO waters (Table 33). ANOVA of mean per trip variable costs by stream type showed significantly higher mean per trip variable costs for TMA and FFO waters, accounting for 45% of the variability in mean per trip variable costs seen between streams.

A Duncan's multiple range test showed significant differences in expenditures between anglers fishing stream in the Northeast region ($9.29) and those fishing in the Southwest region ($6.16), but there was overlap between these two regions and all other regions (Table 34). This reflects the differences seen earlier in the distance anglers traveled to fish streams in different portions of the state. Anglers fishing in the Southwest portion of the state do not generally travel as far and so have a lower travel component in their variable costs.

Variable cost per kilometer of stream ranged from $290.91 to $12,343.83 for the average of different regions and stream types (Table 35). In general, TMAs and FFO areas, had higher average variable costs per kilometer (average $4,023.83) than other stream types ($2,163 for adult stream and $280.09 for yearling streams)

Table 33.-The mean daily variable expenditures per angler from Connecticut streams using all interviews. Averages were determined for three gear types and by stream type.

Stream Type	Fly Anglers	Lure Anglers	Bait Anglers	Total
Adult Stocked 37 streams	$ 6.69	$ 8.51	$ 8.49	$ 8.63
Yearling Stocked 11 streams	$ 7.46	$ 3.60	$ 5.58	$ 6.32
TMAs and FFO 13 streams	$12.44	$ 5.31	$ 5.79	$11.51

Table 34.-The average of mean daily variable cost per angler for each stream calculated for stream type and gear type within each region.

		Region					
Stream Type	Angler Type	NW	SW	C	NE	SE	All
Adult	Bait	$ 9.75	$ 6.25	$ 9.79	$ 6.99	$ 8.42	$ 8.49
	Fly	$ 7.87	$ 4.58	$ 6.36	$ 6.87	$ 7.47	$ 6.63
	Lure	$ 6.02	$ 5.63	$10.29	$ 8.67	$ 8.45	$ 8.51
	All	$ 9.44	$ 5.58	$ 9.71	$ 7.93	$ 8.61	$ 8.63
Yearling	Bait	$ 5.91	NC[1]	$ 5.22	NC[1]	$ 6.44	$ 5.58
	Fly	$ 3.54	NC	$ 5.90	NC	$ 7.08	$ 5.15
	Lure	$ 2.93	NC	$ 3.67	NC	$ 5.86	$ 3.60
	All	$ 7.84	NC	$ 5.57	NC	$ 6.29	$ 6.33
TMAs & FFO	Bait	$ 7.18	$ 8.07	$ 7.55	$ 2.49	$ 9.33	$ 5.79
	Fly	$ 8.98	$ 9.40	$14.04	$13.07	$12.45	$12.44
	Lure	$ 4.05	$ 7.18	$ 8.05	$ 2.87	$ 4.05	$ 5.31
	All	$ 8.93	$ 6.88	$13.24	$15.54	$12.05	$12.49
All Stream Types	All	$ 9.29	$ 6.16	$ 9.46	$11.01	$ 8.89	$ 9.53

[1] No yearling streams creeled in this region.

Table 35.-Mean of total annual variable cost per kilometer calculated for each stream type within a region. A range of values were calculated using both 2.0 hrs and 4.2 hrs as average angler trip length.

		Region					
Stream Type/	Trip length(hr)	NW	SW	C	NE	SE	All
Adult	4.2	$ 812.80	$ 788.75	$ 4,089.78	$ 1,026.32	$1,269.70	$2,163.27
	2.0	$1,706.88	$1,656.38	$ 8,588.54	$ 2,155.27	$2,666.37	$4,542.87
Yearling	4.2	$ 290.91	NC[1]	$ 260.67	NC[1]	$ 358.13	$ 280.09
	2.0	$ 610.91	NC[1]	$ 549.51	NC[1]	$ 752.07	$ 588.19
TMAs & FFO	4.2	$ 803.66	$4,033.68	$12,343.83	$ 2,018.97	$3,443.31	$4,967.04
	2.0	$1,686.30	$8,470.73	$25,922.04	$ 3,949.41	$7,230.95	$8,450.04

[1] No yearling streams creeled in this region.

and streams in the central portion of the state had considerably greater mean total annual variable expenditures on a per-kilometer basis ($3,353) (Table 35) than other regions ($1,207). Total annual variable expenditures per kilometer is a function of the number of individuals who use an area and the length of that stream available for stocking and the average individual variable expenditure. There is a high annual variable expenditure per kilometer in TMAs because though generally not very long, TMA and FFO areas have a much higher individual angler variable expenditure than other stream types and a higher density of angler usage. Similarly streams from the Central region of the state, which have moderate average individual variable costs, are under considerably heavier angler pressure (average angler effort 2,552 hrs/km) than the four other regions of the state (average angler effort 557 hrs/km) and so the Central region has a higher annual variable cost per kilometer (Table 36). This results in high mean total variable expenditure for this region, (Table 35) and is a direct result of the density of anglers located in this region. This trend is repeated in other economic variables.

4.10.2 Fixed expenditures:

Fixed expenditures are the annual mean expenditures for equipment prorated on a per-trip basis (13.6 trips/year, USFWS 1991) over the projected "life" of the item (based on frequency of purchase, USFWS 1991). Mean fixed expenditures per stream were averaged by angler type, region and stream type (Table 37). ANOVA with a Duncan multiple range test showed significantly higher mean fixed cost for fly fishermen and for areas where fly fishing was the most common method used (Table 38). Fixed cost of TMA-FFO and FFO areas were significantly higher than other stream types, and were significantly different from each other, with FFO areas having the higher fixed costs. There were no significant regional differences in fixed costs. The single most important component driving these differences in fixed costs is the high cost of fly fishing rods.

Table 36.-The total kilometers of stocked streams in Connecticut for each stream type, within each region.

	Region					
Stream Type	NW	SW	C	NE	SE	All
Adult	172.7	77.5	230.9	210.4	87.0	778.5
Yearling	36.9	12.2	131.0	48.9	39.6	268.6
TMAs & FFO	19.0	5.8	7.3	7.5	13.0	52.6
All	228.6	95.5	369.2	266.8	139.6	1,099.7

Table 37.-The mean daily fixed expenditures per angler from Connecticut streams using all interviews. Averages were determined for three gear types and by stream type.

Stream Type	Fly Anglers	Lure Anglers	Bait Anglers	Total
Adult Stocked 37 streams	$16.62	$ 6.10	$ 3.77	$ 5.89
Yearling Stocked 11 streams	$11.86	$ 4.09	$ 3.51	$ 6.21
TMAs & FFO 13 streams	$17.29	$ 3.46	$ 2.57	$15.86

Table 38.-The average of mean daily fixed cost per angler for each stream calculated for stream type and gear type within each region.

		Region					
Stream Type	Angler Type	NW	SW	C	NE	SE	All
Adult	Bait	$ 4.09	$ 3.67	$ 3.74	$ 3.77	$ 3.54	$ 3.77
	Fly	$18.63	$18.63	$14.64	$16.94	$18.64	$16.62
	Lure	$ 6.37	$ 6.43	$ 6.05	$ 5.84	$ 6.43	$ 6.10
	All	$ 4.67	$ 5.61	$ 4.78	$ 8.16	$ 5.49	$ 5.89
Yearling	Bait	$ 3.42	NC[1]	$ 3.47	NC[1]	$ 4.05	$ 3.51
	Fly	$13.98	NC	$ 9.32	NC	$18.63	$11.86
	Lure	$ 3.21	NC	$ 4.28	NC	$ 6.43	$ 4.09
	All	$ 5.06	NC	$ 6.71	NC	$ 6.05	$ 6.21
TMAs & FFO	Bait	$ 4.05	$ 1.97	$ 2.31	$ 2.43	$ 4.05	$ 2.57
	Fly	$18.64	$18.77	$18.64	$15.10	$18.53	$17.29
	Lure	$ 6.43	$ 3.21	$ 4.82	$ 1.29	$ 6.43	$ 3.46
	All	$18.43	$13.33	$13.17	$15.97	$17.75	$14.94
All Stream Types	All	$ 6.29*	$ 9.00	$ 8.22	$12.32*	$ 8.70	$ 6.17

[1] No yearling streams creeled in this region.

*Significantly different ($P < 0.05$)

The average total annual fixed cost generated per kilometer of stream varied regionally and by stream type (Table 39). Values of average total fixed cost per kilometer were considerably higher in the Central region for adult streams, a result of higher angler density. The higher average total fixed cost per kilometer on TMA and FFO areas in the Southwest region ($9,448 total fixed cost/km) is probably due to the limited availability of TMA and FFO areas in that region (5.8 km) and high usage by fly anglers.

Table 39.-Mean of total springtime fixed cost per kilometer calculated for each stream type within a region. A range of values were calculated using both 2.0 hrs and 4.2 hrs as average angler trip length.

Stream Type\	Trip Length(Hr)	Region					
		NW	SW	C	NE	SE	All
Adult	4.2	$ 364.83	$ 803.00	$ 2,050.30	$ 992.39	$ 805.49	$ 1,250.45
	2.0	$ 766.14	$ 1,686.30	$ 4,305.63	$2,084.02	$ 1,691.53	$ 2,625.95
Yearling	4.2	$ 226.75	NC[1]	$ 248.16	NC[1]	$ 344.30	$ 251.35
	2.0	$ 476.17	NC[1]	$ 521.14	NC[1]	$ 724.03	$ 527.84
TMAs[2] & FFO	4.2	$1,659.10	$ 9,447.91	$18,598.00	$1,974.45	$ 5,072.83	$ 6,222.64
	2.0	$3,484.11	$19,840.61	$39,055.80	$4,146.34	$10,652.94	$13,067.54

[1] No yearling streams creeled in this region

2. Values do not include Farmington River or Housatonic River TMA's

4.10.3 Net economic impact:

Following Hyatt (1986), net economic impact was calculated by applying an income multiplier (1.5) to the sum of the variable and fixed expenditures. Net economic impact in the spring per kilometer of stocked stream ranged from $141.73/km (Parmalee Brook, a yearling stream) to $82,920/km (Salmon River-FFO area)(Appendix C). The average springtime net economic impact of stocked streams for all stream types was $4,592.65/km of stream (Table 40). TMA and FFO areas had the highest springtime net economic impact ($15,370/km) and yearling streams had the lowest springtime net economic impact ($952/km). All values discussed in the text are based on a 4.2 hour trip time unless otherwise noted.

Table 40.-The average springtime net economic impact per kilometer of Connecticut stream calculated for each stream type within a region. A range of values were calculated using both 2.0 hrs and 4.2 hrs as average angler trip length.

Stream Type	Trip Length(hr)	Region NW	SW	C	NE	SE	All
Adult	4.2	$ 1,766.45	$ 2,388.65	$ 9,210.22	$ 3,028.02	$ 3,112.74	$ 5,120.58
	2.0	$ 3,709.55	$ 5,016.16	$19,341.46	$ 6,358.84	$ 6,536.75	$10,753.22
Yearling	4.2	$ 776.49	NC[1]	$ 764.75	NC[1]	$ 1,053.65	$ 797.16
	2.0	$ 1,630.63	NC[1]	$ 1,605.98	NC[1]	$ 2,212.67	$ 1,674.04
TMAs & FFO	4.2	$ 3,694.14	$20,222.38	$46,413.63	$ 6,258.32	$12,774.21	$14,888.35
	2.0	$ 7,757.67	$42,466.98	$97,468.63	$12,143.63	$26,825.84	$32,276.37
All	4.2	$ 1,532.39	$10,233.67	$ 9,825.62	$ 3,565.28	$ 5,013.36	$ 6,534.70
	2.0	$ 3,218.02	$21,490.71	$20,633.02	$ 7,487.09	$10,280.56	$13,722.87

[1] No yearling streams creeled in this region.

The average expenditure per angler trip (variable plus fixed expenditures) for all streams creeled during this study was $18.26. This results in an average net economic impact of $27.39 ($18.26 * 1.5) for each angler-day of stream trout fishing in Connecticut. The highest mean total expenditure per angler-day was on the Willimantic River TMA during the early spring period ($44.62/angler-day). The highest mean total expenditure per angler-day value during the spring period was again on the Willimantic River TMA ($35.68/angler-day). The lowest mean total expenditure per angler-day was on Beacon Hill Brook, a yearling stream ($8.96/angler-day). Data from Hyatt (1986) indicate an expenditure of $9.18/angler-day (1984 dollars) for Farmington

River anglers. Barry's (1986) data yields an average expenditure per angler-day of $33.66 for the TMA portion of the Housatonic River, calculated from data for the entire year. The value from Hyatt (1986) does not pertain to any FFO or TMA waters.

4.10.4 Consumer surplus:

Consumer surplus was measured using the contingent value method (Walsh, 1986). A question was asked that measured how much greater an angler's expenses would have to be before he would decline to participate. Consumer surplus is a measure of the value of a resource above what has already been paid (fixed and variable expenditures). For all calculations we used the median rather then means to minimize the effects of outliers (extremely high bids). Only those median bids (Table 41) from a sample size of 25 interviews or greater were used. Otherwise, the median bid value for the next most similar resource/angler type were used. The bid responses showed considerable numerical bias, and all three angler types and all stream types had the same median bid of $20.00. These bid values are consistent with values from Barry (1986) for wadable areas of the Housatonic River, but were more than were determined for the Farmington River (median approximately $10.00, 1984 dollars) (Hyatt, 1986).

Since all median bids were the same, the total annual consumer surplus directly reflects the amount of angler usage. The highest total consumer surplus was seen on an adult stream, the Mill River, Hamden ($120,141/year) for the entire stocked section of stream. This stream is a heavily used adult stream close to an urban center, New Haven. The highest total consumer surplus for TMA and FFO areas was $51,211/year from the Salmon River TMA-FFO, and for a yearling stream, $4,286/year from Branch Brook.

Table 41.-Median contingent value bids from all anglers interviewed during the 1988-1994 creels on Connecticut streams calculated for each stream type and gear type. Number of interviews in parentheses.

Question format: How much greater do you think your total expenses for today's trip would have to become before you would probably have decided not to have gone fishing today?

Stream Type	All Angler Types	Fly Anglers	Lure Anglers	Bait Anglers
Adult	$ 20.00 (463)	$ 20.00 (34)	$ 20.00 (67)	$ 20.00 (362)
TMA-ALT	$ 20.00 (47)	$ 25.00 (15)	$ 20.00 (6)	$ 20.00 (26)
TMA-FFO	$ 25.00 (10)	$ 25.00 (10)	---- ---	---- ---
Fly-Fishing-Only	$ 20.00 (37)	$ 20.00 (36)	---- ---	$ 15.00 (1)
Preseason	$ 20.00 (14)	$ 20.00 (8)	$ 10.00 (6)	---- ---
Yearling	$ 20.00 (34)	$ 30.00 (1)	$ 20.00 (3)	$ 20.00 (30)
Nonstocked	$ 10.00 (16)	---- ---	$ 10.00 (8)	$ 15.00 (8)
TMAs & FFO	$ 20.00 (94)	$ 25.00 (63)	$ 20.00 (7)	$ 20.00 (27)
All Stream Types	$ 20.00 (621)	$ 20.00 (104)	$ 20.00 (90)	$ 20.00 (427)

All values are reported. For the purpose of calculating the total contingent value of a stream, only subtotals with greater than 25 observations were used.

There were considerable differences in the average per-kilometer consumer surplus between regions and stream types (Table 42). These are primarily reflections of differences in the density of angler usage since there was no difference in the median of individual bids. TMA and FFO areas had an average springtime consumer surplus of $8,661.70/km. This is 91% higher than the average for adult stocked streams. Yearling streams had the lowest springtime consumer surplus, averaging $861.22/km.

4.10.5 Compensatory value:

Compensatory value questions are designed to determine the dollar value that would be needed to compensate anglers for any reduction or loss in public angling opportunity. The total compensatory value represents the aggregate of the minimum dollar amount anglers would be willing to voluntarily receive to accept

Table 42.-The average springtime contingent value per kilometer of Connecticut stream calculated for each stream type and within each region. A range of values were calculated using both 2.0 hrs and 4.2 hrs as average angler trip length.

Stream Type\	Trip Length(hr)	Region					
		NW	SW	C	NE	SE	All
Adult	4.2	$ 1,568.78	$ 2,776.40	$ 8,010.39	$ 2,594.40	$ 2,930.74	$ 4,540.10
	2.0	$ 3,294.44	$ 5,830.44	$16,821.82	$ 5,448.22	$ 6,154.55	$ 9,534.21
Yearling	4.2	$ 772.97	NC	$ 890.97	NC	$ 947.46	$ 861.22
	2.0	$ 1,623.24	NC	$ 1,871.04	NC	$ 1,989.67	$ 1,808.56
TMAs & FFO	4.2	$ 1,773.00	$13,031.25	$26,765.40	$ 2,809.97	$ 5,714.00	$ 8,661.70
	2.0	$ 3,723.30	$27,365.63	$56,207.34	$ 5,900.94	$11,999.40	$18,189.57

[1] No yearling streams creeled in this region.

a loss rather than the sum they would be willing to pay (contingent value) (Meyer 1980a and Meyer 1980b). The responses to these two questions were used to investigate the value of fishing in general and the value of fishing a particular stream.

The median bids for the compensatory questions were listed by stream type and angler type in Tables 43 and 44. The limited number of samples did not permit calculation of median bids for separate regions. The means of all combinations of stream type and angler type are reported, but only values based on sample sizes of 25 interviews or more were used for expanded estimates. The bid value from the next most similar resource/angler type were used to replace those cells with inadequate sample sizes. The bid values for fishing varied by angler type and by river type (Table 43). Fly fishing anglers and anglers fishing TMA and FFO areas had the highest median bid values (median bid $100.00) for the loss of fishing. The median bid values for loss of fishing a specific stream (Table 44) were highest for bait anglers on the TMA-ALT and for fly anglers on FFO areas ($50.00).

The compensatory values were expanded to the total annual value necessary to compensate anglers for the loss of their right to fish and for the loss of their right to fish specific waters. An average annual value per kilometer of stream was calculated for compensating anglers by stream type and region (Table 45 and 46). The cost of compensating anglers for loss of springtime

Table 43.-Compensatory value median bids from all anglers interviewed during the 1988-1994 creels calculated for each stream type and gear type. Number of interviews in parentheses.

Question format: What would be the minimum amount of money that you would consider to be adequate compensation for not being able to fish today?

Stream Type	All Angler Types	Fly Anglers	Lure Anglers	Bait Anglers
Adult	$ 40.00 (467)	$ 50.00 (34)	$ 35.00 (67)	$ 40.00 (366)
TMA-ALT	$100.00 (52)	$ 50.00 (16)	$ 50.00 (7)	$ 50.00 (30)
TMA-FFO	$100.00 (10)	$100.00 (10)	----- ----	----- ----
Fly-Fishing-Only	$100.00 (37)	$100.00 (36)	----- ----	$ 20.00 (1)
Preseason	$ 25.00 (14)	$100.00 (8)	$ 20.00 (6)	----- ----
Yearling	$ 25.00 (37)	$ 50.00 (2)	$ 20.00 (3)	$ 50.00 (32)
Nonstocked	$ 50.00 (15)	----- ----	$ 50.00 (8)	$ 50.00 (7)
TMAs & FFO	$100.00 (99)	$100.00 (62)	$ 50.00 (7)	$ 50.00 (31)
All Stream Types	$ 50.00 (632)	$100.00 (106)	$ 40.00 (91)	$ 50.00 (436)

Table 44.-Compensatory value median bids from all anglers interviewed during the 1988-1994 creels calculated for each stream type and gear type. Number of interviews in parentheses.

Question format: What would be the minimum amount of money that you would consider to be adequate compensation for not being able to fish in "X" location today, and having to fish elsewhere today?

Stream Type	All Angler Types	Fly Anglers	Lure Anglers	Bait Anglers
Adult	$ 20.00 (456)	$ 20.00 (32)	$ 20.00 (67)	$ 20.00 (356)
TMA-ALT	$ 20.00 (48)	$ 20.00 (15)	$ 15.00 (6)	$ 50.00 (27)
TMA-FFO	$ 20.00 (10)	$ 20.00 (10)	----- ----	----- ----
Fly-Fishing-Only	$ 50.00 (38)	$ 50.00 (36)	----- ----	$ 5.00 (1)
Preseason	$ 20.00 (14)	$ 20.00 (8)	$ 20.00 (6)	----- ----
Yearling	$ 20.00 (34)	$ 50.00 (1)	$ 20.00 (3)	$ 20.00 (30)
Nonstocked	$ 30.00 (15)	----- ----	$ 50.00 (8)	$ 20.00 (7)
TMAs & FFO	$ 25.00 (96)	$ 25.00 (62)	$ 15.00 (7)	$ 25.00 (31)
All Stream Types	$ 20.00 (615)	$ 25.00 (104)	$ 20.00 (90)	$ 20.00 (421)

Table 45.-Mean springtime compensatory value per kilometer per year for fishing in a specific river for each stream type by region. A range of values were calculated using both 2.0 hrs and 4.2 hrs as average angler trip length.

Stream Type\ Trip Length(hr)		Region					
		NW	SW	C	NE	SE	All
Adult	4.2	$ 1,568.78	$ 2,776.39	$ 8,010.39	$ 2,594.39	$ 2,930.74	$ 4,050.00
	2.0	$ 3,294.44	$ 5,830.42	$ 16,821.82	$ 5,448.22	$ 6,154.55	$ 8,505.21
Yearling	4.2	$ 792.86	NC[1]	$ 940.26	NC[1]	$ 1,136.96	$ 915.71
	2.0	$ 1,665.00	NC[1]	$ 1,974.55	NC[1]	$ 2,387.62	$ 1,922.99
TMA & FFO	4.2	$ 4,459.50	$ 30,048.39	$ 53,080.20	$ 2,592.26	$ 13,771.43	$ 16,670.14
	2.0	$ 9,364.32	$ 63,101.62	$111,468.42	$ 5,443.75	$ 28,920.00	$ 35,007.29

[1] No yearling streams creeled in this region.

Table 46.-Mean springtime compensatory value per kilometer per year for fishing for each stream type by region. A range of values were calculated using both 2.0 hrs and 4.2 hrs as average angler trip length.

Stream Type\ Trip Length(hr)		Region					
		NW	SW	C	NE	SE	All
Adult	4.2	$ 3,129.95	$ 5,364.66	$ 15,628.00	$ 5,326.20	$ 5,846.43	$ 8,938.61
	2.0	$ 6,572.89	$ 11,265.79	$ 32,818.80	$ 11,185.02	$ 12,277.50	$ 18,771.08
Yearling	4.2	$ 1,869.27	NC[1]	$ 2,921.42	NC[1]	$ 2,250.58	$ 1,814.65
	2.0	$ 3,925.47	NC[1]	$ 6,134.98	NC[1]	$ 4,726.22	$ 5,331.25
THAs & FFO	4.2	$ 8,925.75	$ 54,862.86	$102,286.00	$ 10,834.85	$ 27,600.00	$ 34,652.71
	2.0	$ 18,744.08	$115,212.00	$214,800.60	$ 22,753.19	$ 57,960.00	$ 72,770.69

[1] No yearling streams creeled in this region.

fishing on specific adult streams was highest in the Central region ($8,010.39/km/yr), an area with the highest density of anglers for the amount of resources available. Anglers in the Central and Southwest regions would have required considerably higher amounts of compensation for loss of their TMA and FFO areas than anglers in other regions. These costs were primarily the result of the high value placed on the Salmon River TMA-FFO area and the Saugatuck River FFO area.

The cost of compensating anglers for loss of all fishing was 200-350% higher than the cost of compensating anglers for loss of fishing a single stream. It would take considerably more money to compensate anglers who utilize TMA and FFO areas ($34,652.71/km/yr of stream) for their loss of springtime fishing than it would to compensate anglers fishing adult or yearling streams ($8,938/km/yr and $1,814.65/yr/km respectively).

4.10.6 Statewide expansion of economic values:

The per-kilometer values of economic impact, consumer surplus, and compensatory values were multiplied by the kilometers of stream type per region (Table 36) to generate expanded annual economic values (Tables 47, 48, 49, and 50) for trout fishing in Connecticut's publicly stocked streams. Expansions include fall and early spring fishing activity, but do not include the value of trout fishing during the summer nor the year round value of lakes or privately stocked waters.

An estimated $4,983,896 to $10,013,770 in annual net economic impacts (Table 47) are generated as a result of the State's stream stocking program. Net economic impact was greatest in the Central region of the state, where 33.2% of all the stocked streams (Table 36) are located. TMAs and FFO areas account for approximately 23% of the economic impacts while accounting for only 6% of the total kilometers of stream stocked. Annual economic impacts for the Farmington River TMA (Hyatt, 1992) and Housatonic River TMA (Barry, 1986) are included in the expanded estimates. Yearling streams account for 3.2% of the economic impacts and account for 23.5% of the stream kilometers stocked.

The expanded consumer surplus for all streams stocked by the state is $4,101,037.45 to $8,366,663.04 per year (Table 48). This is the value of state stocked trout streams to the anglers over and above their expenditures ($3,737,922.37 to $7,510,327.67 per year).

The compensatory value of fishing in Connecticut state stocked streams (Table 49) is estimated at between $8,911,256.04 and $18,337,834.53 per year. This is the amount of money that would have to be paid to anglers of stocked streams each year for them to willingly give up fishing Connecticut's public trout streams. The compensatory value of fishing a particular resource (stream) was expanded over the entire state (Table 50). This represents how much anglers value certain streams relative to the total value of fishing ($4,496,494.69 and $9,152,845.20). The high value placed on particular streams is an indication of the fidelity anglers have to their favorite fishing areas.

Table 47.-Expansions to statewide net economic impact values were calculated by stream types within each region for all DEP stocked streams. A range of values were calculated using both 2.0 hrs and 4.2 hrs as average angler trip length. The more precise data for the Farmington River (Hyatt 1986) and Housatonic River (Barry 1986) were used for those areas rather than the averages from this study.

Stream Type	Region NW	SW	C	NE	SE	All
Adult	$286,164.90	$185,187.05	$2,007,827.96	$ 636,944.01	$ 270,808.38	$3,386,832.30
Yearling	$ 28,652.48	$ 9,725.35	$ 95,593.75	$ 38,981.12	$ 41,724.54	$ 214,677.25
TMAs & FFO	$ 9,235.33	$117,289.80	$ 227,426.79	$ 43,370.10	$ 165,936.99	$ 563,258.95
Subtotal 4.2 hour trips	$324,052.71	$312,102.15	$2,330,848.50	$ 719,295.23	$ 478,469.91	$4,164,768.49
2.0 hour trips	$680,510.68	$655,414.51	$4,894,781.84	$1,510,519.99	$1,004,786.81	$8,746,013.83
(Early Spring)						
4.2 hour trips						$ 102,478.00
2.0 hour trips						$ 217,744.80
(Fall)						
4.2 hour trips						$ 304.156.00
2.0 hour trips						$ 638,727.60
Housatonic River						$ 219,684.00
Farmington River						$ 191,600.00
Total using 4.2 hour average trip length						$4,983,896.49
using 2.0 hour average trip length						$10,013,770.23

Table 48.-Expansions to annual statewide contingent values (consumer surplus) calculated by stream types within each region for all DEP stocked streams. A range of values were calculated using both 2.0 hrs and 4.2 hrs as average angler trip length. The more precise data for the Farmington River (Hyatt 1986) and Housatonic River (Barry 1986) were used for those areas rather than the averages from this study.

Stream Type	NW	SW	C	Region NE	SE	All
Adult	$254,142.36	$215,171.00	$1,746,265.02	$ 545,732.04	$ 270,808.38	$3,016,284.80
Yearling	$ 28,522.59	$ 10,506.88	$ 111,371.25	$ 42,113.66	$ 37,519.42	$ 230,033.80
THAs & FFO	$ 4,432.50	$ 75,581.25	$ 131,150.46	$ 21,074.78	$ 74,224.86	$ 306,463.85
Subtotal						
4.2 hour trips	$287,097.45	$301,259.13	$1,988,786.73	$ 608,920.47	$ 366,718.66	$3,552,782.45
2.0 hour trips	$602,904.65	$632,644.18	$4,176,452.13	$1,278,732.99	$ 770,109.18	$7,460,843.14
(Early Spring)						
4.2 hour trips						$ 57,489.00
2.0 hour trips						$ 120,726.90
(Fall)						
4.2 hour trips						$ 267,570.00
2.0 hour trips						$ 561,897.00
Housatonic River						$ 121,326.00
Farmington River						$ 101,870.00
Total						
using 4.2 hour average trip length						$4,101,037.45
using 2.0 hour average trip length						$8,366,663.04

Table 49.-Expansions to statewide compensatory values of fishing calculated by stream types within each region for all DEP stocked streams. A range of values were calculated using both 2.0 hrs and 4.2 hrs as average angler trip length. The more precise data for the Farmington River (Hyatt, 1986) and Housatonic River (Barry, 1986) were used for those areas rather than the averages from this study.

Stream Type	Region					
	NW	SW	C	NE	SE	All
Adult	$ 507,035.70	$ 415,761.15	$3,406,904.00	$1,120,366.17	$ 508,639.41	$ 5,958,706.43
Yearling	$ 68,976.06	$ 25,398.69	$ 270,005.00	$ 101,802.95	$ 89,122.97	$ 555,305.68
TMAs & FFO	$ 22,314.38	$ 318,204.59	$ 501,201.40	$ 81,261.38	$ 358,524.00	$ 1,281,505.74
Subtotal 4.2 hour trips	$ 598,326.14	$ 759,364.43	$4,178,110.40	$1,303,430.50	$ 956,286.38	$ 7,795,517.85
2.0 hour trips	$1,256,484.89	$1,594,665.30	$8,774,031.84	$2,737,204.05	$2,008,201.39	$16,370,587.47
(Early Spring)						
4.2 hour trips						$ 70,953.00
2.0 hour trips						$ 149,001.03
(Fall)						
4.2 hour trips						$ 703.145.97
2.0 hour trips						$ 1,476,606.54
Housatonic River						$ 207,799.22
Farmington River						$ 133,840.00
Total						
using 4.2 hour average trip length						$ 8,911,253.04
using 2.0 hour average trip length						$18,337,834.53

Table 50.-Expansions to statewide compensatory values of fishing a specific DEP stocked stream calculated by stream types within each region for all DEP stocked streams. A range of values were calculated using both 2.0 hrs and 4.2 hrs as average angler trip length. The more precise data for the Farmington River (Hyatt, 1986) and Housatonic River (Barry, 1986) were used for those areas rather than the averages from this study.

	Region					
Stream Type	NW	SW	C	NE	SE	All
Adult	$ 254,142.36	$ 215,170.23	$1,746,265.02	$ 545,729.94	$ 254,974.38	$ 3,9016728.92
Yearling	$ 29,256.53	$ 11,171.66	$ 117,532.50	$ 44,778.22	$ 45,023.62	$ 247,762.53
TMAs & FFO	$ 11,148.38	$ 174,280.66	$ 260,092.98	$ 19,441.95	$ 178,890.88	$ 643,854.47
Subtotal 4.2 hour trips	$ 294,546.89	$ 400,622.55	$2,123,890.50	$ 609,890.11	$ 478,888..87	$ 3,907,898.92
2.0 hour trips	$ 618,548.48	$ 841,307.35	$4,460,170.05	$1,280,895.22	$1,005,666.63	$ 8,206,587.73
(Early Spring)						
4.2 hour trips						$ 56,763.00
2.0 hour trips						$ 119,202.30
(Fall)						
4.2 hour trips						$ 268.384.97
2.0 hour trips						$ 563,606.40
Housatonic River						$ 197,031.16
Farmington River						$ 66,417.61
Total using 4.2 hour average trip length						$ 4,496,494.69
using 2.0 hour average trip length						$ 9,152,845.20

4.10.7 Benefits:

The net economic impact per trout stocked ranged from $4.81/trout for yearling streams to $31.24/trout for TMA and FFO areas (Table 51). The overall net economic impact per trout for all streams combined is $11.65 to $24.46 per trout stocked.

The benefit/cost of trout stocking in streams was generated based on the angler's consumer surplus versus the cost of stocking. This is the "benefit" to the angler compared to the cost of providing the fish. Costs of production plus distribution were $1.05 per stocked adult trout and $0.58 per stocked yearling trout (Hyatt, 1992). The benefit/cost ratios (Table 51) were: adult stocked streams 9:1 to 19:1, yearling stocked streams 9:1 to 18:1, and TMA and FFO areas 20:1 to 42:1. The benefit/cost ratio for all parts of the state stream trout stocking program was 10:1 to 20:1. This benefit analysis does not include summer trout fishing.

Table 51.-Benefit/cost ratios of Connecticut DEP's stream trout stocking programs.

Stream Type	Hours/ Trip	Number Stocked[1]	Stocking Cost	Consumer Surplus	Economic Impact per Trout Stocked	Benefit Cost Ratio
Adult	4.2	352,285	$369,899.00	$3,227,157.46	$13.74	9:1
	2.0	352,285	$369,899.00	$6,454,314.92	$28.85	19:1
Yearling	4.2	44,610	$ 25,874.00	$ 230,033.80	$ 4.81	9:1
	2.0	44,610	$ 25,874.00	$ 460,067.60	$10.11	18:1
Adult Special Regulation:						
Fly Only		13,404				
TMA		17,510				

	4.2	30,914	$ 32,460.00	$ 643,846.19	$31.24	20:1
	2.0	30,914	$ 32,460.00	$1,287,692.38	$65.60	42:1
All streams					$11.65-24.46	10:1-20:1

[1] J. Moulton, pers. communication.

5.0 Models:

Three models are reviewed in detail for predictability of the whole model and the predictive ability of each model's individual components. Predictive equations were generated from Type-1 trout populations specific to age and species. Attempts were made to avoid many of the pitfalls and errors that Fausch et al. (1988) had outlined as common problems during model development. Residuals were examined for indications of bias or sources of error in the models. A brown trout biomass model's reliability was tested for sources of bias or error using standing crops of Type-2 trout populations.

5.1 Testing of Trout Carrying Capacity Models:

In our efforts to manage trout in Connecticut waters, we identified a need for estimating the carrying capacity (CC) for trout in streams. Knowing the CC of streams would allow us to fine tune our stocking program so that numbers, species, sizes of fish, regulations, and the timing of stocking could be tailored to stream conditions. Streams with significant unused CC and good potential for growth, once identified, could be planted with fry, fingerlings, or yearlings under put-grow-take management. Knowing the CC would also allow us to identify streams with the most potential for increasing the standing crop of wild trout with restrictive harvest regulations. Potentially, we could identify and diminish factors other than harvest that are currently limiting wild trout production in streams. Habitat enhancement efforts could be channeled into more productive avenues as limiting factors are identified. Impact assessments conducted before and after development activities could be presented quantitatively in terms of effects on CC regardless of whether trout were currently at capacity or even present.

We examined three models which are currently used by other agencies to predict CC. Two Habitat Quality Index models (HQI; Binns and Eiserman 1979) were developed by the Wyoming Game and Fish Department for Wyoming streams. The third model was developed by the New York State Department of Environmental Conservation as a tool to guide and standardize the trout stocking program (Engstrom-Heg 1990). This New York model is referred to as the "WNHF" model, which is an abbreviation for the major data inputs (Wild trout, Non-trout fish, Habitat, and Fertility).

5.1.1 HQI Models:

The HQI models were developed from data collected on 36 Wyoming streams that were not heavily stocked and had not been unusually impacted. Two different models (Model 1 and Model 2) were developed which predicted trout CC based on ratings of physical, chemical, thermal, and biotic attributes. The ten attributes used in Model 1 were: late summer flow, flow variation, maximum water temperature, nitrate concentration, food abundance, food diversity, cover for trout, stream bank erosion, water velocity, and stream width. Values of each attribute were rated on a scale of 0-4, based on suitability for trout (0 was marginal for trout, 4 was ideal). In Model 2, a rating of submerged aquatic vegetation was substituted for food abundance and diversity, and several other attributes were weighted differently. When predicted standing crops were compared to actual measured standing crops, the authors obtained a correlation coefficient (r) of 0.977 for Model 1, which explained 95% of the variation. Model 2 was more precise with r = 0.983 and 97% of the variation in standing crop explained. The maximum possible predicted standing crop for Model 1 was 1,034 kg/ha; the maximum for Model 2 was 1,086 kg/ha. The performance of these models was aided greatly by one site (Sand Creek) with exceptionally high trout biomass (634 kg/ha), and by three poorly rated streams with no trout present. Sand Creek had the unique set of attributes common to spring runs: cold stable temperature, little flow fluctuation, steady nutrient supply, and abundant submerged aquatic vegetation. Most attributes for Sand Creek were rated as ideal (4), and predicted and actual standing

Table 52.-Correlation of measured standing crops of trout (kg/ha) with standing crop of trout predicted by HQI Models 1 and 2. r = correlation coefficient; P = probability of greater |r| under Ho: population correlation coefficient = 0; N = number of streams.

Model	Trout Population Category	r	P	N
HQI1	Type-1	0.050	0.630	93
HQI2	Type-1	0.060	0.510	105
HQI1	Brook-1	-0.002	0.990	70
HQI2	Brook-1	0.070	0.540	81
HQI1	Brown-1	-0.330	0.530	7
HQI2	Brown-1	-0.540	0.210	7
HQI1	Brook/Brown-1	-0.010	0.970	17
HQI2	Brook/Brown-1	0.060	0.820	17

crops were very close. Consequently the HQI models rely heavily on the presence of large-spring qualities (stable flows, low temperatures) to predict high trout standing crops.

Data collection methods for the Connecticut stream survey were designed to allow evaluation of the HQI models. Some procedural modifications were necessary, however, so that some of our attribute measurements were not exactly comparable to those used in the HQI. In order to evaluate these models, we selected a set of streams that had good trout reproduction, good wild trout population structure, and little fishing pressure (Type-1 streams). We believed that standing crops in this set of streams would most closely reflect ambient conditions. We also selected a larger set of streams with significant numbers of wild trout, but with one or more of the above requirements violated (Type-2 streams). These groups were subset by species present (brook trout, brown trout, or both), and different combinations of sets and subsets were tested by comparing predicted and measured standing crops. In all cases model performance was poor (Table 52). Correlation coefficients were small or negative, and not significant (P = 0.05), despite relatively large sample sizes in several sets.

In addition to geographic and weather-related differences between Wyoming streams and Connecticut streams, several other factors may have played a role in the poor performance of the HQI models in Connecticut. The HQI models relied on the presence of the aforementioned spring run qualities to predict high standing crops. Few Connecticut streams are strongly influenced by large amounts of groundwater. Most of the streams used to develop the HQI models contained rainbow trout and/or cutthroat trout as major or minor components of the trout biomass. Requirements for these species may be significantly different from those of brook trout and brown trout. Sympatric non-trout species were also different and may have influenced standing crops. For food diversity calculations, our aquatic invertebrate samples were identified to the family level. The HQI models call for identification to the genus level for mayflies, stoneflies, and caddisflies. Also the HQI models call for collection of invertebrate samples in August or early September. Our samples were collected in May and June in most years, and in June through October in 1988. Ratings of invertebrate diversity and abundance may have been different if the HQI protocol had been followed more closely.

We were not able to obtain nitrate concentrations from any streams with significant numbers of wild trout. We examined nitrate concentration data collected by the USGS on several streams, and observed a significant correlation ($r = 0.70$, $P = 0.0003$) between nitrate and conductivity. We were thus able to estimate nitrate from conductivity for all of our sample streams. The lack of precision of our estimated nitrate values, however, may have affected the standing crop predictions.

Other modifications of methods included differences in definitions of trout cover, estimation rather than measurement of many maximum summer temperatures, earlier start to the fish sampling period (June rather than August), and uniform assignment of the highest rating for the eroding bank attribute because eroding banks were perceived as rare. Binns and Eiserman (1979) comment that a high level of expertise was necessary for proper application of these models. It is possible that inconsistency among years and crews may have generated additional variance or bias which contributed to the poor performance of these models.

Table 53.-Correlation of measured trout standing crop (kg/ha of all trout combined) with raw data and ratings of attributes used in the HQI carrying capacity models, in Type-1 trout assemblages (see text for definitions of types). r = correlation coefficient; P = probability of greater |r| under Ho: population correlation coefficient = 0; N = number of streams.

		Raw Data			Ratings		
Attribute	Trout Population Category	r	P	N	r	P	N
Late Summer Stream Flow	Brook-1	----	----	-	0.103	0.355	83
	Brn-1,Brk/Brn-1	----	----	-	0.480	0.020*	23
	All Type-1	----	----	-	0.261	0.007*	106
Flow Stability	Brook-1	----	----	-	0.227	0.039*	83
	Brn-1,Brk/Brn-1	----	----	-	0.283	0.191	23
	All Type-1	----	----	-	0.246	0.011*	106
Maximum Water Temperature	Brook-1	0.124	0.584	22	0.036	0.750	83
	Brn-1,Brk/Brn-1	0.221	0.540	14	-0.299	0.166	23
	All Type-1	0.309	0.085	32	-0.187	0.055	106
Nitrate (conductivity)	Brook-1	0.129	0.249	82	-0.037	0.741	83
	Brn-1,Brk/Brn-1	-0.116	0.598	23	0.395	0.186	23
	All Type-1	0.130	0.188	105	-0.058	0.554	106
Aquatic Insect Abundance (no./m^2)	Brook-1	0.143	0.231	72	0.081	0.497	72
	Brn-1,Brk/Brn-1	0.021	0.924	23	-0.008	0.970	23
	All Type-1	0.102	0.325	95	0.064	0.541	95
Aquatic Insect Diversity Index	Brook-1	0.060	0.618	72	0.123	0.305	72
	Brn-1,Brk/Brn-1	0.121	0.583	23	0.050	0.825	22
	All Type-1	0.108	0.296	95	0.086	0.412	94
Percent of Sample Area Providing Trout Cover	Brook-1	0.082	0.463	83	0.066	0.553	83
	Brn-1,Brk/Brn-1	0.693	0.0002*	23	0.545	0.007*	23
	All Type-1	0.276	0.004*	106	0.243	0.012*	106
Eroding Stream Banks	Brook-1	----	----	-	All Rated 4		
	Brn-1,Brk/Brn-1	----	----	-			
	All Type-1	----	----	-			
Water Velocity	Brook-1	-0.170	0.180	64	-0.135	0.231	81
	Brn-1,Brk/Brn-1	-0.109	0.656	19	-0.089	0.688	23
	All Type-1	-0.027	0.806	83	0.030	0.766	104
Stream Width	Brook-1	-0.263	0.016*	83	-0.255	0.020*	83
	Brn-1,Brk/Brn-1	-0.167	0.446	23	-0.135	0.539	23
	All Type-1	-0.073	0.456	106	-0.059	0.547	106
Aquatic Vegetation Rating (Model 2 only)	Brook-1	----	----	-	0.097	0.381	83
	Brn-1,Brk/Brn-1	----	----	-	0.095	0.666	23
	All Type-1	----	----	-	0.053	0.587	106

* significant at $P \leq 0.05$

We pursued our evaluation of the HQI models further to determine whether any of the attributes performed well as rated, and whether the raw data correlated with standing crops (Tables 53 and 54). If the raw data were highly correlated but the ratings were not, then perhaps rescaling of the rating process would produce better results. We also plotted standing crops against each attribute to look for non-linear relationships and optimum ranges of values.

Raw data and ratings for many attributes were poorly correlated with standing crop, however several significant and interesting observations were apparent from this analysis.

Table 54.-Correlation of raw data and ratings of attributes used in the HQI carrying capacity models, with measured standing crop (kg/ha) of trout, by species, in Type-1 and Type-2 trout populations combined (see text for definitions of types). r = correlation coefficient; P = probability of greater |r| under Ho: population correlation coefficient = 0; N = number of streams.

Attribute	Species	Raw Data			Ratings		
		r	P	N	r	P	N
Late Summer Stream Flow	brook	----	----	-	0.121	0.094	193
	brown	----	----	-	0.255	0.039*	66
	brook/brown	----	----	-	0.248	0.0004*	200
Flow Stability	brook	----	----	-	0.084	0.245	193
	brown	----	----	-	0.252	0.041*	66
	brook/brown	----	----	-	0.187	0.008*	200
Maximum Water Temperature	brook	-0.163	0.245	53	0.186	0.010*	193
	brown	0.250	0.227	25	0.250	0.227	25
	brook/brown	0.156	0.257	55	0.156	0.257	55
Nitrate (conductivity)	brook	-0.109	0.134	192	0.135	0.062	193
	brown	0.116	0.356	66	-0.249	0.044*	66
	brook/brown	0.053	0.459	191	-0.028	0.694	200
Aquatic Insect Abundance (no./m^2)	brook	-0.007	0.926	176	0.004	0.963	176
	brown	0.074	0.563	64	-0.009	0.941	64
	brook/brown	0.069	0.356	182	0.034	0.651	182
Aquatic Insect Diversity Index	brook	0.014	0.854	176	0.013	0.860	176
	brown	0.025	0.843	64	-0.075	0.557	63
	brook/brown	0.064	0.391	182	0.043	0.562	181
Percent of Sample Area Providing Trout Cover	brook	0.113	0.119	191	0.098	0.180	191
	brown	0.285	0.021*	66	0.351	0.004*	66
	brook/brown	0.159	0.026*	198	0.218	0.002*	198
Eroding Stream Banks	brook	----	----	-	All Rated 4		
	brown	----	----	-			
	brook/brown	----	----	-			
Water Velocity	brook	-0.221	0.008*	145	-0.265	0.002*	190
	brown	0.189	0.183	51	0.303	0.013*	66
	brook/brown	-0.053	0.518	150	-0.260	0.716	197
Stream Width	brook	-0.433	0.0000*	193	-0.426	0.0000*	193
	brown	0.107	0.392	66	0.157	0.201	66
	brook/brown	-0.197	0.005*	200	-0.175	0.013*	200
Aquatic Vegetation Rating	brook	----	----	-	0.165	0.022*	193
	brown	----	----	-	0.063	0.618	66
	brook/brown	----	----	-	0.102	0.153	200

* significant at $P \leq 0.05$

Brook trout and brown trout appeared to respond differently to some attributes, indicating that these species' carrying capacities may be easier to model separately rather than combined as is done in the HQI. For example, raw data and ratings for water velocity and stream width were highly *negatively* correlated with brook trout standing crop (Table 54). For brown trout standing crop the correlation coefficients for these two variables were *positive* and, for water velocity ratings, significant. The highest correlation coefficient in either Table 53 or Table 54 was for the trout cover attribute correlated with total trout biomass in the best brown trout streams (r = 0.693; N = 23; P = 0.0002). Thus approximately half (48%) of the stream-to-stream variation in standing crop in Type-1 wild brown trout streams (Brown-1 and Brook/Brown-1) was explained by the amount of cover present. Trout standing crop in the best brook trout streams (Brook-1), however, was poorly correlated with cover and the relationship was not significant (r = 0.082; N = 83; P = 0.463). This apparent difference between species in the importance of cover was most likely a result of our modification of the definition of cover used in the HQI models. Our cover criteria were tailored for larger adult trout, 8 inches or greater in length. Cover criteria in the HQI models was more flexible. The species and sizes of trout present in a particular stream were taken into account when measuring cover. In a small stream with small adult brook trout, requirements to qualify as cover were much less stringent. Thus it is not surprising that cover, as we defined and measured it, did not correlate well with brook trout biomass.

Other attributes in these models which showed some promise (at least one significant correlation) were the ratings for late summer flow, annual flow variation, maximum summer water temperature, nitrate (conductivity), and abundance of aquatic vegetation, however correlation coefficients for these ratings were generally low (r = 0.165-0.255).

As with trout growth, trout biomass did not appear to be related to aquatic invertebrate food abundance or diversity. Again, reasons for this lack of correlation are not clear, however this could be due to sampling design, greater importance of other variables, or other important food sources such as terrestrial invertebrates and forage fish. Further analysis may indicate that specific components of the invertebrate community are better predictors of trout standing crop. Plots of standing crop against each model attribute revealed little, due to the large amount of scatter.

5.1.2 WNHF Model:

The WNHF model was developed and modified over many years, and has served as a useful working tool for the New York State (DEC) trout stocking program. This model predicts CC of trout streams which, used in combination with actual standing crop of wild trout and angling pressure, helps determine stocking strategies. It was intended to be easy to use, and flexible enough to accommodate historical data that was collected and recorded in many different ways by different individuals over a long period of time. The model incorporates many subjective evaluations, which reduces the labor needs for field data collection. This model does, however, require electrofishing to collect fish data. The variables used in the model consist of a broad range of attributes taken from the literature and from years of data collection, observation, and intuition. Some of the variables used in the HQI models were incorporated into this model. Variables are rated by assignment of points, with optimum values receiving the most points, and poor values receiving zero or negative points. These points are combined into intermediate values which are again combined into N (non-trout competitors), H (habitat), and F (fertility). These values are then entered into a formula which calculates estimated standing crop. The author (Engstrom-Heg) has recently made available a computer program into which field data may be entered directly, to produce estimates of CC.

The author never offers any quantitative evaluation of the performance of the model, such as a comparison of observed and predicted CC values. He does indicate, however, that CC estimates corresponded reasonably well with observed biomasses of trout in lightly to moderately fished wild trout streams. He also acknowledges that CC predictions are relatively imprecise and that they should be considered as default values to be used in the absence of better information. He states that he would welcome a superior model that could be substituted into the CC-predicting part of the WNHF model.

Table 55.-Correlation of measured standing crops of trout (kg/ha) with carrying capacity for trout predicted by the WNHF model. r = correlation coefficient; P = probability of greater |r| under Ho: population correlation coefficient = 0; N = number of streams.

Trout Population Category	brook trout			brown trout			all trout		
	r	P	N	r	P	N	r	P	N
Brook-1	0.040	0.720	83	0.437	0.461	5	0.039	0.727	83
Brown-1	-0.905	0.035*	5	-0.551	0.200	7	-0.567	0.184	7
Brook/Brown-1	0.002	0.995	18	0.185	0.462	18	0.152	0.547	18
All Type-1	-0.002	0.980	106	0.141	0.465	29	0.041	0.673	108
All Type-1 and 2	-0.064	0.382	191	0.064	0.611	66	0.026	0.712	199

* significant at $P \leq 0.05$

Evaluation of this model followed the same procedures used for the HQI models outlined above. Again, performance of the WNHF model was poor (Table 55). The only subset with a significant correlation between observed and predicted CC was for brook trout in five streams dominated by good brown trout populations (Brown-1), and this correlation was negative.

As with the HQI models, several of the raw and rated variables correlated well with measured standing crop (Table 56). Variables with one or more subsets of raw or rated data significantly correlated with standing crop were: length at age 1, agricultural activity upstream, elevation, flow stability, shelter, canopy cover, pool/riffle ratio, percentage of type 3 substrate (gravel), maximum water temperature, "trout zone" ($gradient/width^{-0.17}$), stream discharge, Ff (an intermediate combination of fertility-related variables), and F (a combination of all fertility-related variables). In general, raw data performed better than rated data, indicating that rescaling of the rating process may improve model performance.

It is interesting to note that variables associated with non-trout fish species (forage fish and competitor abundance) did not correlate with standing crop. As with the invertebrate data, these variables indicate that food abundance may not be an important limiting factor in many streams.

The positive correlation between length at age 1 and standing crop indicates that faster growing fish produce larger

Table 56.-Correlation of raw data and ratings of attributes used in the WNHF carrying capacity model, with measured standing crop (kg/ha) of trout in Type-1 trout populations (see text for definitions of types). r = correlation coefficient; P = probability of greater |r| under Ho: population correlation coefficient = 0; N = number of streams.

Attribute	Trout Population Catogory	Raw Data			Ratings		
		r	P	N	r	P	N
Composite fertility variable (F)	Brook-1	----	----	-	0.235	0.032*	83
	Brn-1, Brk/Brn-1	----	----	-	0.128	0.542	25
	All Type-1	----	----	-	0.258	0.007*	108
Conductivity	Brook-1	0.129	0.249	82	0.138	0.214	83
	Brn-1, Brk/Brn-1	-0.042	0.843	25	0.036	0.866	25
	All Type-1	0.139	0.153	107	0.171	0.077	108
Composite food variable	Brook-1	0.279	0.011*	83	0.268	0.014*	83
	Brn-1, Brk/Brn-1	0.273	0.196	24	0.217	0.298	25
	All Type-1	0.297	0.002*	107	0.275	0.004*	108
Invertebrate abundance (no./m^2)	Brook-1	0.143	0.231	72	0.126	0.257	83
	Brn-1, Brk/Brn-1	0.046	0.831	24	-0.035	0.871	24
	All Type-1	0.108	0.294	96	0.058	0.554	107
Number of invertebrate families	Brook-1	0.003	0.980	72	-0.055	0.624	83
	Brn-1, Brk/Brn-1	0.107	0.618	24	-0.038	0.858	25
	All Type-1	0.027	0.797	96	-0.056	0.565	108
Detritus abundance	Brook-1	----	----	-	0.018	0.872	83
	Brn-1, Brk/Brn-1	----	----	-	----	----	25
	All Type-1	----	----	-	0.031	0.749	108
Slippery rocks	Brook-1	----	----	-	0.178	0.107	83
	Brn-1, Brk/Brn-1	----	----	-	0.184	0.378	25
	All Type-1	----	----	-	0.188	0.051	108
Forage fish abundance	Brook-1	-0.091	0.462	67	-0.121	0.275	83
	Brn-1, Brk/Brn-1	0.327	0.110	25	0.187	0.370	25
	All Type-1	0.120	0.256	92	0.001	0.991	108
Trout length at age 1	Brook-1	0.223	0.049	78	0.240	0.029*	83
	Brn-1, Brk/Brn-1	0.471	0.020*	24	0.250	0.228	25
	All Type-1	0.341	0.0005*	102	0.331	0.0005*	108
Agricultural influence	Brook-1	----	----	-	0.207	0.061	83
	Brn-1, Brk/Brn-1	----	----	-	0.131	0.533	25
	All Type-1	----	----	-	0.218	0.023*	108
Lake or pond outlet insect community	Brook-1	----	----	-	-0.023	0.835	83
	Brn-1, Brk/Brn-1	----	----	-	----	----	25
	All Type-1	----	----	-	-0.029	0.762	108
Elevation	Brook-1	-0.332	0.003*	82	all rated the same		
	Brn-1, Brk/Brn-1	-0.315	0.125	25			
	All Type-1	-0.332	0.0005*	107			
Flow stability	Brook-1	----	----	-	0.217	0.049*	83
	Brn-1, Brk/Brn-1	----	----	-	----	----	25
	All Type-1	----	----	-	0.129	0.182	108
Composite habitat variable (H)	Brook-1	----	----	-	-0.040	0.710	83
	Brn-1, Brk/Brn-1	----	----	-	0.315	0.125	25
	All Type-1	----	----	-	0.138	0.155	108
Overhead canopy	Brook-1	-0.139	0.210	83	-0.190	0.082	83
	Brn-1, Brk/Brn-1	-0.223	0.283	25	-0.170	0.416	25
	All Type-1	-0.129	0.183	108	-0.191	0.048*	108
Trout shelter	Brook-1	0.052	0.643	83	0.021	0.848	83
	Brn-1, Brk/Brn-1	0.488	0.013*	25	-0.125	0.550	25
	All Type-1	0.235	0.015*	108	-0.010	0.915	108

* significant at $P \leq 0.05$

Table 56.-(continued)

Attribute	Trout Population Category	Raw Data			Ratings		
		r	P	N	r	P	N
Composite habitat variable (Hg)	Brook-1	----	----	-	0.032	0.771	83
	Brn-1, Brk/Brn-1	----	----	-	0.294	0.154	25
	All Type-1	----	----	-	0.161	0.097	108
Pool/riffle ratio	Brook-1	-0.031	0.782	83	0.047	0.673	83
	Brn-1, Brk/Brn-1	0.560	0.004*	25	-0.363	0.074	25
	All Type-1	-0.034	0.726	108	-0.064	0.511	108
Percent type 3 substrate	Brook-1	0.008	0.943	83	-0.063	0.574	83
	Brn-1, Brk/Brn-1	0.417	0.038*	25	-0.494	0.012*	25
	All Type-1	0.294	0.002*	108	-0.183	0.059	108
Mean depth	Brook-1	-0.041	0.712	83	-0.094	0.397	83
	Brn-1, Brk/Brn-1	0.191	0.360	25	0.152	0.470	25
	All Type-1	0.137	0.157	108	0.073	0.454	108
Water velocity	Brook-1	-0.132	0.239	81	-0.135	0.231	81
	Brn-1, Brk/Brn-1	0.076	0.717	25	0.014	0.948	25
	All Type-1	0.093	0.344	106	0.039	0.688	106
Maximum water temperature	Brook-1	0.199	0.386	21	0.078	0.484	83
	Brn-1, Brk/Brn-1	0.461	0.153	11	0.008	0.971	25
	All Type-1	0.468	0.007*	32	-0.012	0.901	108
Mean depth/ maximum depth ratio	Brook-1	0.054	0.630	83	-0.114	0.307	83
	Brn-1, Brk/Brn-1	0.029	0.892	25	0.127	0.544	25
	All Type-1	0.085	0.384	108	-0.077	0.428	108
"Trout zone" (gradient/ width$^{-0.17}$)	Brook-1	-0.120	0.072	82	0.080	0.470	83
	Brn-1, Brk/Brn-1	-0.394	0.051	25	-0.135	0.521	25
	All Type-1	-0.244	0.011*	107	0.058	0.551	108
Stream discharge	Brook-1	-0.100	0.376	81	0.189	0.087	83
	Brn-1, Brk/Brn-1	0.094	0.656	25	0.401	0.047*	25
	All Type-1	-0.007	0.937	106	0.267	0.005*	108
Weight of non-trout competitors (N)	Brook-1	0.073	0.515	83	-0.087	0.434	83
	Brn-1, Brk/Brn-1	0.020	0.926	25	-0.191	0.360	25
	All Type-1	0.093	0.341	108	-0.175	0.071	108

* significant at $P \leq 0.05$

standing crops. Thus, variables which correlate with growth rate (which are numerous and highly significant) may also affect standing crop.

The WNHF Model, together with the HQI Models, offered promise for development of a new model for Connecticut trout streams. We believed that by selecting the variables that performed the best, rescaling some of the ratings, incorporating some new variables, and recognizing the different requirements and population dynamics of brook trout and brown trout, we might develop a reasonably accurate model for predicting standing crop.

5.2 Population Model Development:

5.2.1 Correlation analysis:

In preparing to develop predictive models for trout populations, it is first necessary to learn how the various population variables relate to the physical and chemical variables we measured. We used correlation analysis to explore these relationships. Based on the evidence from HQI and WNHF evaluations, correlations were calculated for Type-1 streams by species, using individual age classes as well as the total population.

Biomass:

As shown in the model evaluation section, brown trout biomass had several significant positive correlations with channel morphometry variables, cover, water temperature, and some types of substrates (Table 57). There were also negative correlations with large substrate types. Many of these variables are related to stream depth, width, and cover. The best correlation with brown trout biomass was average stream cross sectional area (r = 0.76). While there seem to be better correlations for brown trout than for brook trout, it should be noted that these correlations were based on much smaller sample sizes (n = 21 for brown trout versus n = 84 for brook trout).

The significance of these variables changed when correlated with individual age classes (Appendix B). The variables that correlated significantly with total biomass also correlated significantly with biomass of either age 1 or age 2 brown trout, which were usually the dominant biomass component in the streams. Four variables, while not significant for total brown trout biomass, were significant for a single age group (stream gradient, percent embeddedness of cobble substrate, D.O. and maximum water temperatures). The strongest correlation was the highly negative relationship between age 0 brown trout biomass and maximum water temperature (r = -0.88, n = 10). This was the only variable which was significantly correlationed with age 0 brown trout biomass. Age 1 brown trout biomass had a strong negative correlation with dissolved oxygen (r = -0.68) and positive correlation

Table 57.-Correlation coefficients (r) for significant correlations of brown trout versus stream variables from Connecticut streams sampled 1988-1994. Significance was defined as an alpha ≤0.05 where (P_a) is the probablity of the population r not being different from zero and number of observations in correlation (N).

Variable	Kg/ha			Num/ha			Num/km		
	r	P	N	r	P	N	r	P	N
Dissolved Oxygen		NS[1]		-49.0	0.02	21	-45.5	0.038	21
% Silt Substrate	57.2	0.0068	21		NS			NS	
% Gravel Substrate	49.4	0.022	21		NS			NS	
% Small boulder Substrate	-50.3	0.02	21		NS		-44.75	0.0419	21
Dominant Substrate Type	-48.5	0.0257	21		NS			NS	
Mean Width		NS			NS		56.0	0.0083	21
Mean Depth	50.0	0.0207	21		NS		43.9	0.0463	21
Maximum Depth	54.0	0.025	17		NS		52.9	0.0256	17
Water Temperature	59.9	0.0041	21		NS			NS	
Total Length of Cover	57.7	0.006	21		NS		74.0	0.0001	21
Length as Cover - Deep Water	66.5	0.001	21		NS		73.1	0.0002	21
Area as Cover-Deep Water	64.1	0.0017	21		NS		63.7	0.0019	21
Length as Cover-Logs		NS			NS		62.3	0.0025	21
% Sample Area as Cover	68.9	0.0005	21		NS		59.5	0.0044	21
% Sample Length as Cover		NS			NS		63.3	0.0021	21
Mean Cross Sectional Area of Stream	75.9	0.0001	21		NS			NS	

[1] NS = nonsignificant

with mean embeddedness of cobble (r = 0.53). This runs contrary to what would be expected for these variables. Gradient was negatively correlated with age 2 and age 4 brown trout biomass.

Table 58.-Correlation coefficients (r) for significant correlations of brook trout versus stream variables from Connecticut streams sampled 1988-1994. Significants was defined as an alpha ≤0.05 where (P_a) is the probablity of the population r not being different from zero and number of obserations in correlation (N).

		Kg/ha			Num/ha			Num/km	
Variable	r	P	N	r	P	N	r	P	N
Alkalinity		NS[1]		-22.1	0.031	90		NS	
Velocity	-30.7	0.0029	92	-32.3	0.0019	80	-24.7	0.0174	92
% Silt Substrate		NS		31.9	0.0017	94		NS	
% Gravel Substrate	24.5	0.0169	94	20.6	0.0454	94		NS	
% Cobble Substrate	-20.8	0.0436	94		NS			NS	
% Small boulder Substrate		NS		-22.4	0.029	94	27.7	0.0068	94
Dominant Substrate Type		NS		-24.9	0.0165	92		NS	
Mean Width	-41.1	0.0001	94	-50.0	0.0001	94		NS	
Mean Depth	-22.6	0.028	94	-37.8	0.0002	94		NS	
Maximum Depth	-24.2	0.0308	80	-37.3	0.0006	80		NS	
Maximum Riffle Length	-28.4	0.0055	94	-22.6	0.0283	94		NS	
Elevation	-23.5	0.0235	93		NS			NS	
Total Length of Cover		NS		-28.8	0.0048	94		NS	
Length as Cover-Deep Water		NS		-22.8	0.027	94		NS	
Area as Cover-Rocks		NS		-23.8	0.0209	92		NS	
Length as Cover-Rocks	-21.2	0.045	94	-28.0	0.0062	94		NS	
Subjective Fishing Pressure	-32.2	0.0001	94	-32.4	0.00164	92		NS	
Mean Cross Sectional Area of Stream	-35.4	0.0005	94	-44.2	0.0001	92		NS	

[1] Not significant

Correlations between parameters and total brook trout biomass were primarily negative (Table 58 and Appendix B). The only positive correlation was with percentage of gravel substrate. The negative correlations with channel morphometry variables (mean width, mean depth, mean cross sectional area and maximum depth of sample area) indicate that the highest biomasses of brook trout are found in smaller streams. A significant negative correlation with subjective fishing pressure estimates possibly existed because smaller streams with higher biomasses often had no detected fishing pressure.

Biomass of age 0 and age 1 brook trout were not significantly correlated with any of the measured variables. However, age 2 brook trout were significantly correlated with cover variables (best correlation: percent sample area as cover, r = 0.24). It appears that older (age 2 and age 3) brook trout may respond to cover variables in a manner similar to older brown trout, however older brook trout are rare in most populations. Cover for fish greater than 8 inches may not adequately represent actual available cover for the majority of brook trout present. A revised cover definition which includes cover for age 1 brook trout may be more appropriate for small brook trout streams.

Density of trout:

Population density variables (number/km and number/ha) of brown trout and physical and chemical parameters were negatively correlated with dissolved oxygen (r = -0.49 for number/ha, and r = -0.46 for number/km, Table 59). These negative correlations may be due to the narrow range of dissolved oxygen values found for the Brown-1 populations. Although dissolved oxygen was close to saturation at all these sites. Differences in water temperatures at the time of sampling resulted in different values for dissolved oxygen since the 100% saturation level of dissolved oxygen is temperature dependent.

The total number of brown trout per kilometer showed similar trends to total biomass of brown trout for variable examined. Total numbers per kilometer and total biomass of brown trout correlated best with channel morphometry and cover variables.

Since number of wild trout in a sample area is often dominated by the abundance of age 0 and age 1 trout, one would expect that similar relationships would exist between the dominate age class of trout and any variable examined as exist between the total number and that same variable. The correlations that were significant for all combined age classes brown trout were generally also significant for age 1 or age 2 brown trout (depth, percent cover, and mean width). Variables related to deep water cover (maximum depth, mean width) also correlated well with older age 3 or age 4 brown trout. Positive correlations were found for number per kilometer of age 1 or age 3 brown trout with the percentage of fine sand substrate (Appendix B). The best correlation was between number of age 2 brown trout and percentage of sample area as cover (r = 0.79, n = 21). Similar to trends in biomass, these results reinforced the idea that channel size and cover are of primary importance to the abundance of older brown trout. There were no significant correlations for density of age 0 with any measured variables, probably because we did not attempt to quantify age 0 habitat.

Densities of all brook trout ages combined were generally only weakly negative correlations with physical and chemical parameters (alkalinity, velocity, percentage of substrate as small boulders, maximum depth, and length of cover, etc. Appendix B, Table B9), primarily with number of brook trout per hectare. The best relationship was mean width with number per hectare (r = -0.5). Unlike brown trout, only three variables were significantly correlated with number per kilometer for brook torut (conductivity: r = -0.21, velocity: r = -0.25, and percentage of small boulder substrate: r = 0.28).

When brook trout density was separated by age class, most of the significant correlations were between cover variables, width and depth, and age 0 and age 1 brook trout. Most of these were negative relationships. The strongest positive correlations were age 0 brook trout/ha with percentage of sample area as log cover (r = 0.43) and percentage of sample area as undercut bank cover (r = 0.30).

There were negative relationships between mortality rates of age 1 and older brook trout with several channel morphometry variables (mean stream width, mean stream depth, and maximum stream depth). This suggests better survival of older brook trout in wider, deeper streams (Appendix B, Tables B3 and B4). Maximum stream depth was also negatively correlated with brown trout mortality, as was the amount of adult brown trout cover. Maximum water temperature was correlated negatively with brook trout mortality and positively with brown trout mortality. The negative correlation with brook trout is probably an artifact produced by the much larger population sizes for brook trout found in colder streams.

Correlation summary of physical and chemical parameters:

Several trends stand out among these correlations. There were quite different relationships between young-of-the-year trout and older trout. Chemical and temperature variables were more likely to correlate with young-of-the-year trout. Young-of-the-year brook trout generally correlated negatively with channel morphometry variables (width, depth) while older brown trout correlated positively with this same group of variables. In the streams studied, the older trout of both species correlated with the amount of cover, brown trout best with deep water cover and brook trout best with log cover. Young-of-the-year brown trout density and biomass had significant negative correlations with dissolved oxygen and maximum water temperatures. The range of dissolved oxygen values from the populations used were all close to 100% saturation (all greater than 8.5 mg/l), for the temperatures at the time of sampling. This may be a case of dissolved oxygen being autocorrelated with temperature. The 100% saturation of dissolved oxygen is temperature dependent, and dissolved oxygen should not be limiting to brown trout populations at levels close to saturation.

Invertebrates:

Correlation analysis was used to test for relationships between trout population parameters for Type-1 populations and invertebrate population variables (number of invertebrate families, number of invertebrates per square meter, and weight of invertebrates per square meter). Very few significant correlations were found. No significant correlations were found for combined age groups of either brown trout or brook trout. For individual age groups, the biomass of age 4 brown trout positively correlated with the number of invertebrates ($r = 0.46$), as did age 0 brook trout biomass ($r = 0.38$). Frequency distributions showed that no streams with wild trout were found to have less than four invertebrate families. All Type-1 streams had at least six invertebrate families present.

Other species:

No significant relationships, that would warrent further examination, were found between either species of trout, by age group, with the density or biomass of other fish species present in the stream. Several significant correlations that were driven by a single sample location were found. All significant correlations became nonsignificant upon the removal of these single sites from the data set.

5.2.2 Predictive regressions:

In preparation for applying regression techniques, variables that showed nonlinear relationships were transformed using the best curvilinear relation suggested by scatter plots of raw data versus trout population parameters. Parabolic relationships were often most appropriate for pH, pool-riffle ratio, maximum water temperature and water temperature at the time of sampling. All curvilinear relationships were centered with maximum population values at zero. These curvilinear variables, along with the significant linear variables from the correlation analysis were combined to determine the best predictive subset of variables using a series of stepwise regressions. The best subset of variables from the stepwise regression was then augmented with interaction terms and power functions for these variables, and was retested using the stepwise regression techniques for their ability to improve model predictability and significance. This process was done iteratively, until no additional improvements were seen in model predictability and significance. All models were evaluated for significance of the regression based on adjusted R^2 (coefficient of determination), significance of F test value, Mallory's C(p), and on whether all model variables were significant within the model, as suggested by Fausch et al. (1988). Any model that did not meet these criteria was rejected. **The resulting equations can only be expected to accurately predict population parameters for the range of variable values from which they were developed.**

The best regression for each population parameter was calculated for all ages combined, for age 0 trout, and for trout age 1 and above (potentially harvestable size trout) (Tables 59 and 60). The order of listing is the order of significance of the variables to the model.

An integral part of model development is testing the models. Due to the limited number of samples for Brown-1 and Brook/Brown-1 trout populations, all 25 sites were used for initial model development to maintain as many degrees of freedom as possible. Inadequate sample sizes are cited by Fausch et al. (1988) as being a common problem in model building. Therefore it was also decided to use as wide a range of brook trout populations as possible for model development. All Brook-1 populations were included. It is hoped that future collections of brown trout and brook trout populations can be used to validate these equations.

Models developed for different age groups of trout generally used the same variables, but with different coefficients (Tables 59 and 60). Width, depth, velocity, percentage of substrate as gravel and percentage of sample area as cover occurred most frequently and in combinations for brook trout models. Water temperature, percentage of sample area as cover, percentage of deep water cover, and a modified pool/riffle ratio were the most common variables for brown trout. The same variables occurred in some models for both species, but sometimes with opposite effects for different age groups. Percentage of sample area as cover was negative in the model for brown trout biomass over age 1 and was a positive value for the model of the biomass of all ages of brown trout. These models do not necessarily imply a causal relationship. Many variables may be cross-correlated, e.g.

Table 59.-The best predictive regression equations for brown trout populations generated from Brown-1 and Brook/Brown-1 trout populations in stream survey data collected 1988-1994.

Population Variable / Age Class	R^2	F Value	Number of Observations /	Equation	
Biomass					
All Ages	0.78[1]	26.5	21		
				kg/ha = 36.8+7.16(water temp.-16)-1039.7(percentage deep water cover) +8.97(length of deep water cover)	(21)
Age 1 and older	0.84	26.9	21		
				kg/ha = 19.7+6.36(water temp.-16)-358.8(percentage stream area as cover) -947.5(percentage deep water cover)+7.32(length of deep water cover)	(22)
Age 0	0.86	16.9	21		
				kg/ha = 7.06+0.48(water temp.-16)-510(percentage stream area as cover) -5.03((percentage deep water cover)*(water temp.-16)^{2})+35.3(percentage of substrate as gravel)+16.4(mean depth*percentage stream area as cover)	(23)
Number/ha					
All Ages	no significant relationships.				

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[1] R^2 = coefficient of determination

Table 59.-(Cont.)

Population Variable / Age Class	R^2	F Value	Number of Observations /	Equation
Number/ha				
Age 1 and older	0.62	8.6	21	
				Num/ha = 906-1767(velocity)-168(pool/riffle ratio-1.5)^2 +13.28(water temp.-16)^2+2601(percentage of stream area as cover) (24)
Age 0	No significant relationships.			
Number/km				
All ages	0.47	10.3	21	
				Num/km=30,021-226,204(percentage of stream area as cover)+919(water temp.-16)^2 (25)
Age 1 and older	0.49	5.8	21	
				Num/km=28,314-219,688(percentage of stream area as cover)+924(water temp.-16)^2 (26)
Age 0	0.28	4.4	21	
				Num/km = 837-6221(percentage of stream area as cover)+24.55(water temp.-16)^2 (27)

Table 60.-The best predictive regression equations for brook trout population generated from Brook-1 and Brook/Brown-1 trout populations in stream survey data collected 1988-1994.

Population Variable / Age Class	R^2	F Value	Number of Observations /	Equation	
Biomass					
All Ages	0.40	12.3	77		
				kg/ha = 68.3-706(mean width)-0.53(length of cover)+821(percentage of sample area as cover)-27.56(percentage of sample area as cover*mean depth)	(28)
Age 1 and older	0.33	27.0	84		
				kg/ha = 49.1+4.89(mean width)-666.6(percentage stream area as cover) -19.6(percentage of sample area as cover*mean depth)+40.8(percentage of substrate as gravel)-0.108(mean width*length of cover) -0.67(water temp.-16)	(29)
Age 0					
No significant relationships.					
Number/ha					
All Ages	0.37	13.6	84		
				Num/ha = 11,611.8+19,078(percentage of substrate as gravel) -953(percentage of substrate as gravel*mean depth) -18,006(velocity)-1,656(mean width)	(30)

Table 60.-(Cont.)

Population Variable / Age Class	R^2	F Value	Number of Observations /	Equation	
Number/ha					
Age 1 and older	0.39	11.23	84		
				Num/ha = 397,787+78,481((percentage of substrate as gravel)-96,345(mean width) +447,542(mean width*velocity)-1,806,908(velocity)	(31)
Age 0	0.34	13.26	77		
				Num/ha = 6,323+ 22,071(percentage of substrate as gravel) -1,103(percentage of substrate as gravel*mean depth) -1,225(mean width)	(32)
Number/km					
All ages	0.51	12.32	77		
				Num/km = 529,743-112,097(mean width)-2,099,229(velocity) -465,694(velocity*mean width)+151,216(percentage substrate as gravel)+3,799(mean width*mean depth)	(33)
An alternate model of equal predictive value used the percentage of substrate as sand (fine and coarse) instead of the mean width*mean depth interaction term and slightly different variable coefficients.					
Age 1 and older	0.52	11.26	84		
				Num/km = 584,474-127,295(mean width)-20,369(mean depth)-2,687,086(velocity) +215,107(percentage of substrate as sand)+3,49(Mean width*mean depth)	(34)
Age 0	0.20	10.76	84		
				Num/km = 1,048-57.6(mean depth)+27.7(length of longest pool in sample area)	(35)

headwater streams are smaller, colder and usually contain brook trout, while larger streams tend to be warmer. Width correlates better with brook trout biomass, but the water temperature may be the actual control mechanism.

The biomass predicted from the best biomass model for age 1 and older brown trout (Equation 22) agreed well with the actual values (Figure 27). The model was reviewed for potential bias by plotting residual values (deviation of actual values from the predicted regression line) against each model variable. There was one observation from the development data set that had deep water cover greater than 20% of the sample area and measured more than 40 m in total length. This site had an extremely high residual compared to all other points, pointing to a possible bias problem. Over the temperature range used in the initial model development, there was an even distribution of deviations around the water temperature of 16°C, indicating no bias in the model based on temperature.

This brown trout biomass model (Equation 22) was subsequently tested against the Brown-2 and Brook/Brown-2 populations to see how far below carrying capacity they were, and to determine if the wider range of values from these populations would invalidate the model. As anticipated, the actual biomass values of the Type-2 population data set were lower than the predicted values (Figure 28). The residual values were examined for additional indication of bias in the model. A distinct trend of increased residuals with increased cover area was apparent. The sites with greater than 20% deep water cover or more than 40 m of deep water cover (the upper range of the development set) were the sites with the highest residuals. It appears that while some of the residual difference can probably be attributed to the effects of fishing, there is a breakdown in this model at the higher levels of cover. It is only valid to apply this model in streams with less than 20% deep water cover.

Time limitations precluded similar evaluations of the other models listed. All the models should be tested before any attempt is made to apply them for predictive purposes.

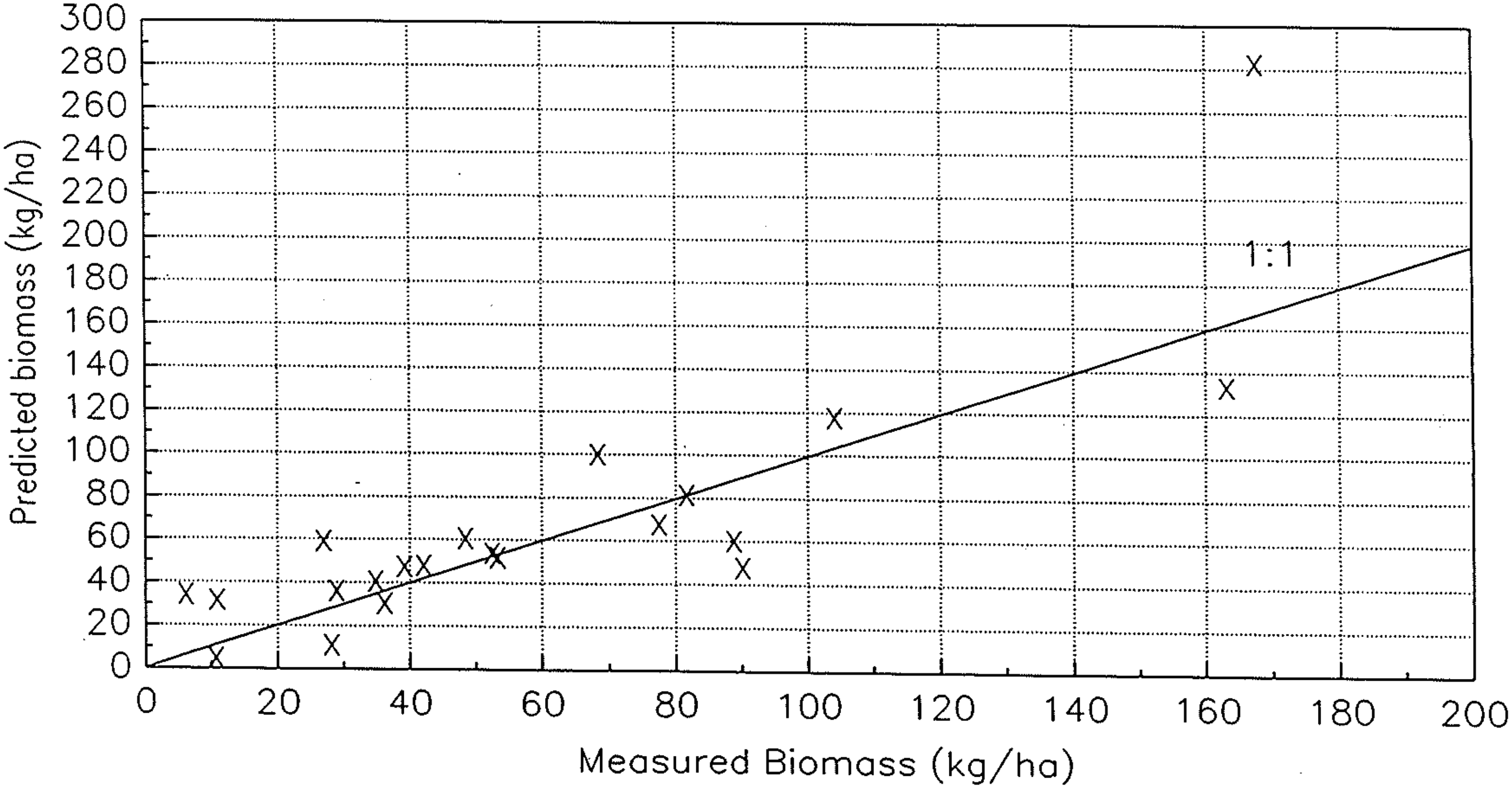

Figure 27.–Predicted versus actual biomass of age 1 and older brown trout from Type–1 streams

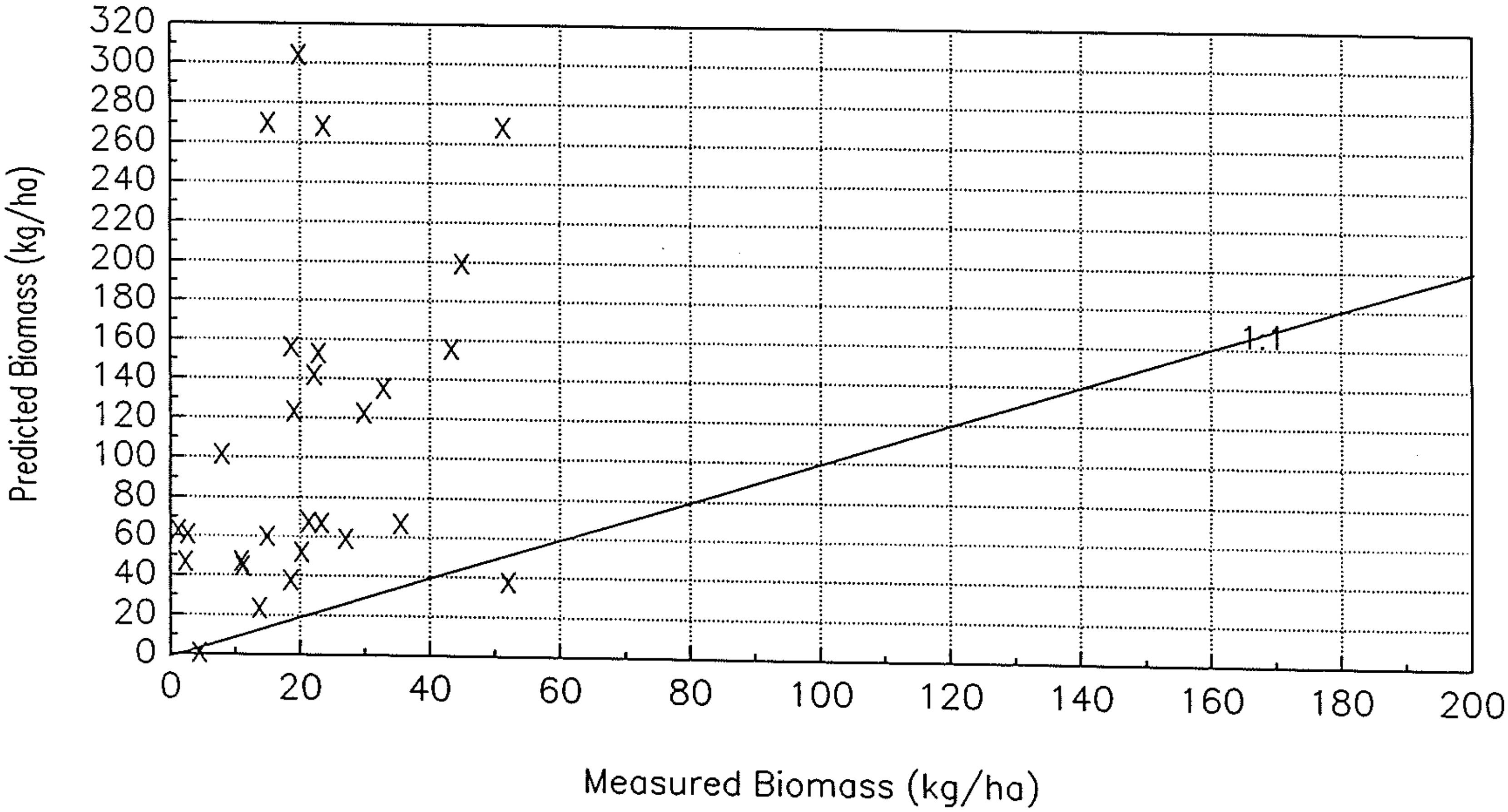

Figure 28.—Predicted versus actual biomass of age 1 and older brown trout from Type–2 Connecticut streams.

5.3 Limiting Factor Analysis:

Hunter (1991) often uses limiting factor analysis in examples of trout restoration work. A review of potential limiting factors in Connecticut streams was attempted using some of the variables from Table 20 and data from all streams sampled. The Type-1 trout populations were used to define an optimum range for each variable. The range of values between the Type-1 populations and Type-2/Trace populations was treated as partially limiting and values outside of this second range were considered severely limiting.

Several variables appear to be severely limiting to brown trout and, to a lesser degree, to brook trout (Table 61). Chief among these are D.O. and pH. The range of values used to set the criteria for being partially limiting to brown trout was drawn from a small sample size (n=21) which resulted in a narrow range of values with no impacts from D.O. These values were all close to 100% saturation. It seems unlikely that D.O. needs to be at saturation levels for brown trout populations. Since good brook trout populations were found at D.O. levels as low as 6.0 ppm. It seems reasonable to assume that D.O. would become limiting to brown trout in the range of 5.5 to 6.0 ppm. If this range is used, only 8 streams would be partially limiting for D.O and 32 would be severely limiting for D.O. This seems more reasonable than the initial estimate of 320 streams.

Certain physical factors represent habitat that cannot be changed, such as stream gradient. At least half of the streams sampled had gradients that were outside the preferred range for brown trout.

Variables that can possibly be influenced through habitat work are embeddedness of gravel, and maximum and mean water depth, all of which are important in limiting brown trout in at least 17% of streams. Water temperature is at least partially limiting for both brook and brown trout in about 12% of the streams. Changes in land use, riparian habitat, minimum flows and ground water diversions may be useful in reducing summer water temperatures.

Table 61.-The number of sites that had physical variable values determined to be severely limiting or partially limiting to trout.

	Brown Trout		Brook Trout	
Variable	Partially Limiting	Severely Limiting	Partially Limiting	Severely Limiting
D.O	320 (33.6%)	44 (4.6%)	39 (4.0%)	16 (1.7%)
Modified*	8 (0.1%)	32 (3.4%)		
pH	26 (2.7%)	28 (2.9%)	39 (4.1%)	6 (0.1%)
Mean Depth	171 (18.0%)	12 (1.2%)	5 (0.5%)	1 (0.1%)
Mean Width	192 (20.0%)	42 (4.4%)	0	2 (0.2%)
Velocity	424 (50.0%)	1 (0.1%)	75 (8.0%)	3 (0.3%)
Discharge	61 (6.5%)	0	50 (5.3%)	11 (1.1%)
Maximum Pool length	121 (12.8%)	0	18 (1.9%)	7 (0.7%)
Water Temperature	120 (12.4%)	5 (0.5%)	116(12.0%)	4 (0.4%)
Maximum Water Temp.	35 (12.1%)	5 (1.8%)	24 (8.7%)	4 (1.4%)
Gradient	343 (51.0%)	149 (15.6%)	5 (0.5%)	0
Embeddedness of Gravel	168 (17.8%)	0	0	0
Maximum site Depth	162 (18.5%)	13 (1.4%)	14 (1.5%)	2 (0.2%)
Alkalinity	18 (1.9%)	17 (1.9%)	0	5 (0.5%)

Column values are exclusive.
* Partially limiting range reduced to 5.5 to 6.0 ppm D.O.

6.0 Utilization of Stream Survey Data:

Information from this study has already been widely used. Both state and federal agencies (DEP River Assessment, DEP permit reviews, DOT environmental review, Conte Refuge project, Army Corps of Engineers), universities (a review of potential for Zebra Mussel-alkalinity requirements), landowners, municipalities (environmental inventories) and private consultants (EPA site reviews) regularly request data. To date, over 700 copies of annual progress reports have been issued as well as data for over 2,500 individual site reports and creels. Public access to the database through a GIS format is planned. This database should continue to grow as additional information from other sampling activity is added.

This data is also forming part of the basis for a statewide trout management plan. This plan is scheduled for development during 1996-97.

7.0 Expenditures:

A total of $1,404,450 was expended on the Stream Survey Project from 1988-1996 for Jobs 1-4. Federal reimbursement under the Federal Aid in Sport Fish Restoration Act amounts to 75% of the cost, $1,004,269. State expenditures for this project amount to $400,181.

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Appendix A: Fish Species Distributions

Index of Fish species in Appendix A:

Anguilidae-Eel Family

Species: **American eel,** Anguilla rostrata (Catadromous)

Number of occurrences: 422 sites, 43.1% of sites.

The highest population densities of this species occurred in streams adjacent to Long Island Sound or just upstream from large rivers. The highest densities were in streams under 20 m wide and averaging less than 50 cm deep. Large numbers of small eels were collected close to Long Island Sound (L.I.S.). Further inland, there tended to be fewer and larger individuals.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	80.1	1997	0.0015
Num/ha:	713.8	8294.5	3.861
Num/km:	385.4	7140	4.35

Range: American eels were found statewide except where migration was limited by dams and/or natural falls (American eels are catadromous). Most dams do not appear to be complete barriers to eels, however larger dams and greater numbers of dams were found to reduce the occurrence of eels. On the Housatonic River few records of eels exist above the Shepaug Dam, the third in a series of mainstem dams. No eels were collected in samples above Barkhamsted Reservoir, a reservoir with a very high dam, or above the Nepaug Reservoir. Levesque and Whitworth (1987) discussed this phenomenon in detail for the Shetucket River where upstream migration was reduced, but not eliminated by mainstem dams. The distribution of eels was found to extend further inland than is shown in Whitworth et al. (1988). See map 1.

Catostomidae-Sucker Family

Species: **Longnose sucker,** Catostomus catostomus (Native)

New Species Record-Connecticut

Number of occurrences: 1 site, 0.1% of sites.

The longnose sucker is found across most of northern North America in clear cold streams. The longnose sucker is one of two species not listed by Whitworth et al. (1988). It is presently listed as a species of special concern in Connecticut.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	0.97		
Num/ha:	16.3		
Num/km:	18.6		

Range: Longnose suckers were collected only from the Konkapot River near the Massachusetts border. This is a tributary stream to the Housatonic River. Multiple individuals in several age classes were collected. See map 2.

Species: **White sucker**, Catostomus commersoni (Native)

Number of occurrences: 596 sites, 60.9% of sites.

The white sucker is the most common stream species in Connecticut. Large individuals from lakes and rivers spawn in smaller tributary streams.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	33.4	1,171.8	0.0005
Num/ha:	1,488.5	78,842.8	5.67
Num/km:	715.9	33,535.0	6.66

Range: The white sucker is found statewide in all regional basins in Connecticut. One area of the state had few of records for this species, a portion of the Eastern Coastal Basin east of the Thames River. The only specimens sampled in this area were found at two sites on Anguilla Brook. White suckers also appear absent from this area in Whitworth et al. (1988). See map 3.

Species: **Creek chubsucker**, Erimyzon oblongus (Native)

Number of occurrences: 35 sites, 3.6% of sites.

Creek chubsuckers are found in ponds and in streams with slow currents. They show a distinct color pattern change between adult and juvenile stages. The majority of specimens sampled were juveniles from slow stream sections near ponds.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	1.5	11.6	0.002
Num/ha:	340.5	5,670.5	4.2
Num/km:	116.4	1,480.0	6.67

Range: The creek chubsucker has a scattered distribution across the state. Our data is similar to the pattern in Whitworth et al. (1988). See map 4.

Centrarchidae-Sunfish Family

Species: **Rock bass**, **<u>Ambloplites</u> <u>rupestris</u>** (Introduced)

Number of occurrences: 62 sites, 6.3% of sites.

The rock bass is a centrarchid species found in lakes and larger streams.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	2.6	18.7	0.004
Num/ha:	108.2	1,142.9	2.15
Num/km:	96.33	1,027.8	5

Range: Rock bass were limited to larger streams and a few smaller coastal streams. Whitworth et al. (1988) had no records of rock bass from the Thames River Basin, however our survey produced specimens from the lower Willimantic River, lower Shetucket River and upper Quinebaug River. This species was common in portions of the Housatonic River and Connecticut River basins. No individuals were collected during this study in the Eastern Coastal or Pawcatuck River basins. A dense population was centered at the confluence of the Little and Shetucket rivers. See map 5.

Species: **Banded sunfish**, **<u>Enneacanthus</u> <u>obesus</u>** (Native)

Number of occurrences: 4 sites, 0.4% of sites.

The banded sunfish is currently listed as a threatened species in Connecticut. This species prefers slow, tannic waters and can tolerate pH values as low as 3.3. Banded sunfish habitat was not well covered during the stream survey because areas with undefined channels were not easily sampled with our gear and methodology. It is almost certain that more populations exist, but it would require a concerted effort to sample these habitats. One additional record for banded sunfish was Peg Mill Brook, a Pawcatuck River Basin stream (B. Murphy, DEP unpublished data).

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	0.15	0.19	0.10
Num/ha:	42.4	54.5	30.2
Num/km:	14.85	20.0	9.7

Range: The range of this species is limited to the eastern half of the state. Whitworth et al. (1988) had records of occurrences in several areas in the lower Connecticut River Basin and in the Whitford Brook system. We did not encounter any specimens in these areas. See map 6.

Species: **Redbreast sunfish**, **Lepomis auritus** (Native)

Number of occurrences: 179 sites, 18.3% of sites.

The redbreast sunfish is commonly found in streams and rivers. Hence, established populations were frequently encountered during the Stream Survey. This is in contrast with other centrarchid species for which a high percentage of collections were of transient individuals.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	2.4	36.5	0.004
Num/ha:	242.5	2,912.6	3.37
Num/km:	237.1	4,310.0	5.0

Range: Distribution records from this study are similar to Whitworth et al. (1988). The occurrence of redbreast sunfish in the Western Highlands was sporadic, especially in the upper Farmington River Regional Basin. See map 7.

Species: **Green sunfish**, **Lepomis cyanellus** (Introduced)

Number of occurrences: 44 sites, 4.5% of sites.

The green sunfish is generally found in ponds and small streams and is known to be tolerant of low water quality. This centrarchid can establish populations in small streams as well as larger rivers. Green sunfish were collected in streams from 1.7 to 20 m wide.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	1.0	12.05	0.005
Num/ha:	206.3	1,397.8	1.5
Num/km:	94.8	746.7	4.9

Range: The majority of green sunfish populations were found in the Thames River Basin and in portions of the Western Coastal Basin. A single population was sampled in the Housatonic River Basin in Town Farm Brook. Whitworth et al. (1988), found green sunfish in a Hudson River Basin stream, but no populations were found in that basin during this survey. See map 8.

Species: **Pumpkinseed**, Lepomis gibbosus (Native)

Number of occurrences: 461 sites, 47.1% of sites.

A common pond centrarchid, pumpkinseed are often found in streams as transient individuals. Stable stream populations are limited to larger waters.

Statewide.	Mean	Max.	Min.
Biomass (kg/ha):	1.5	42.6	0.002
Num/ha:	298.3	9,924.8	0.61
Num/km:	119.7	2,560.0	3.3

Range: Statewide distribution. Pumpkinseed are present in every regional basin sampled. See map 9.

Species: **Bluegill**, Lepomis macrochirus (Introduced)

Number of occurrences: 335 sites, 34.2% of sites.

The bluegill is a common and widely introduced pond centrarchid with transient individuals occurring in streams. Stream populations of bluegills are only found in large, slow moving rivers.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	1.97	63.6	0.01
Num/ha:	290.5	8,105.3	2.96
Num/km:	125.5	1,566.7	5.0

Range: This species is found statewide in all major basins. See map 10.

Species: **Smallmouth bass, <u>Micropterus</u> <u>dolomieu</u>** (Introduced)

Number of occurrences: 83 sites, 8.5% of sites.

The smallmouth bass is a popular game fish that has been widely introduced in Connecticut. This species was found in most of the major rivers in the state. Occurrence in smaller streams (less than 8 m) is often the result of lake escapement or immigration from larger rivers. Known populations that were not sampled exist in the upper Connecticut River and the lower Farmington River. See map 11.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	5.1	20.6	0.1
Num/ha:	145.9	839	2.8
Num/km:	199.6	1,044.7	5.0

Species: **Largemouth bass, <u>Micropterus</u> <u>salmoides</u>** (Introduced)

Number of occurrences: 347 sites, 35.4% of sites.

The largemouth bass is a widely introduced lentic centrarchid species, with transient individuals from ponds commonly found in streams. Resident populations occur in some larger rivers.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	1.2	33.6	0.004
Num/ha:	206.7	5,462.96	4.1
Num/km:	92.2	1,180.0	4.7

Range: This species is found statewide in all major drainages. Collections in this study show a more extensive coverage than in Whitworth et al. (1988). The current study found only a few locations with largemouth bass in streams in the Farmington River Drainage above the Nepaug River confluence. There are largemouth bass present in several reservoirs and lakes (West Hill Pond, Barkhamsted Reservoir and Highland Lake) at the top end of this system, thus it would not be unexpected to find transient individuals in streams in this area. The cooler temperatures of water released from the West Branch Reservoir may cause largemouth bass and smallmouth bass to avoid this area. See map 12.

Species: **Black crappie, Pomoxis nigromaculatus** (Introduced)

Number of occurrences: 20 sites, 2.0% of sites.

A widely introduced lentic centrarchid species, black crappie were collected below impoundments and in large rivers. Most stream records represent transitory individuals rather than established populations.

Statewide.	Mean	Max.	Min.
Biomass (kg/ha):	0.26	1.72	0.007
Num/ha:	19.88	58.3	2.82
Num/km:	17.33	59.5	5.0

Range: Black crappie were collected statewide from the three large river systems and from the Western and Central Coastal systems. See map 13.

Clupeidae-Herring Family

Species: **Alewife, Alosa pseudoharengus** (Anadromous)

Number of occurrences: 3 sites, 0.3% of sites.

An anadromous clupeid species, the alewife is often introduced as a forage species in lakes. The timing of our sampling prevented us from accurately representing this species' utilization of Connecticut streams.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	0.12	0.13	0.11
Num/ha:	3,992	7,972	12.7
Num/km:	1,753	3,500	6.66

Range: Anadromous runs occur in coastal streams, while transient individuals occur below lakes with landlocked populations (See Whitworth et al. (1988), and Phillips et al. (1987)). The specimens collected in this study were found in spawning streams near the head of tide. (Mill Brook/Lieutenant River, Pattagansett River and Naugatuck River). See map 14.

Species: **Gizzard shad**, Dorosoma cepedianum (Anadromous)

Number of occurrences: 1 site, 0.1% of sites.

Range: One population was encountered in the Quinnipiac River, below Wallace Dam. At least three ages were present. Gizzard shad had previously been documented from Community Lake about 1/4 mile upstream. Additional gizzard shad have been documented from fishways on large rivers in the Connecticut River and Thames River basin. The range of this species appears to be expanding along the coast of Connecticut (S. Gephard, personal communication). See map 15.

Cottidae-Sculpin Family

Species: **Slimy sculpin**, Cottus cognatus (Native)

Number of occurrences: 18 sites, 1.8% of sites.

The slimy sculpin is usually found in cold clear gravel-bottomed streams. Populations had a wide range of densities, with several collections of possibly transient individuals in larger streams. The presence of transient individuals indicates an established population upstream. Specimens were found in streams with a dissolved oxygen concentration of at least 8 mg/l, and summer water temperature below 23°C.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	8.9	70.05	0.04
Num/ha:	5,059.1	51,272.7	5.4
Num/km:	1,384.4	7,540.0	6.7

Range: Distribution is similar to Whitworth et al. (1988), with the addition of several locations in the Western Highlands, and one site in a Shetucket River tributary. Populations can be very localized and therefore difficult to locate. Any site with slimy sculpin present should have water quality that is suitable for trout. See map 16.

Cyprinidae-Minnow Family

Species: **Goldfish**, Carassius auratus (Introduced)

Number of occurrences: 10 sites, 1.0% of sites.

Release of unwanted aquarium fish has resulted in collections of individuals from several locations. One site Folley Brook had an established populations. See map 17.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	11.9	52.6	0.02
Num/ha:	669.8	4,528.9	10.6
Num/km:	298.9	1,862.5	6.5

Species: **Common carp**, <u>Cyprinus carpio</u> (Introduced)

Number of occurrences: 18 sites, 1.9% of sites.

This introduced species was found primarily in larger rivers or small streams associated with large rivers and ponds. The smallest stream where carp were caught was 4 meters wide.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	45.8	178.0	0.003
Num/ha:	125.0	1109.8	1.4
Num/km:	72.5	587.1	5

Range: Mainstem and large tributaries of the Connecticut, Housatonic, Quinnipiac and Thames Rivers. See map 18.

Species: **Cutlips minnow**, <u>Exoglossum maxillingua</u> (Native)

Number of occurrences: 42 sites, 4.3% of sites.

This species is found in riffles of moderate to large streams (width greater than 3.5 m).

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	4.9	32.5	0.1
Num/ha:	704.1	6,459.2	22.3
Num/km:	814.6	9,286.6	10.0

Range: With the exception of a single specimen captured in the Slocum River at the top of the Farmington River Drainage, all populations were in either the Housatonic Basin below Bulls Bridge, or the Western Coastal streams. The distribution pattern is similar to that shown by Whitworth et al. (1988). See map 19.

Species: **Common shiner**, <u>Luxilus cornutus</u> (Native)

Number of occurrences: 285 sites, 29.1% of sites.

This minnow occurs in a wide range of stream habitats.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	5.2	163.9	0.01
Num/ha:	1,152.3	28,889.5	4.1
Num/km:	940.9	59,165.6	6.5

Range: The common shiner is found in many streams throughout the state, with the exception of some small coastal drainages and the Pachaug River system where no specimens were collected. See map 20.

Species: **Golden shiner, Notemigonus crysoleucas** (Native)

Number of occurrences: 275 sites, 28.1% of sites.

This species is widely distributed minnow species commonly used as bait. Established populations usually occur in lakes and ponds, however specimens are commonly encountered in streams and rivers.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	2.2	41.4	0.004
Num/ha:	387.0	7,542.4	2.82
Num/km:	137.5	1,780.0	5.0

Range: Golden shiners are distributed statewide in all major basins having specimens present. See map 21.

Species: **Bridled shiner, Notropis bifrenatus** (Native)

Number of occurrences: 8 sites, 0.8% of sites.

This small cyprinid, found in lakes and slow moving streams, can easily be confused with blacknose dace due to their small size and color pattern.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	0.095	0.24	0.03
Num/ha:	42.3	202.5	30.2
Num/km:	14.85	186.7	9.7

Range: Our survey data show only eight sites, however Whitworth et al. (1988) depicts a more widespread distribution of this species. See map 22.

Species: **Spottail shiner, Notropis hudsonius** (Native)

Number of occurrences: 50 sites, 5.1% of sites.

The spottail shiner is a minnow species common in both lakes and larger streams. This species was found in streams as small as 2.5 m. Sample sites with spottail shiners on smaller streams were often close to the confluence with larger rivers.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	6.2	48.3	0.004
Num/ha:	840.4	6,213.0	2.94
Num/km:	1,240.3	14,620.0	5.0

Range: Our data, together with that of Whitworth et al. (1988), shows a statewide distribution of this species. See map 23.

Species: **Bluntnose minnow**, **<u>Pimephales notatus</u>** (Introduced)

Number of occurrences: 5 sites, 0.5% of sites.

The bluntnose minnow is a minnow species that may inhabit a broad range of lentic and lotic conditions. This species can be confused with the spottail shiner.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	0.91	3.6	0.02
Num/ha:	553.7	1,648	5.9
Num/km:	544.5	1,620	6.66

Range: Populations were found in the Housatonic River and lower reaches of its tributaries from the Massachusetts border downstream to the confluence with the Aspetuck River. See map 24.

Species: **Fathead minnow**, **<u>Pimephales promelas</u>** (Introduced)

Number of occurrences: 27 sites, 2.8% of sites.

This cyprinid species is commonly used as bait, and is also stocked to provide forage in ponds.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	0.4	2.8	0.001
Num/ha:	217.2	1,320.5	3.36
Num/km:	73.6	413.3	5.0

Range: Fathead minnow populations are found at many sites in the Housatonic River Basin. Evidence of established populations outside of the Housatonic River Basin was encountered at two sites. Most collections in other drainages however were of isolated individuals. Whitworth et al. (1988) lists only one site in the Connecticut River Basin with fathead minnows. Because of additional stocking and bait bucket releases the range of this species appears to be expanding. See map 25.

Species: **Blacknose dace, Rhinichthys atratulus** (Native)

Number of occurrences: 670 sites, 68.4% of sites.

Blacknose dace are a common headwater stream species often associated with brook trout. They are most abundant in clean cobble streams with open canopies and moderate to shallow depth. Blacknose dace also occupy the lateral margins of some larger rivers.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	7.5	198	0.1
Num/ha:	4,012	71,652	2.26
Num/km:	1,597	34,613	6.32

Range: The range of this species is statewide with the exception of a small block of eastern coastal streams, where this survey and that of Whitworth et al. (1988) have no records. We are at a loss to explain the absence of this species from this small area. See map 26.

Species: **Longnose dace, Rhinichthys cataractae** (Native)

Number of occurrences: 280 sites, 28.6% of sites.

The longnose dace is a small cyprinid that prefers riffle habitats.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	5.2	44.3	0.0095
Num/ha:	990.8	9,210.2	10.1
Num/km:	736.8	9,610.0	6.66

Range: The present study shows a longnose dace distribution similar to that of Whitworth et al. (1988), with the addition of new records in the Western Coastal Drainages. There are several areas where longnose dace are absent: the Yantic River, the portion of the Eastern Coastal Drainage west of the Thames River, the Wepawaug River, the Indian River, and several of the Western Coastal streams including the Norwalk River. A single specimen was identified from Roaring Brook in the Willimantic River Drainage. This is the only record of longnose dace above the fall line at Willimantic. It is likely that this specimen was a bait bucket release. In at least some areas, it appears that physical barriers have excluded longnose dace, in others the reason for their absence is not clear. See map 27.

Species: **Creek chub, Semotilus atromaculatus** (Native)

Number of occurrences: 262 sites, 26.8% of sites.

The creek chub is a stream cyprinid that is sometimes sold as bait. Specimens were taken over a very wide range of environmental parameters.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	11.8	135.4	0.002
Num/ha:	2,323.2	34,782.6	3.4
Num/km:	658.1	5,900.0	2.2

Range: They are common in the western third of the state. Scattered records in the central and eastern portions of the state are probably the result of bait bucket releases. See map 28.

Species: **Fallfish, Semotilus corporalis** (Native)

Number of occurrences: 289 sites, 29.5% of sites.

The fallfish is our largest native cyprinid species and is one of the more common native stream fishes. This species can be a dominant biomass component in some streams.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	15.4	828.5	0.001
Num/ha:	1,048.1	17,233.6	2.1
Num/km:	652.7	15,303.5	4.2

Range: Fallfish are found statewide, with the heaviest concentration of records in the Connecticut River and Thames River basins. See map 29.

Cyprinodontidae-Killifish Family

Species: **Banded killifish, Fundulus diaphanus** (Native)

Number of occurrences: 34 sites, 3.5% of sites.

This species utilizes both lakes and slow streams.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	1.7	14.7	0.003
Num/ha:	540.4	3,377.8	1.4
Num/km:	239.3	1,773.3	3.33

Range: Our records for banded killifish are sparse and widely scattered. Whitworth et al. (1988) has additional records of specimens taken from the upper Shetucket River Drainage, numerous coastal streams and tributaries to the Connecticut River. Neither our survey nor Whitworth et al. (1988) collected this species from streams in the Yantic River, Fenton River, Mount Hope River, upper Farmington River or Scantic River drainages. See map 30.

Esocidae-Pike Family

Sub-Species: **Redfin pickerel,** Esox americanus vermiculatus (Native)

Number of occurrences: 135 sites, 13.6% of sites.

Species **Chain pickerel,** Esox niger (Native)

Number of occurrences: 221 sites, 22.6% of sites.

Found in weedy streams or pond outflows.

Redfin pickerel

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	9.5	244.95	0.02
Num/ha:	582.9	13,436.7	3.4
Num/km:	168.2	3,553.3	5.0

Chain pickerel

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	4.5	30.75	0.02
Num/ha:	217.1	10,899	2.7
Num/km:	82.1	2,060	4.7

Range: The distributions of redfin pickerel and chain pickerel are interrelated, with ponds being dominated by chain pickerel, and streams by redfin pickerel (Smith, 1985). Out of 294 sites with pickerel only 24 (8%) had both species present. At sites with both species present, both biomass and numbers were dominated by redfin pickerel. The primary areas of species overlap occur in the lower Connecticut River Basin tributaries, and in the Eastern Coastal and Pawcatuck River basins. In the Central and Western Coastal basins, the distribution of the two species appears mutually exclusive in most streams.

Redfin pickerel are absent from much of the Thames River and Housatonic River basins and the majority of the Farmington River Regional Basin. The reason for the limited distribution of redfin pickerel in the Thames River valley is unclear. Only a few individuals were found in the upper Willimantic River, and Whitworth et al. (1988) shows one site in the upper portion of English Neighborhood Brook in Putnam and one in the upper reaches of the Pachaug River system. No specimens were found in either area during this study. See map 31.

The distribution of chain pickerel is densest in the Thames River Basin and more sparsely scattered throughout the rest of the state. They are common throughout the state in ponds and lakes. See map 32.

Species: **Northern pike, Esox lucius** (Introduced)

Number of occurrences: 5 sites, 0.5% of sites.

Northern Pike are a holartic species introduced into Connecticut.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	2.0	5.7	0.04
Num/ha:	9.2	12.2	4.3
Num/km:	8.0	10.0	6.5

Range: The range of this popular gamefish is increasing in Connecticut through stocking and migration. Northern pike were originally stocked into Bantam Lake and the Connecticut River, with more recent releases in Mansfield Hollow Reservoir. Yearling pike were collected in two tributaries to the Connecticut River. Yearling and older pike were sampled in the Natchaug River below Mansfield Hollow Dam, and young-of-the-year pike were sampled above Mansfield Hollow Dam in the Fenton River. Specimens have been collected by angling or netting in the upper Farmington River (above Colebrook Reservoir), the Shepaug River arm of Lake Lillinonah, the Housatonic River above Falls Village and Tyler Lake in the headwaters of the Bantam River. See map 33.

Gadidae-Cod Family

Species: Burbot, Lota lota (Uncertain: Native or Introduced)

Number of occurrences: 3 sites, 0.3% of sites.

This species is usually associated with large, deep northern lakes and rivers.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	13.6	25.6	0.07
Num/ha:	113.8	212.0	17.5
Num/km:	62.5	114.3	13.3

Range: Only one population of burbot, with several age classes, was sampled in this survey. This population was located in the Hollenbeck River and one of its' tributaries. This survey also collected two young-of-the-year specimens from Salmon Brook just across the river from Wethersfield Cove. There are anecdotal reports of larger burbot being caught in the Wethersfield Cove area. Whitworth et al. (1988) reported the last specimens in Connecticut as having been captured in 1908. See map 34.

Gasterosteidae-Stickleback Family

Species: **Fourspine stickleback, _Apeltes quadracus_** (Amphidromous)

Number of occurrences: 9 sites, 0.9% of sites.

The fourspine stickleback is an amphidromous species with several freshwater populations.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	1.3	4.1	0.009
Num/ha:	2,498.3	8,890.8	39.5
Num/km:	683.8	4,703.2	6.7

Range: This species is found along most of Connecticut's coast (Whitworth et al. 1988). Sites which are still maintaining viable freshwater populations include Patton Brook and Mill River (Hamden). See map 35.

Ictaluridae-Catfish Family

Species: **White catfish, _Ameiurus catus_** (Introduced)

Number of occurrences: 7 sites, 0.7% of sites.

The white catfish is of moderate importance to anglers, and has been introduced to many lakes and pond.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	0.8	1.6	0.02
Num/ha:	22.6	38.8	6.5
Num/km:	13.7	20.0	7.4

Range: This species was found in larger rivers, and downstream of lakes where it had been introduced. It is abundant in the lower reaches of the larger rivers (Connecticut River, Housatonic River and Thames River) where we were not able to sample effectively. See map 36.

Species: **Yellow bullhead, _Ameiurus natalis_** (Introduced)

Number of occurrences: 28 sites, 2.7% of sites.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	2.9	12.9	0.003
Num/ha:	195.6	1,010.2	5.1
Num/km:	192.3	960.0	6.6

Range: This species was not documented in Connecticut by Whitworth et al. (1988). We collected specimens from two sites in the Housatonic River Basin and from numerous sites in the Thames River Basin. Jacobs et al. (1993) found yellow bullhead in lakes of these two drainage basins. It is not clear whether this represents a new introduction and recent range expansion for this species or if yellow bullhead populations had been previously misidentified as brown bullheads. See map 37.

Species: **Brown bullhead**, _Ameiurus_ _nebulosus_ (Native)

Number of occurrences: 241 sites, 24.6% of sites.

The brown bullhead is a common species that is found in lakes, ponds, and rivers. Tolerant of low dissolved oxygen (D.O.), they have been sampled at sites with D.O. as low as 2.2 mg/l.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	2.27	49.8	0.007
Num/ha:	178.9	5501.8	1.4
Num/km:	58.1	1480	3.3

Range: Based on our records and those of Whitworth et al. (1988), and Connecticut Board of Fish and Game records, this species appears to have a statewide distribution. However, there are no records for this species from the Mount Hope River or from the Mianus River. See map 38.

Percicththyidae-Temperate Bass

Species: **White perch**, _Morone_ _americana_ (Marine vistor/Introduced)

Number of occurrences: 6 sites, 0.5% of sites.

This popular panfish species is abundant in many Connecticut waters.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	1.8	3.6	0.02
Num/ha:	28.5	53.7	3.4
Num/km:	22.5	40.0	5.0

Range: The white perch was historically primarily a coastal species, inhabiting brackish areas and lower reaches of large rivers. Introduced populations now exist in many inland lakes and ponds. With the exception of one small tidal creek in Greenwich, our records were primarily from large rivers. Specimens were collected as far upstream as the Moosup River confluence on the Quinnebaug River and at the first dam on the Quinnipiac River. Whitworth et al. (1988) has records of white perch the length of the Connecticut River. Specimens were also found past the Rainbow Reservoir Dam on the Farmington River (S. Gephard, personal communication). White perch do not commonly inhabit smaller streams where our survey would have encountered them. See map 39.

Percidae-Perch Family

Species: **Swamp darter, Etheostoma fusiforme** (Native)

Number of occurrences: 8 sites, 0.8% of sites.

This small uncommon species is found in moderate sized (2.5 -9.0 m) slow, tannic waters, often with aquatic vegetation and low pH (5.0-7.1).

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	0.09	0.4	0.02
Num/ha:	33.0	82.3	12.5
Num/km:	15.7	40.0	6.4

Range: Fewer sites were found than in Whitworth et al. (1988). Although the distributions are similar, in this survey no specimens were taken in the Fivemile River system, Mill River (Plainfield), or the Mystic River system. All samples involved few individuals. The preferred habitat of this species was not targeted or effectively sampled in this survey and our records do not accurately represent the swamp darter's range (see comments on banded sunfish). See map 40.

Species: **Tessellated darter, Etheostoma olmstedi** (Native)

Number of occurrences: 380 sites, 38.8% of sites.

This common stream species is found in a wide range of stream sizes (0.5-82 m) and can tolerate pH at least as low as 5.1. This species is easily confused with the rarer swamp darter, and overlaps the swamp darter distribution.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	1.6	38.0	0.003
Num/ha:	868.5	29,065.3	7.86
Num/km:	426.4	19,706.3	6.25

Range: The distribution from Whitworth et al. (1988) is very similar to the distribution pattern from this study. Additional specimens were collected from the upper Shetucket River Regional Basin, but no specimens were taken from the Natchaug River above Mansfield Hollow Dam. There are also several drainages in both the Western and Central Regional basins that do not have any records of tessellated darters. See map 41.

Species: **Yellow perch, *Perca flavescens*** (Native)

Number of occurrences: 136 sites, 13.9% of sites.

This species is a very popular gamefish. Although populations can be found in larger streams and rivers, the majority of specimens sampled were transient individuals from ponds.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	18.4	2,020.2	0.004
Num/ha:	365.3	11,764.7	1.5
Num/km:	179.5	4,440.0	4.9

Range: Yellow perch have a statewide distribution. See map 42.

Petromyzontidae-Lamprey Family

Species: **Sea lamprey, *Petromyzon marinus*** (Native)

Number of occurrences: 34 sites, 3.5% of sites.

Sea Lamprey are a primitive species having a complex life history. As adults they are parasitic on larger fish in the ocean. Upon maturing they return to freshwater (anadromous) where they spawn in rivers. Young sea lampreys spend 4-8 years in freshwater as filter feeders buried in the substrate. The specimens collected were primarily ammocoetes (an early life stage), although some adults were sampled.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	11.3	85.4	0.09
Num/ha:	611.3	8,944.6	5.4
Num/km:	323.8	3,926.7	6.7

Range: The range is similar to Whitworth et al. (1988) being primarily concentrated in the Connecticut River Basin. The unusual distribution pattern suggests that the plume of the Connecticut River in Long Island Sound attracts most of the adult sea lamprey that enter Connecticut waters. Additional populations were sampled at new sites throughout the Connecticut River Basin, in one Western Coastal stream (Mill River Fairfield), and in several Central Coastal Basin streams. Based on length frequencies, Central Coastal Basin samples were from several age classes. Only three specimens were collected at the Mill River, all probably from a single age class. It is not known whether this collection represents a viable population. Sea lamprey have also been collected from the Farmill River in the lower Housatonic River Basin (N. Kaputa, personal communication). There were multiple age classes at this site. See map 43.

Note: **American brook lamprey, *Lamptera appendix*** (Uncertain: Native/Introduced)

While not encountered during the course of this study, follow up sampling comfirmed the continued presence of the Kettle Brook population reported in Whitworth 1996.

Salmonidae-Trout and Salmon Family

Species: **Rainbow trout, Oncorhynchus mykiss** (Introduced)

Number of occurrences: 41 sites, 4.1% of sites.

This introduced species is stocked widely by the Division of Fisheries. Strains stocked by the state are fall spawning varieties that are not likely to establish populations. The majority of records are stocked fish.

Statewide	Mean	Max.	Min.
Wild Rainbow Trout			
Biomass (kg/ha):	5.9	8.6	3.2
Num/ha:	346.0	581.1	111
Num/km:	2,922	5,752	91.8

Range: The range of this species is statewide and reflects state stocking sites as well as some stocking by private individuals. Five locations were found with limited numbers of wild individuals (see trout reproduction section for details). See map 44.

Species: **Atlantic salmon, Salmo salar** (Native)

Number of occurrences: 21 sites, 2.1% of sites.

Atlantic salmon are an anadromous species. All specimens collected were stocked as part of the New England salmon restoration effort.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	3.4	12.3	0.06
Num/ha:	454.97	3,291.5	5.0
Num/km:	353.5	1,933.3	6.7

Range: Stocking occurs throughout the Farmington River and Salmon River drainages in the Connecticut River Basin. Additional locations where stocked salmon have been sampled include Merrick Brook in the Shetucket River Drainage and the Pawcatuck River (stocked by the State of Rhode Island). See map 45.

Species: **Brown trout, Salmo trutta** (Introduced)

Number of occurrences: 254 sites, 25.9% of sites.

The Fisheries Divisions stocking program has introduced this popular gamefish species across most of the state. Areas with no brown trout present at the time of sampling, either stocked or wild, were the Park River Drainage, the Stony Brook Drainage (Suffield), some of the Western Coastal Basin streams and all portions of the Quinebaug River Drainage above the confluence with Mashamoquet Brook. Table 17 lists the range of environmental conditions in which brown trout populations were found. See map 46.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	12.5	167.6	0.01
Num/ha:	552.6	5,956	0.8
Num/km:	2,367	2,680	3.26

Species: **Brook trout, Salvelinus fontinalis** (Native)

Number of occurrences: 496 sites, 62.2% of sites.

Brook trout are the most common trout species, in Connecticut. Their distribution is statewide in streams not impacted by high levels of development. Areas with this type of development included the Park River Drainage and Stony Brook Drainage (Suffield) and many of the drainages in the Western Coastal Basin. Table 17 lists the range of environmental conditions in which brook trout populations were found. See map 47.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	24.9	375.6	0.04
Num/ha:	2,246	40,746	2.41
Num/km:	547.6	6,926.8	5.0

Umbridae-Mudminnow Family

Species: **Central mudminnow, Umbra limi** (Introduced)

Number of occurrences: 5 sites, 0.5% of sites.

Statewide	Mean	Max.	Min.
Biomass (kg/ha):	1.0	4.5	0.03
Num/ha:	147.85	646.4	10.6
Num/km:	80.5	341.9	6.4

Range:

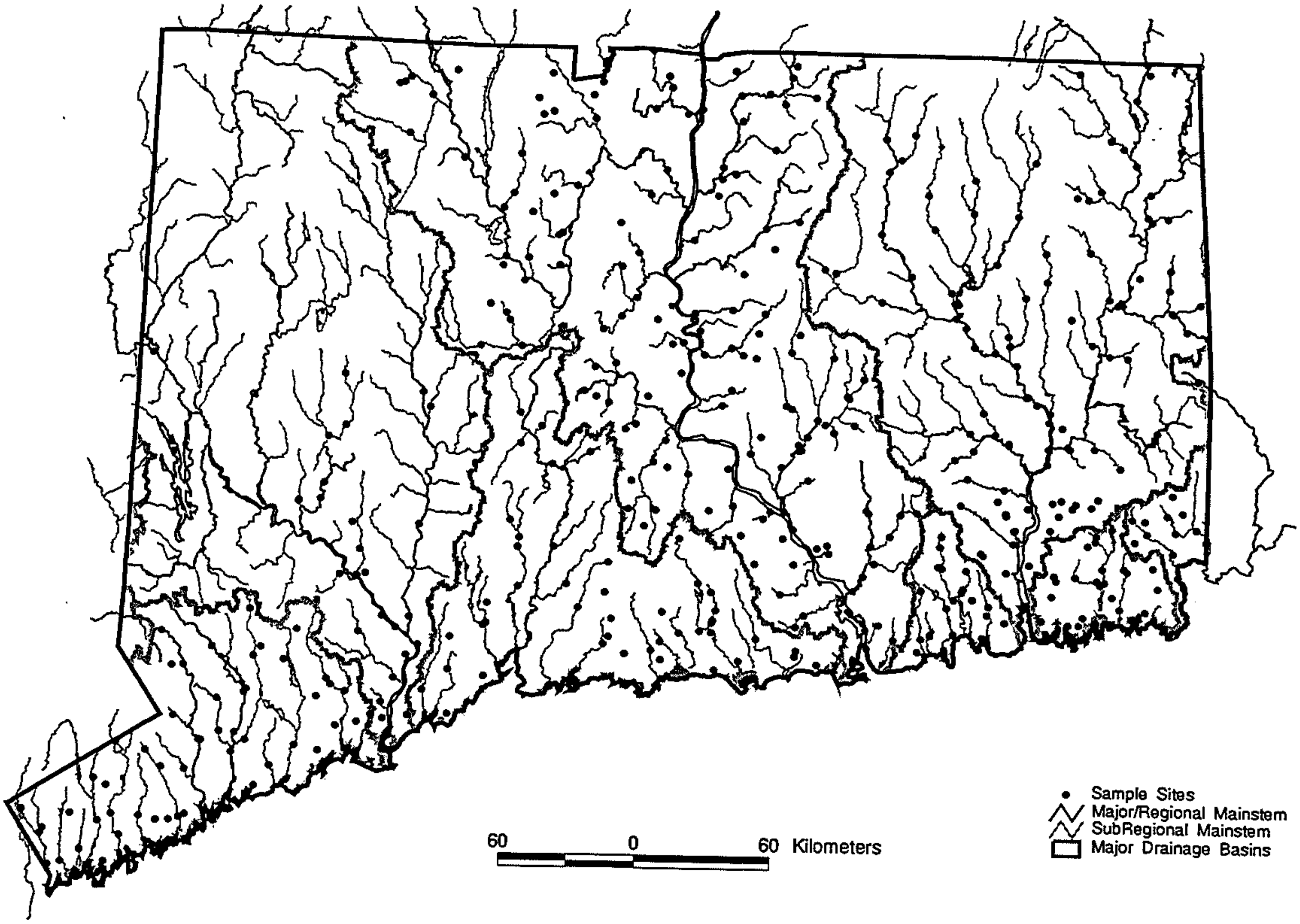
The first reports of this species were in Whitworth et al. (1980). At that time this species was found in vegetated pike spawning marshs located close to the Connecticut River. They are currently found in the Connecticut River Basin from Haddam to Windsor in tributary streams of the Connecticut River and Scantic River. The only dense population was found in Hubbard Brook. At three sites only one or two specimens were collected in the samples. See map 48.

Marine and Amphidromous Species:

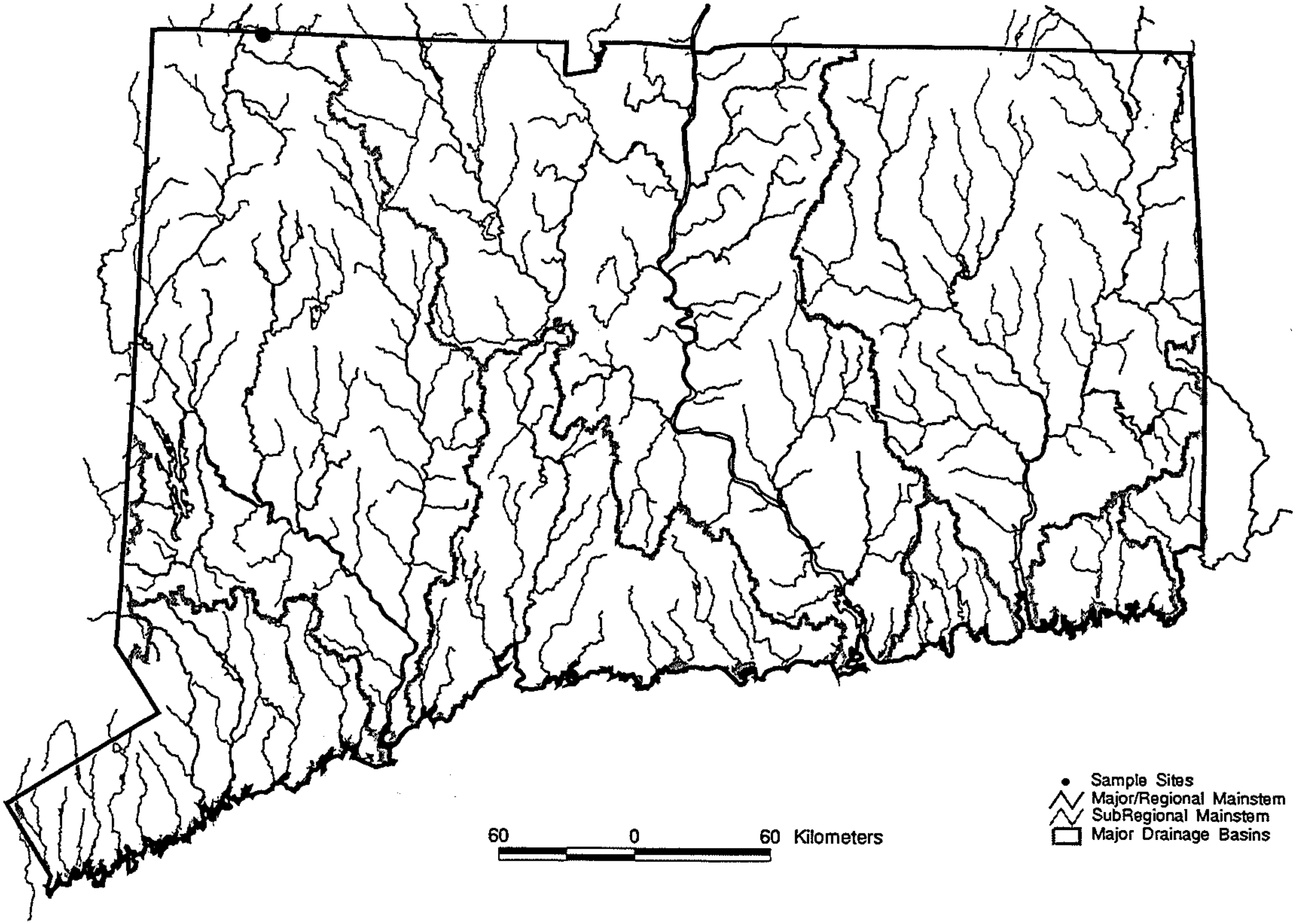
The following species are know to reside at the edge of freshwater, traveling between both environments (amphidromous) or to be marine species that will occasionally be found in freshwater. Most of these species could be collected almost anywhere along the Connecticut coastline or in larger rivers up past the head of tide. The nature of our sampling equipment and the distribution of sample sites caused only a limited number of individuals of the following species to be encountered:

Family Species		Status
Atherinidae Inland Silverside	_Menidia beryllina_	Amphidromous
Cyprinodontidae Mummichog	_Fundulus heteroclitus_	Amphidromous
Striped Killifish	_Fundulus majalis_	Amphidromous
Sheephead minnow	_Cyprinodon variegatus_	Amphidromous
Gasterosteidae Threespine stickleback	_Gasterosteus aculeatus_	Amphidromous
Ninespine stickleback	_Pungitius pungitius_	Amphidromous
Gadidae Tomcod	_Microgadus tomcod_	Amphidromous
Perichthyidae Striped Bass	_Morone Saxatilis_	Marine Visitor
Soleidae Hogchocker	_Trinectes maculatus_	Amphidromous

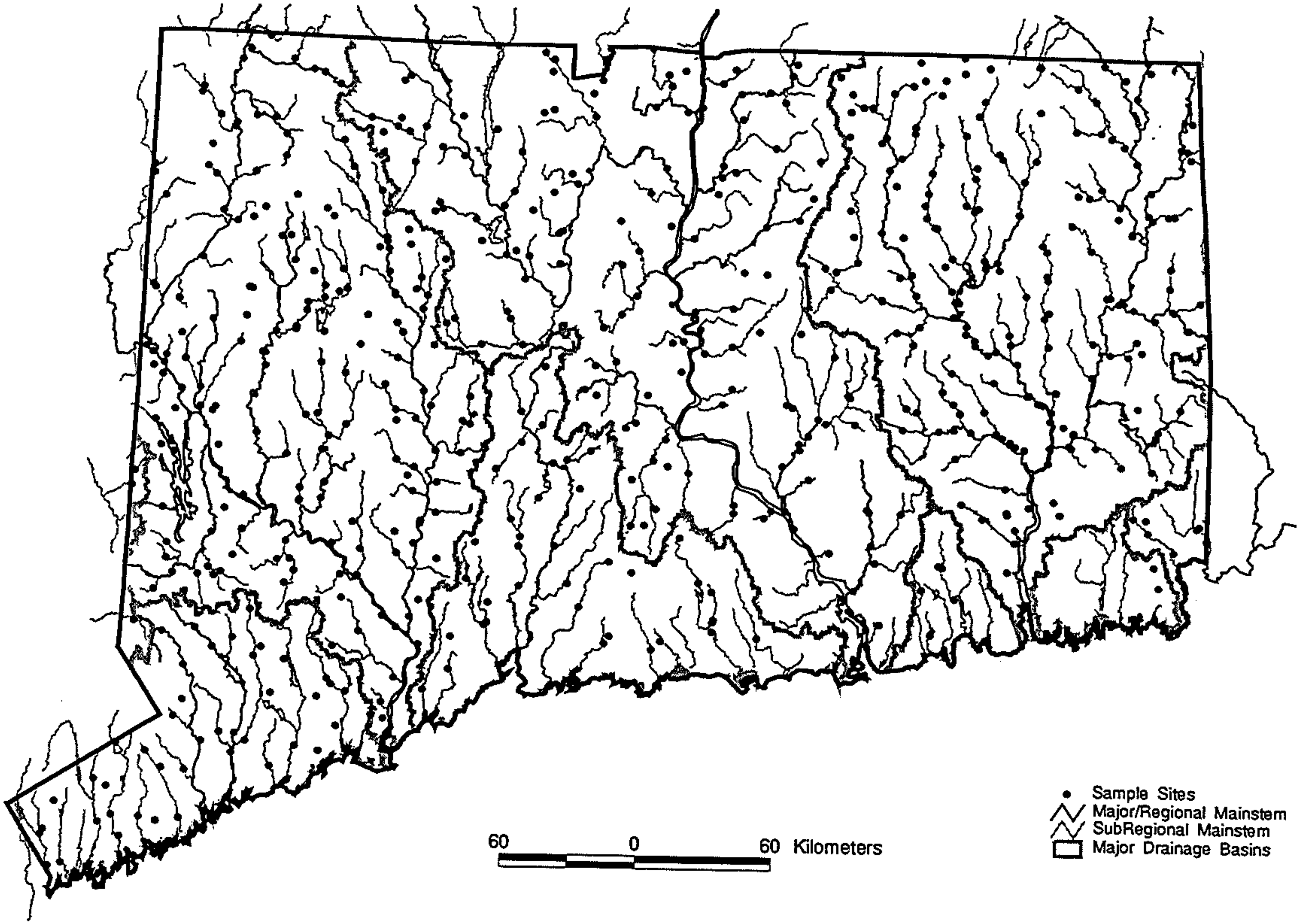
Appendix A: 9.1 Fish Distributions Maps



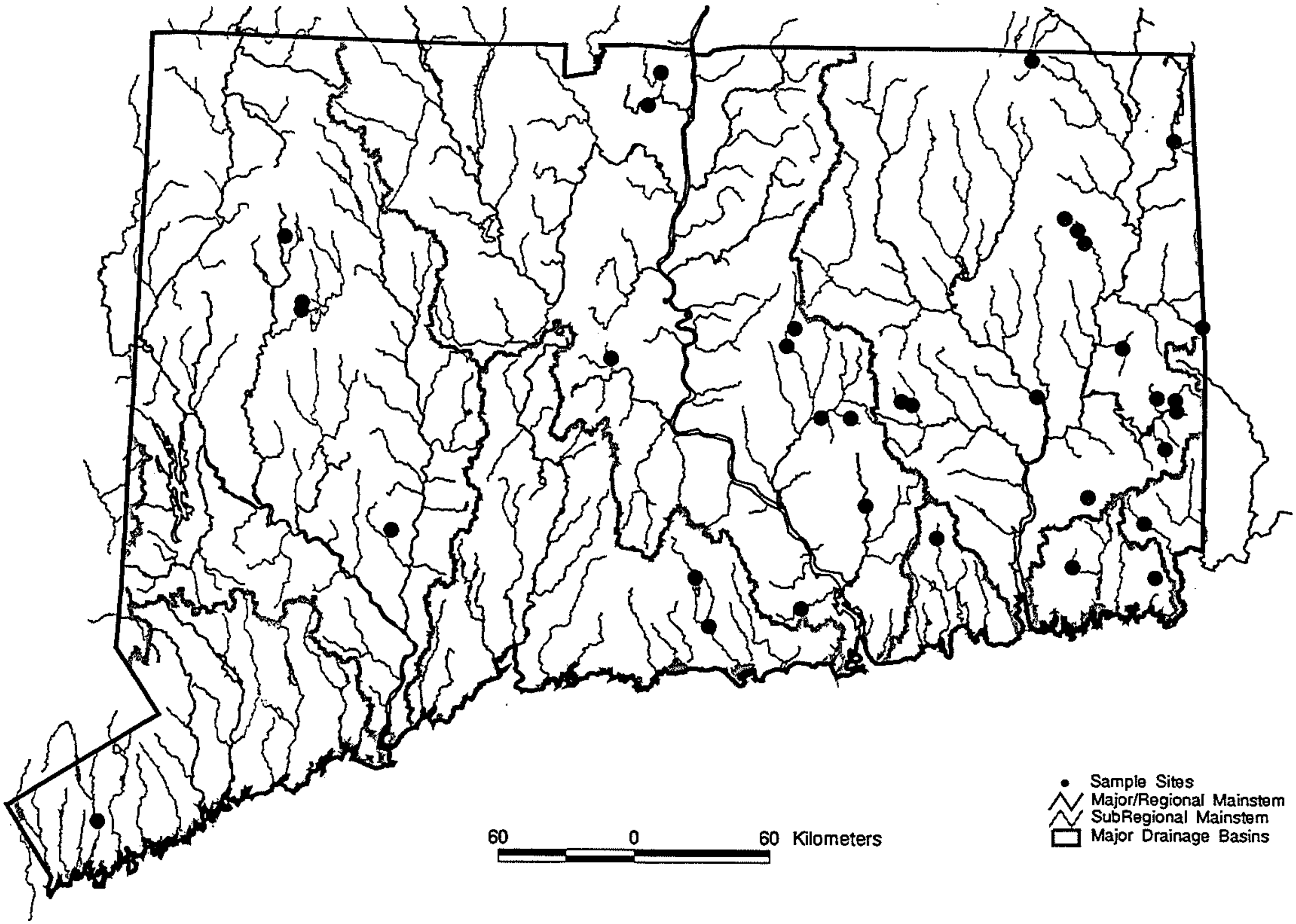
Map 1. American eel distribution.



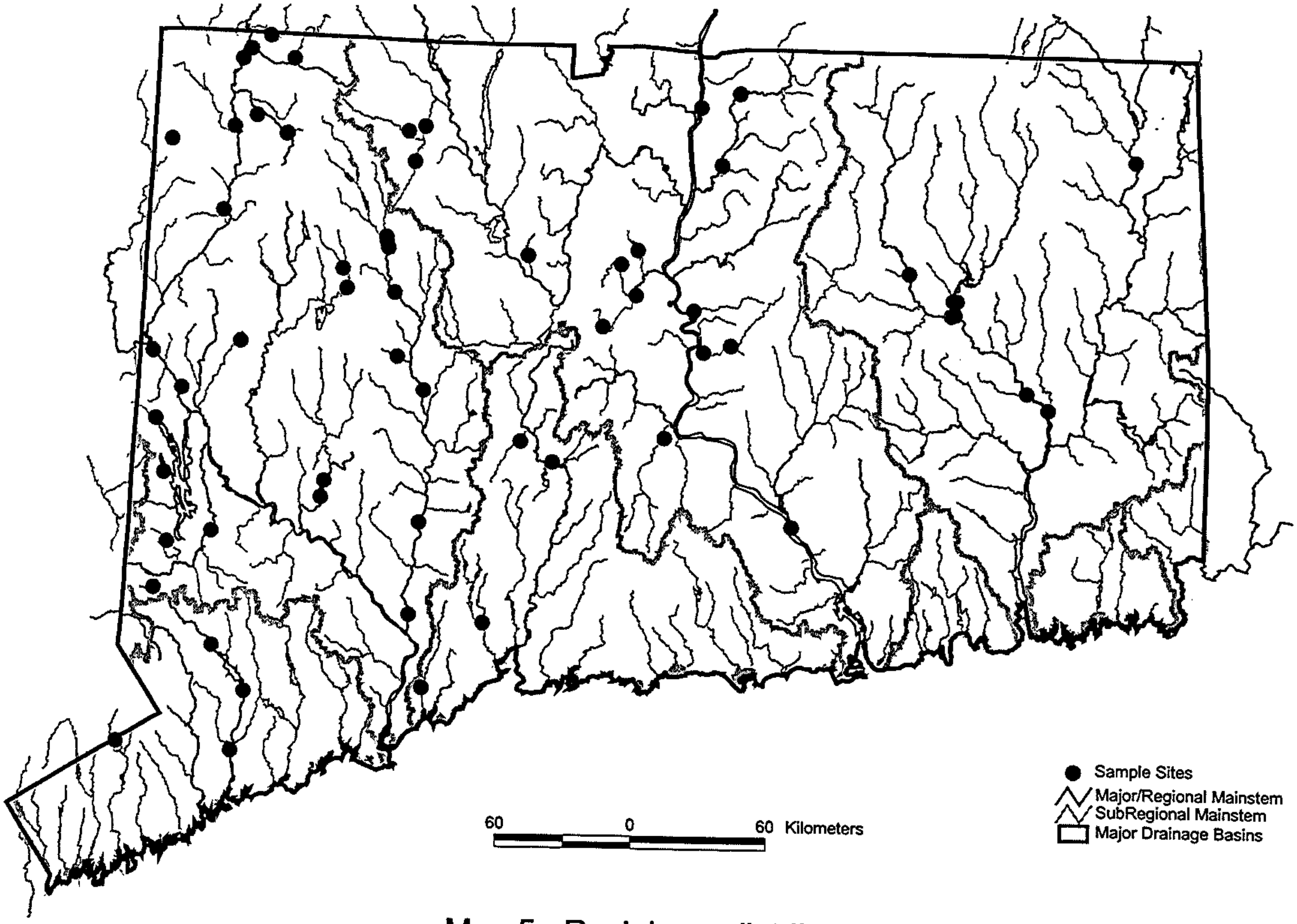
Map 2. Longnose sucker distribution.



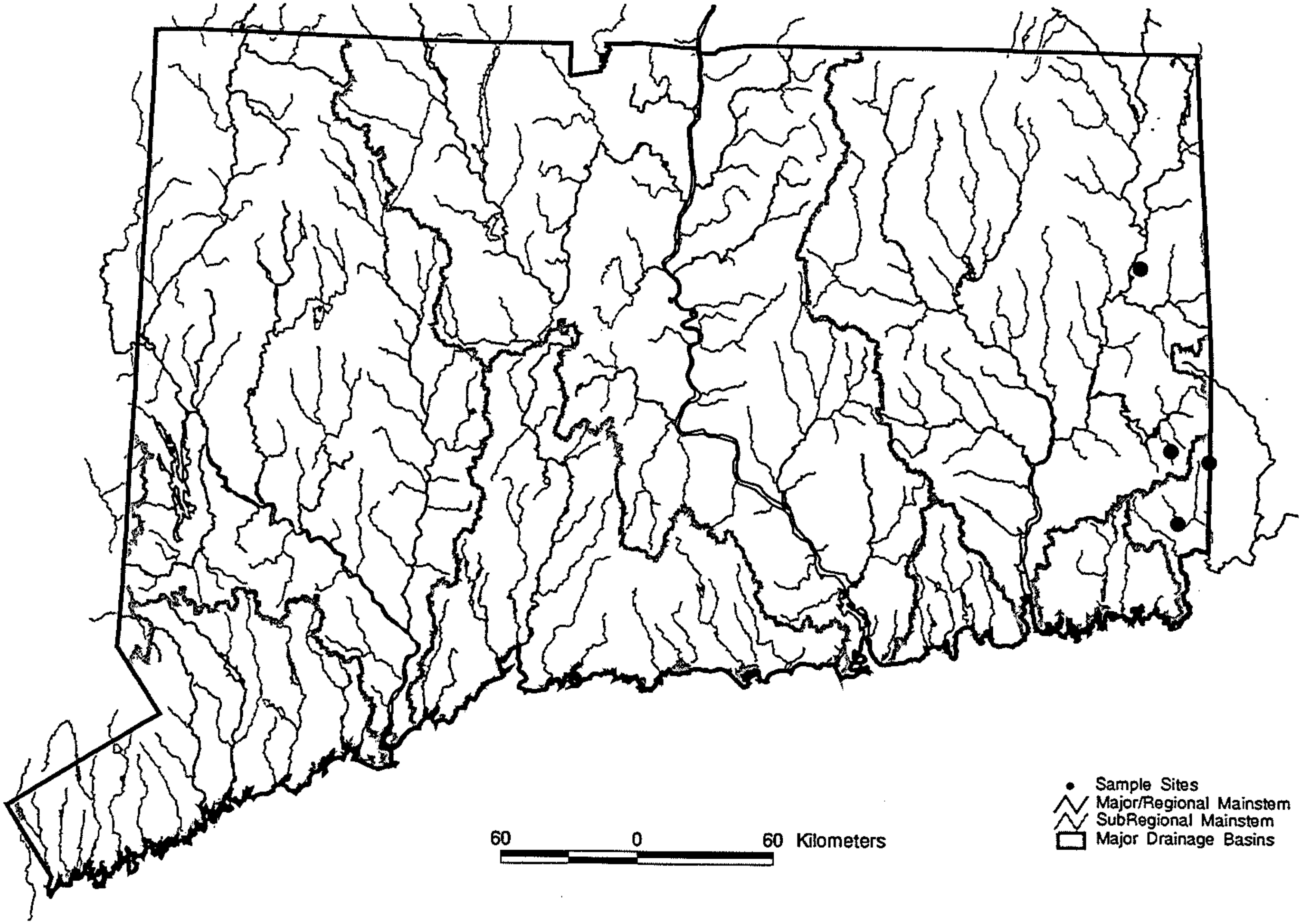
Map 3. White sucker distribution.



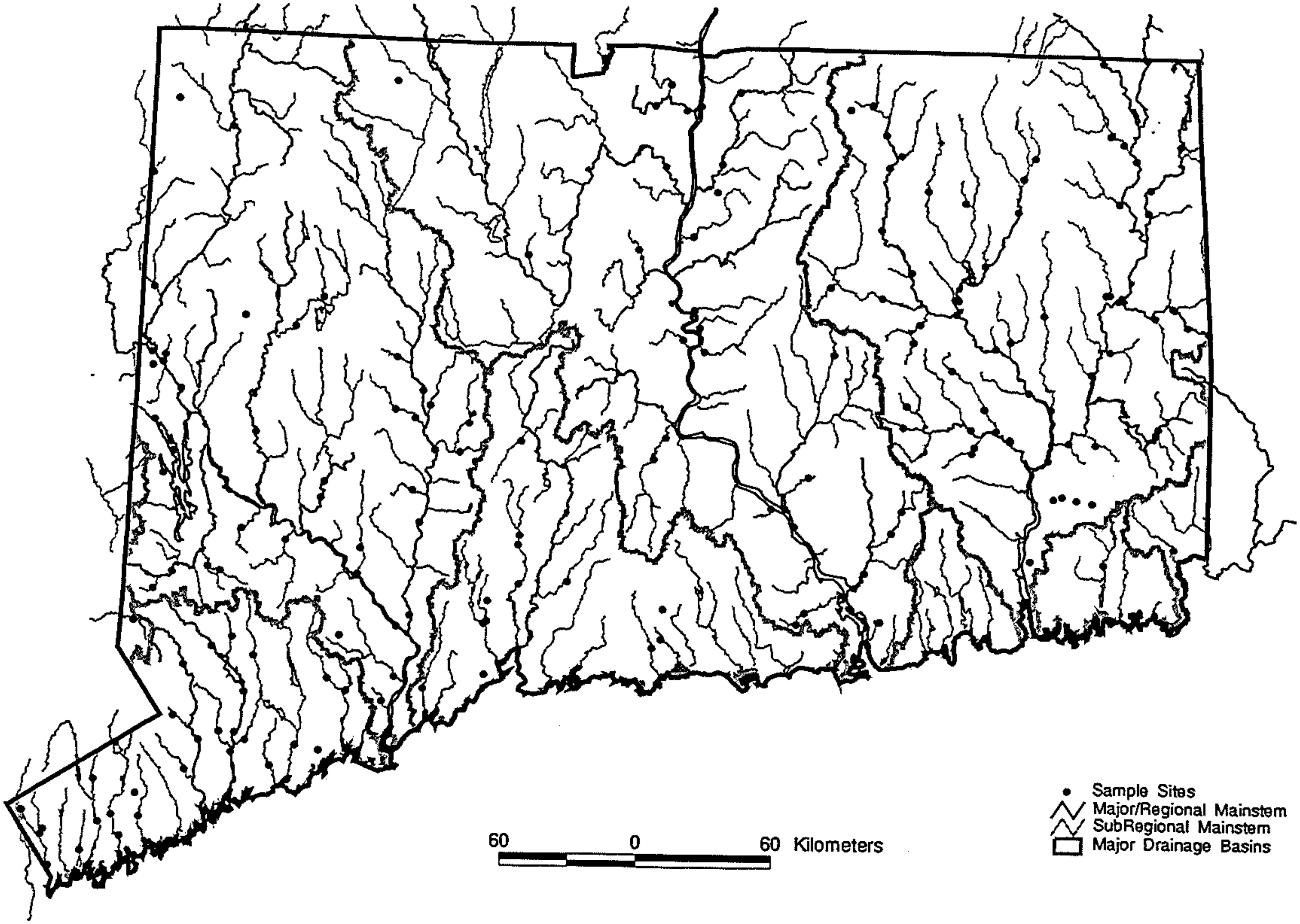
Map 4. Creek chubsucker distribution.



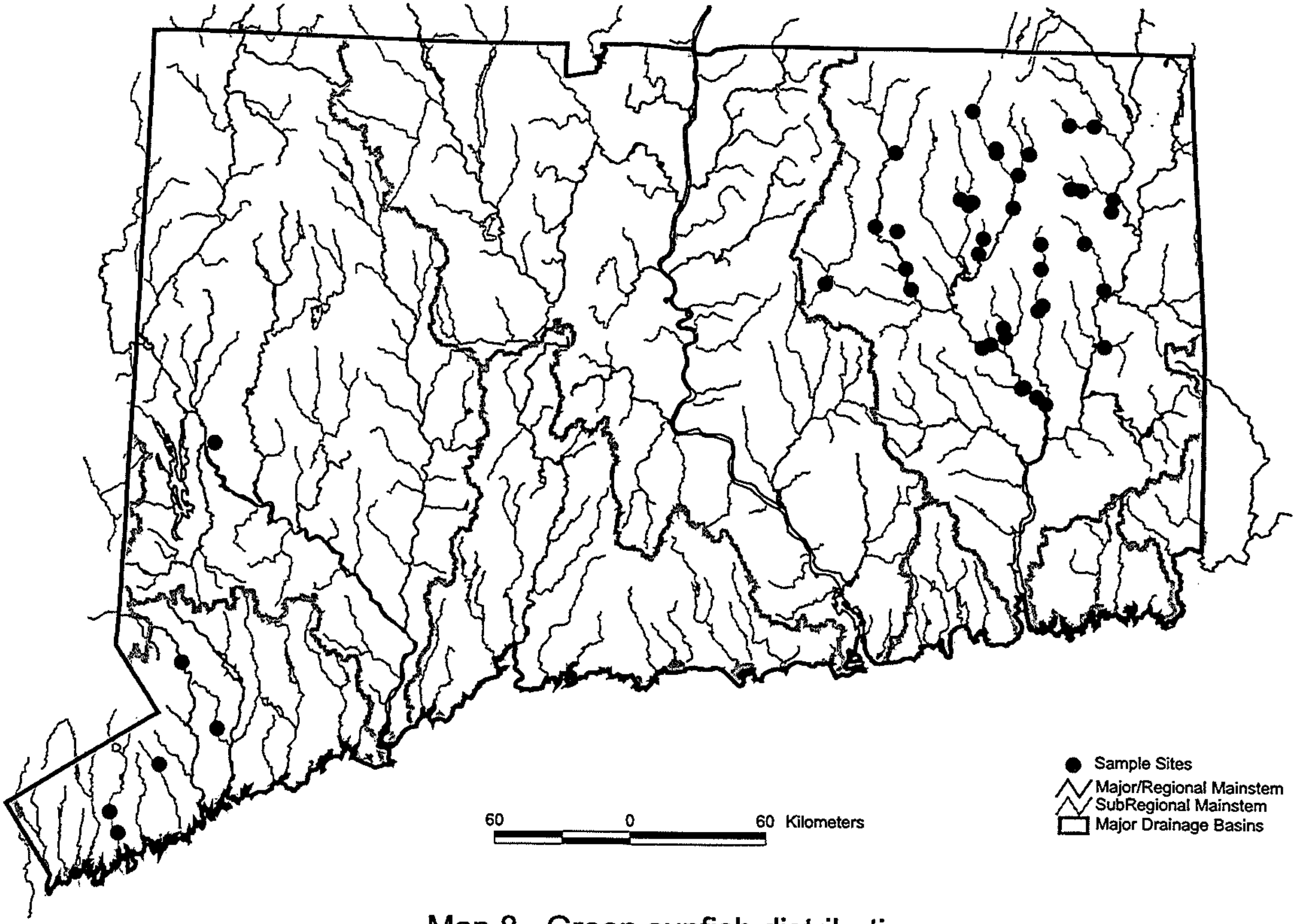
Map 5. Rock bass distribution.



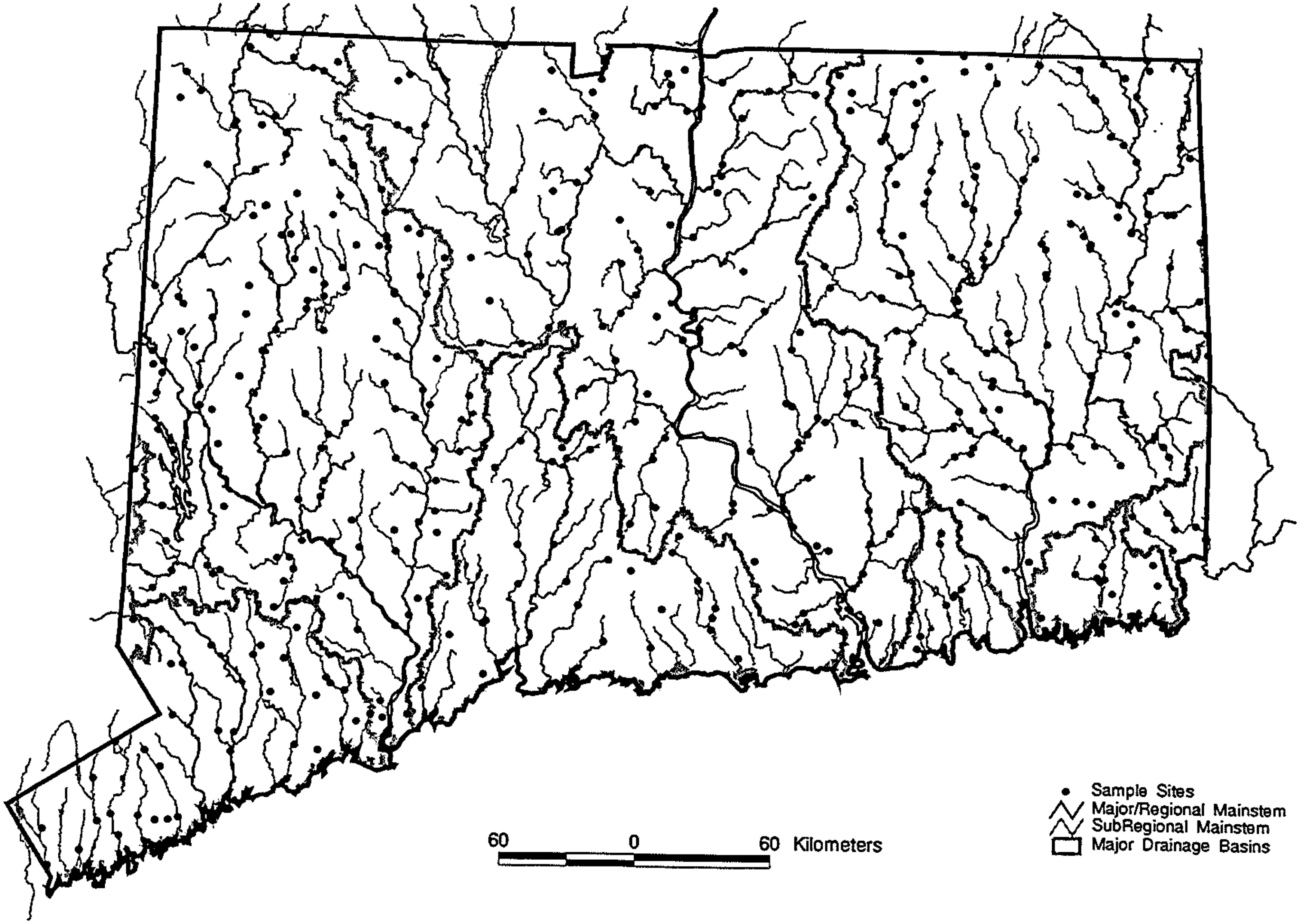
Map 6. Banded sunfish distribution.



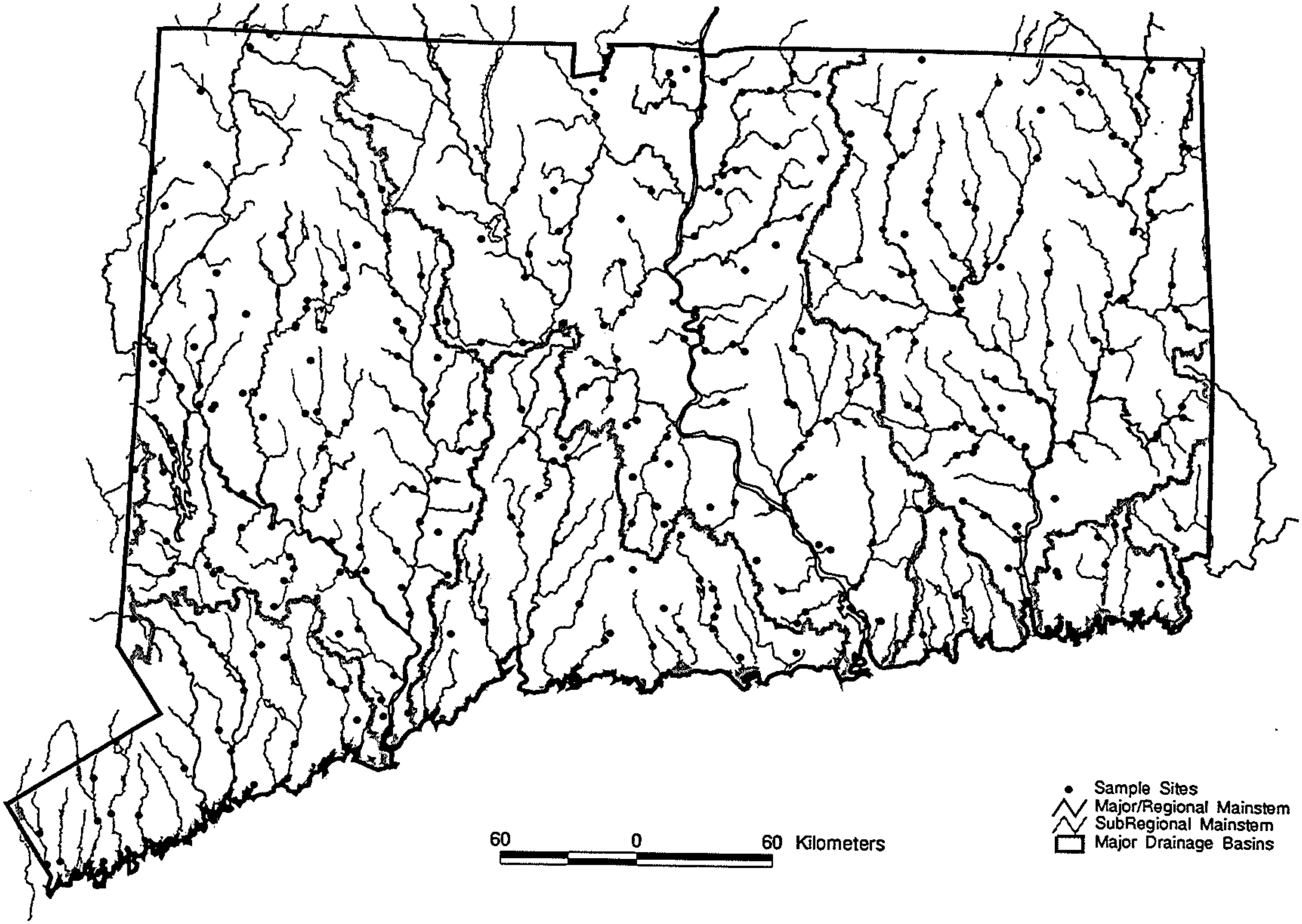
Map 7. Redbreast sunfish distribution.



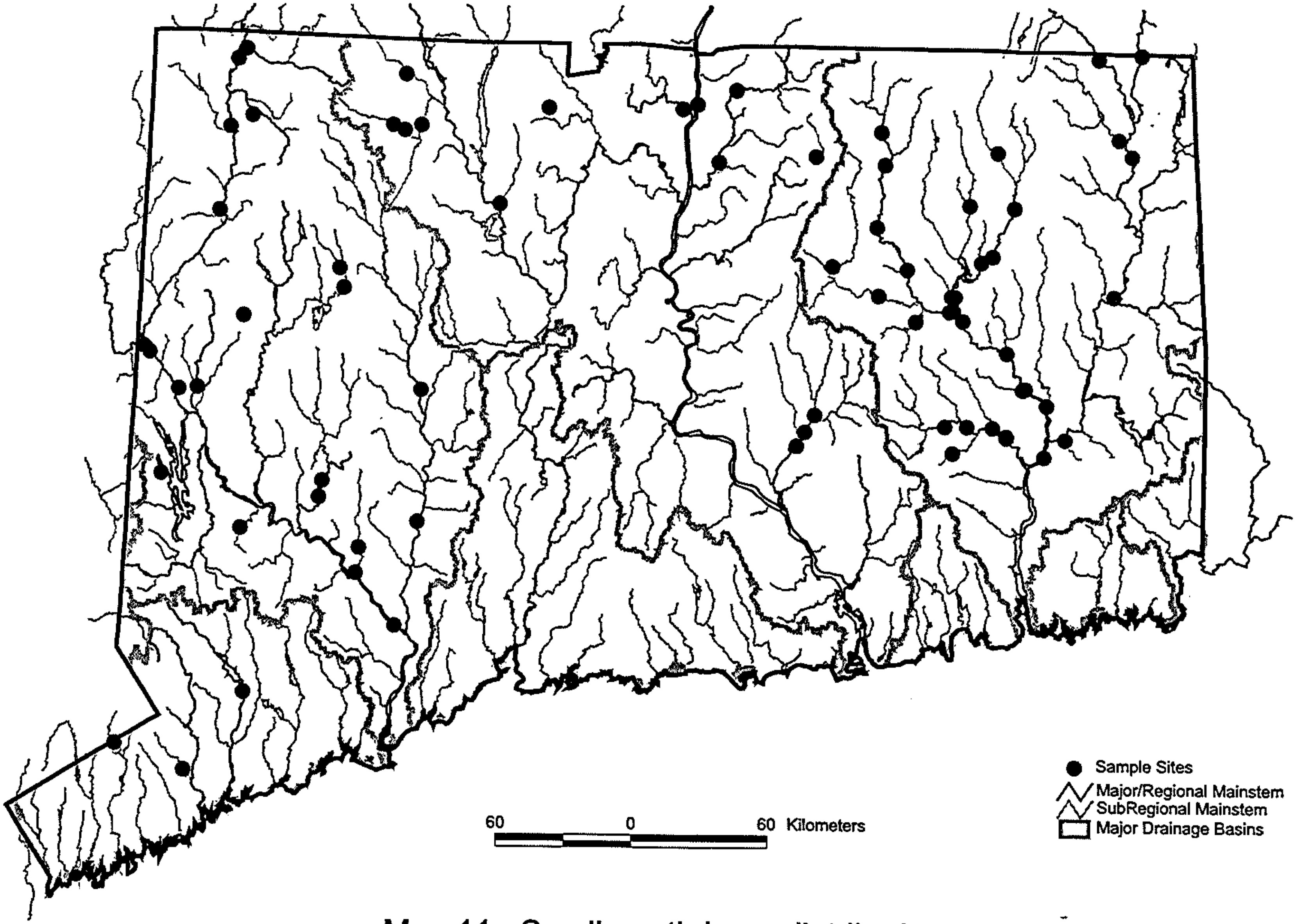
Map 8. Green sunfish distribution.



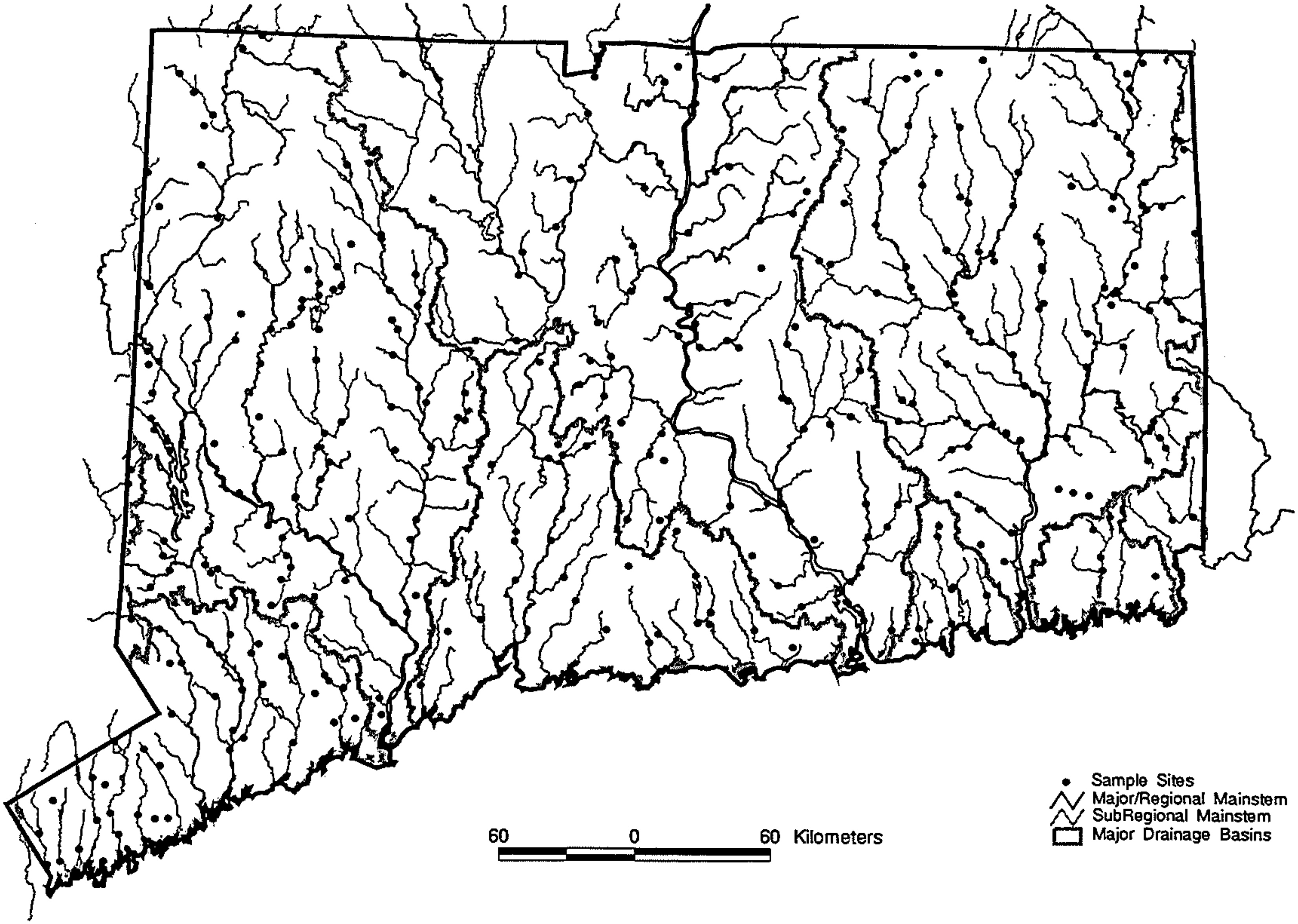
Map 9. Pumpkinseed distribution.



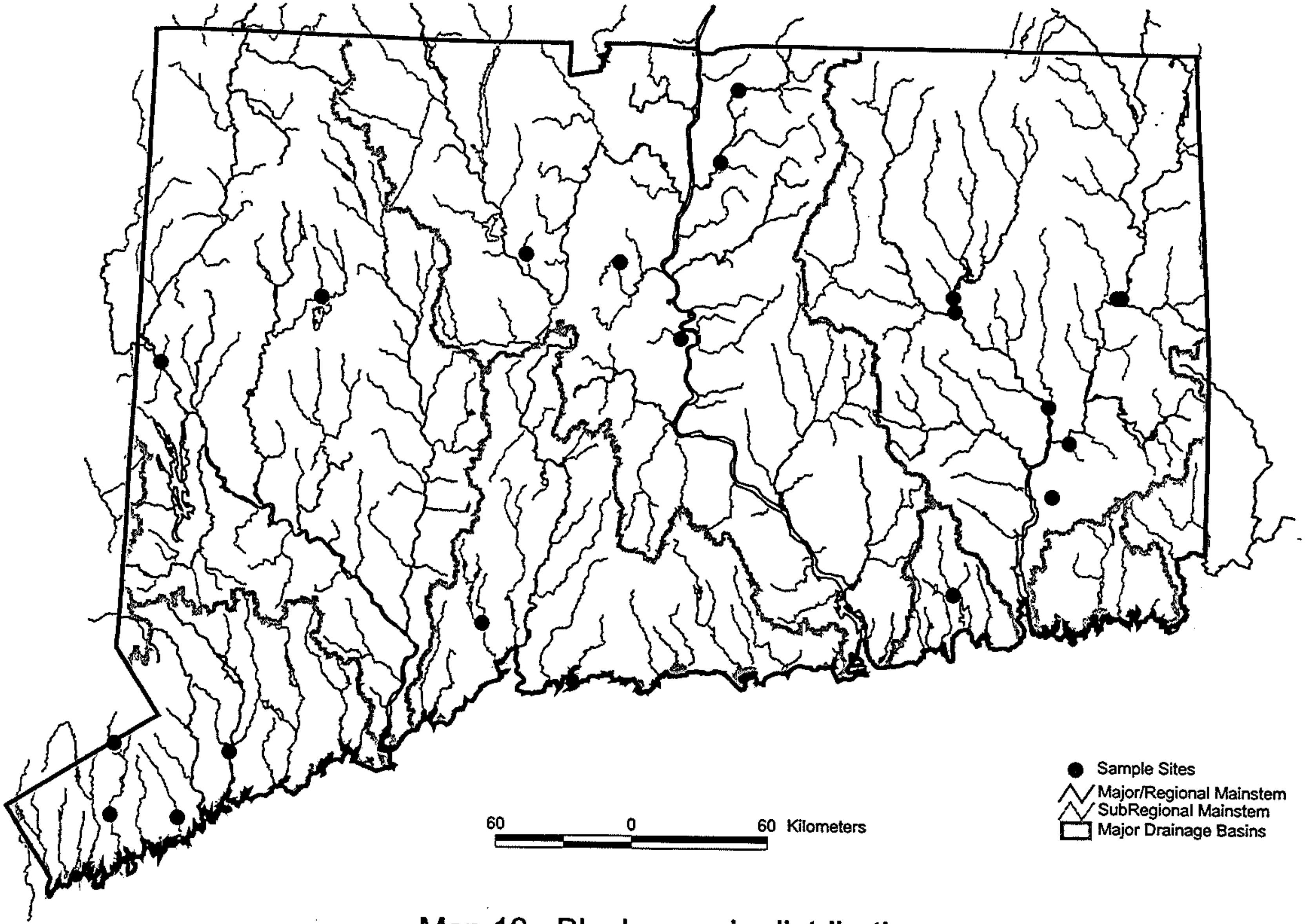
Map 10. Bluegill distribution.



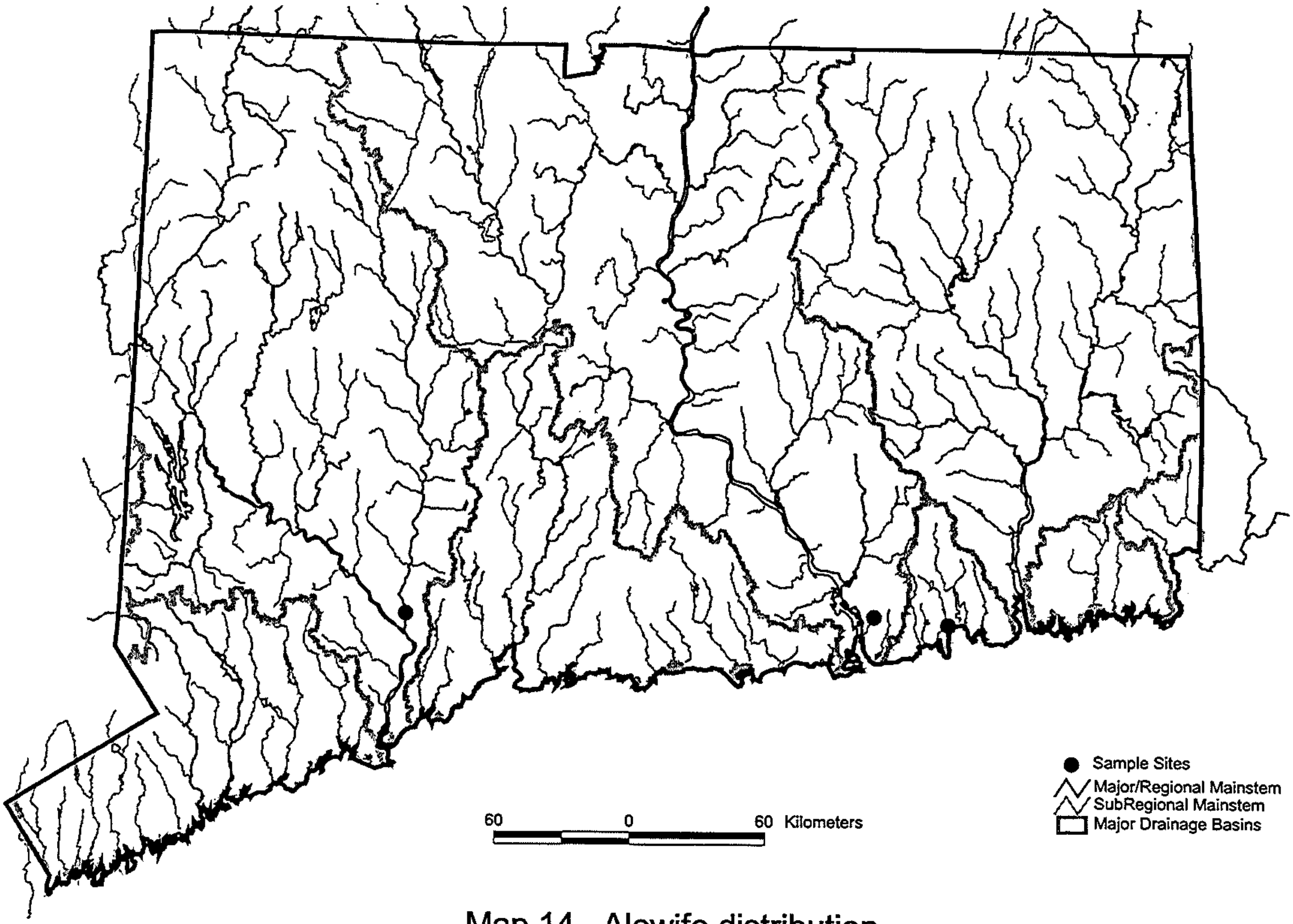
Map 11. Smallmouth bass distribution.



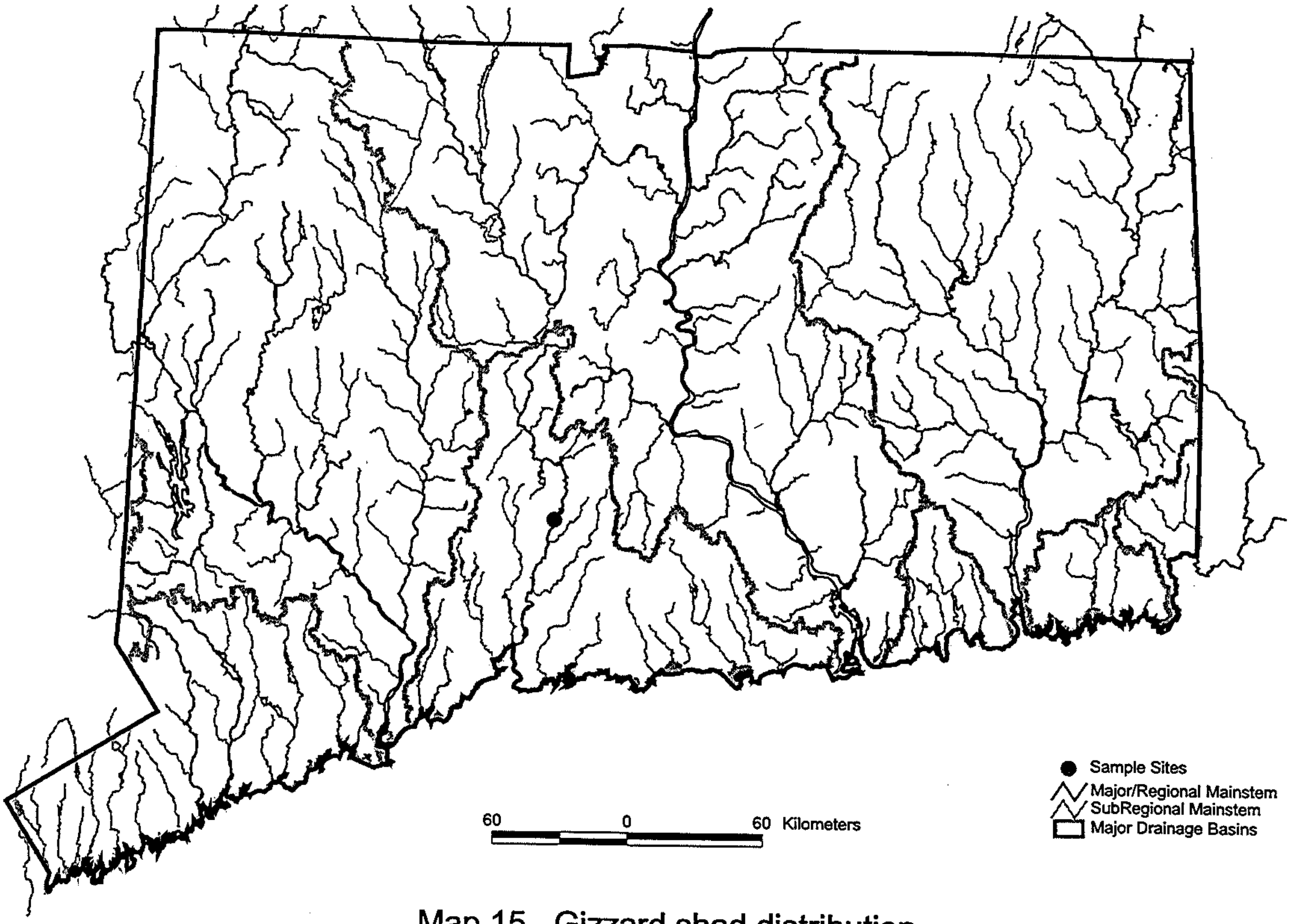
Map 12. Largemouth bass distribution.



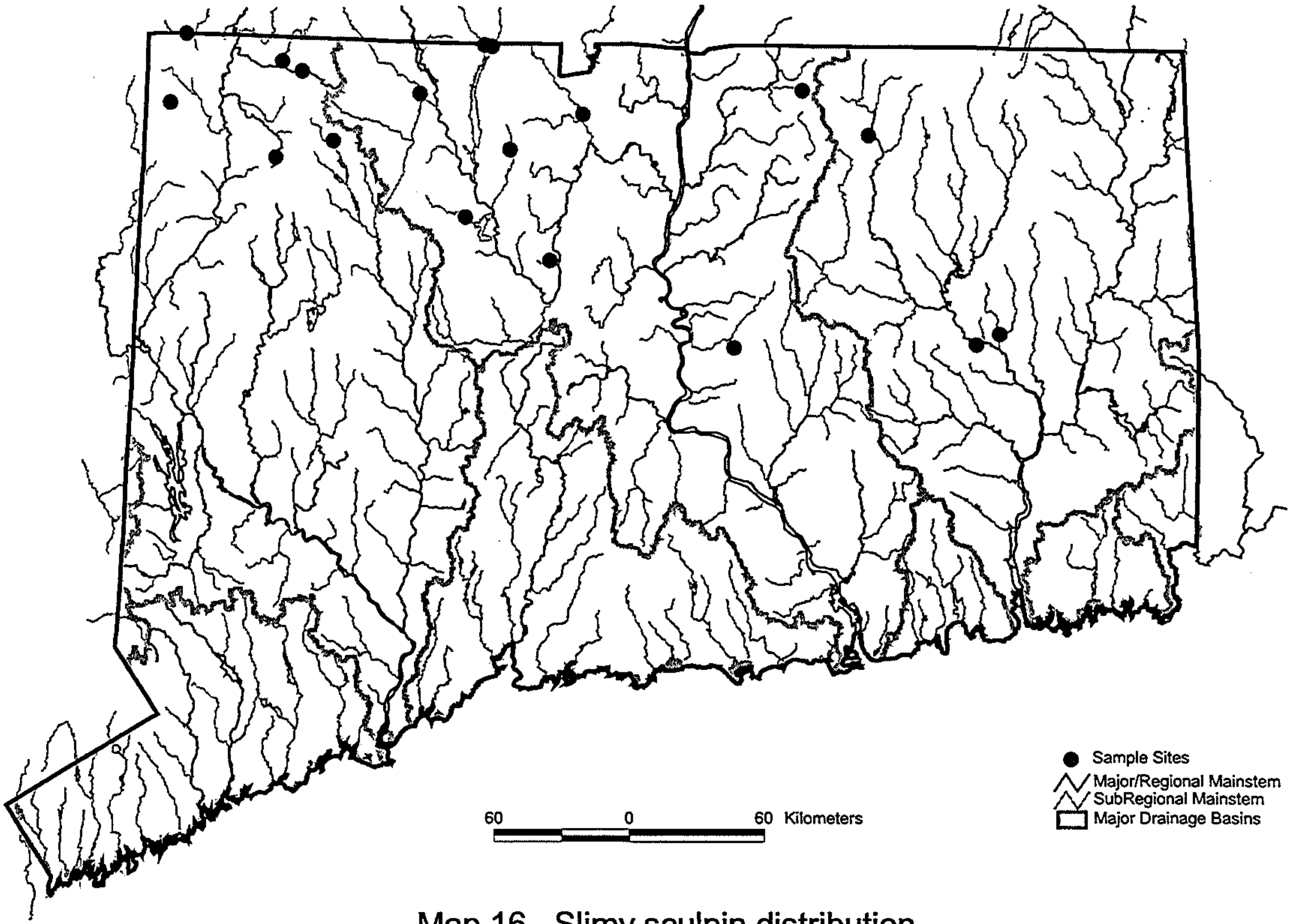
Map 13. Black crappie distribution.



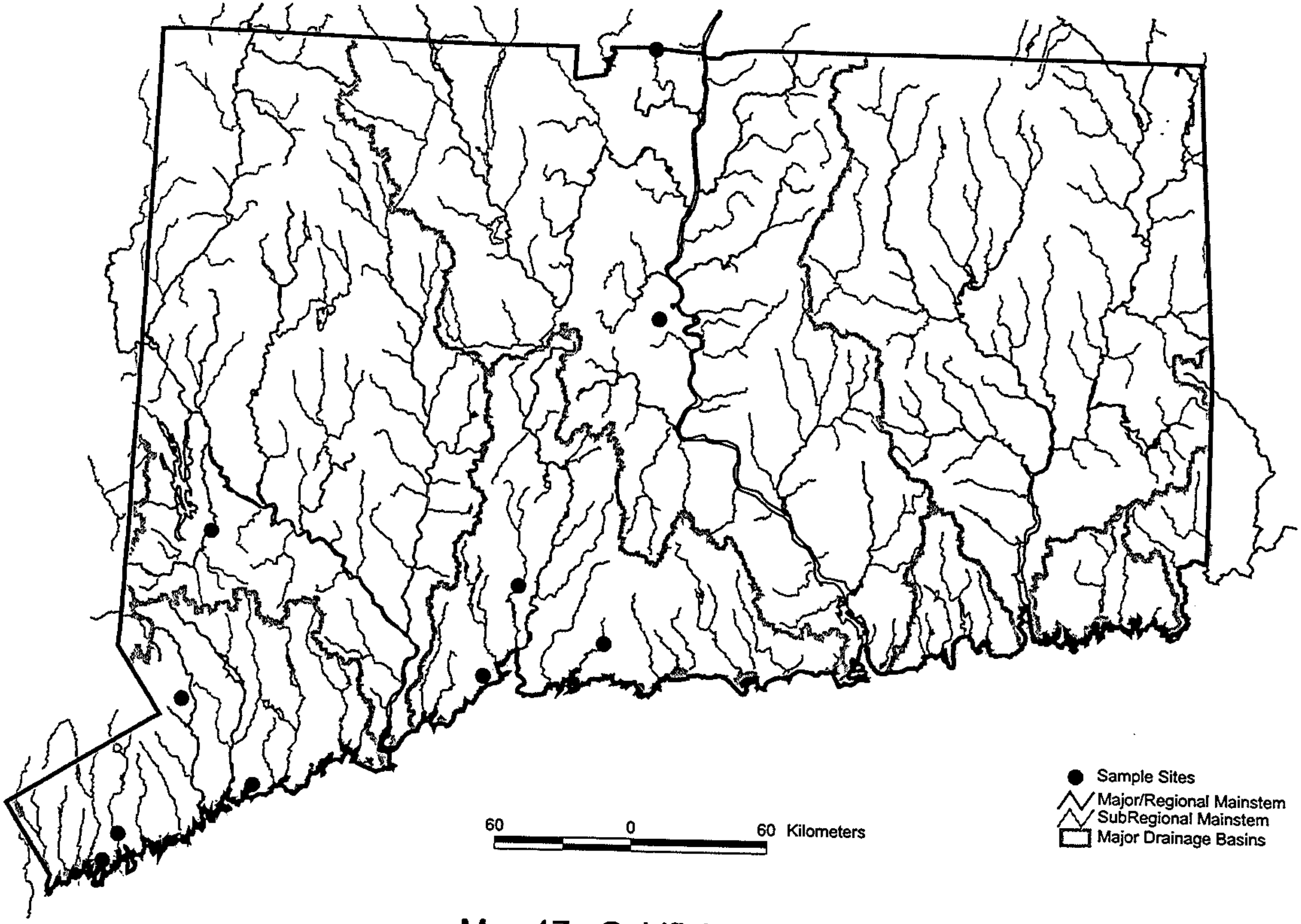
Map 14. Alewife distribution.



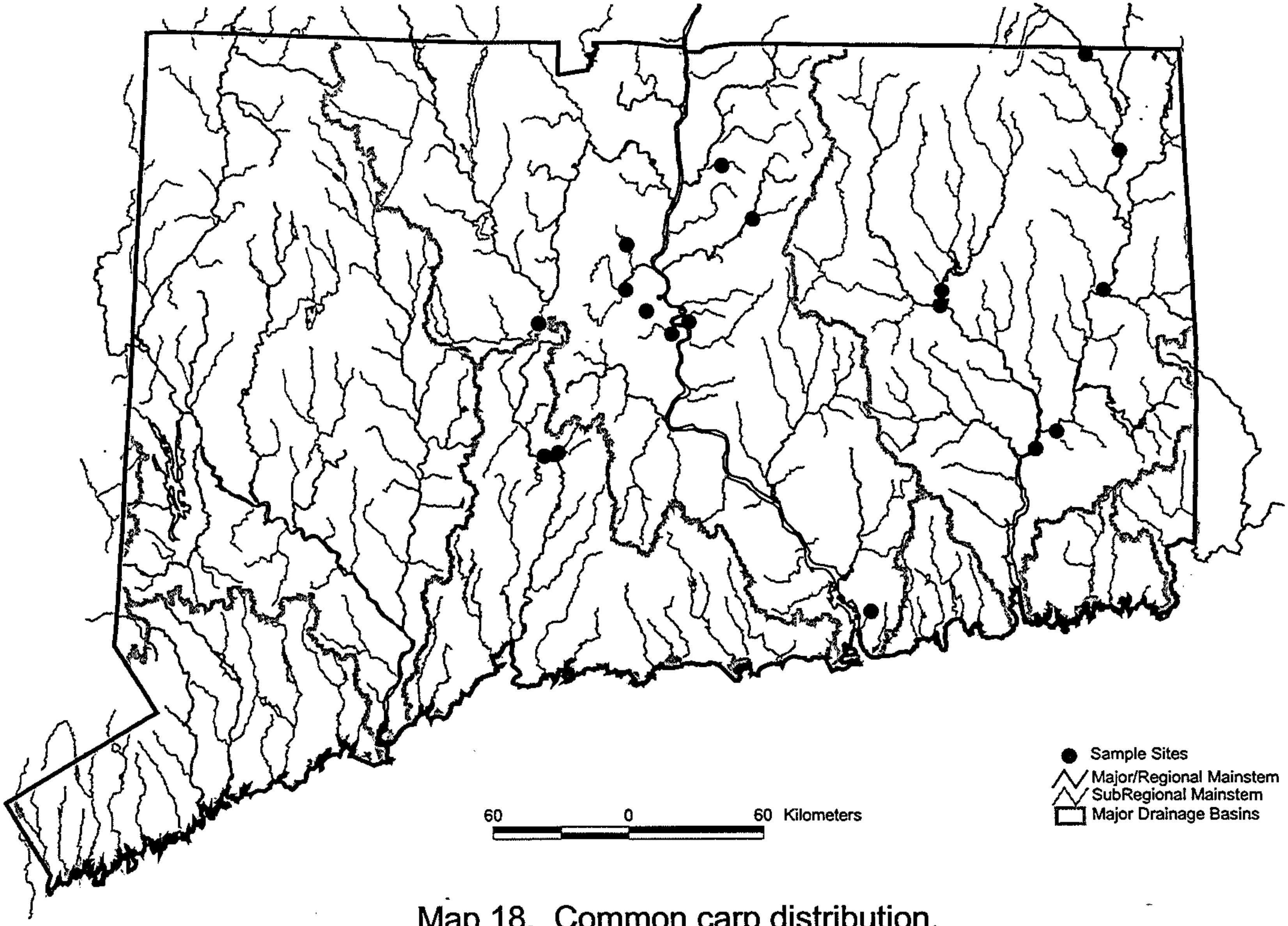
Map 15. Gizzard shad distribution.



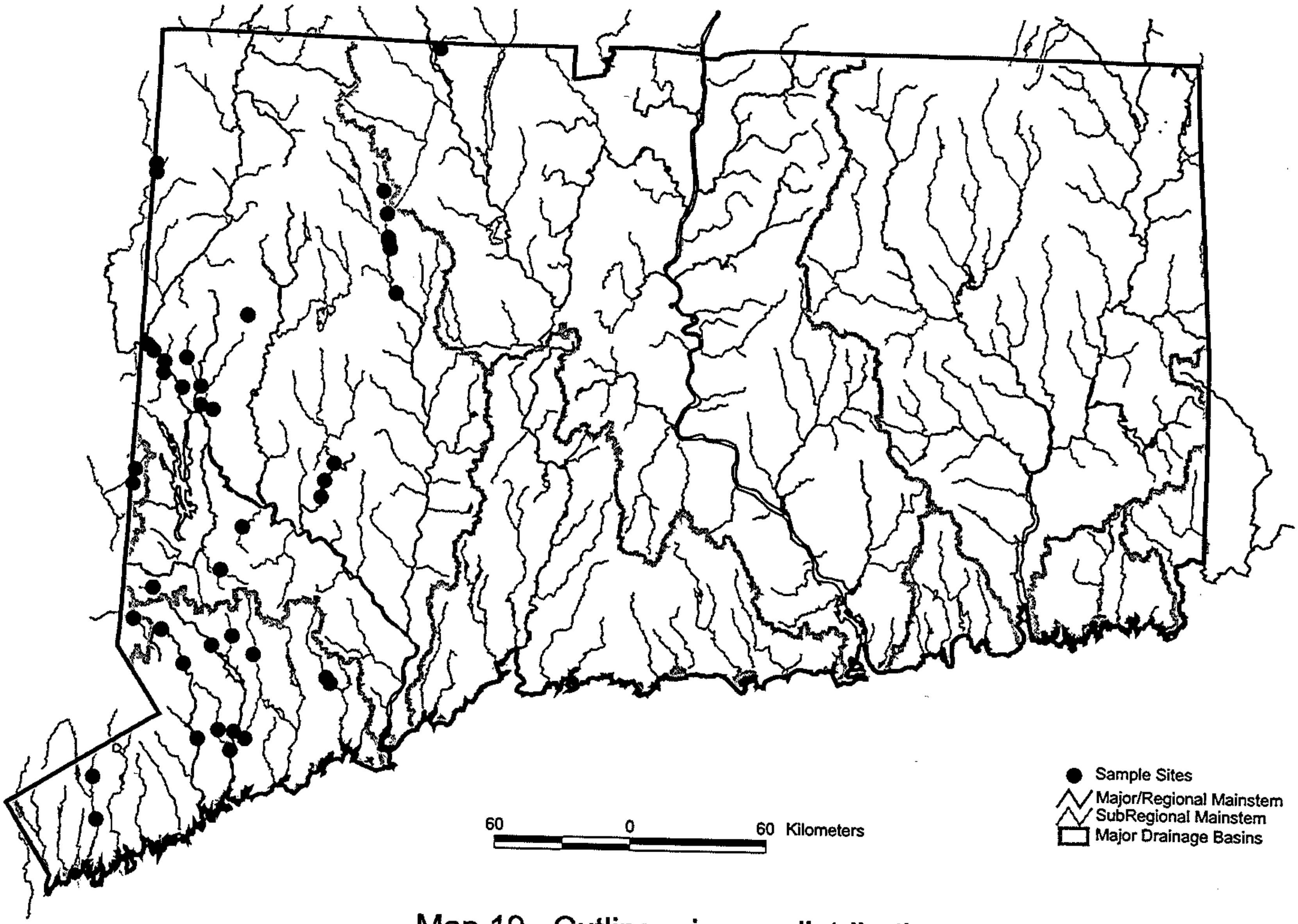
Map 16. Slimy sculpin distribution.



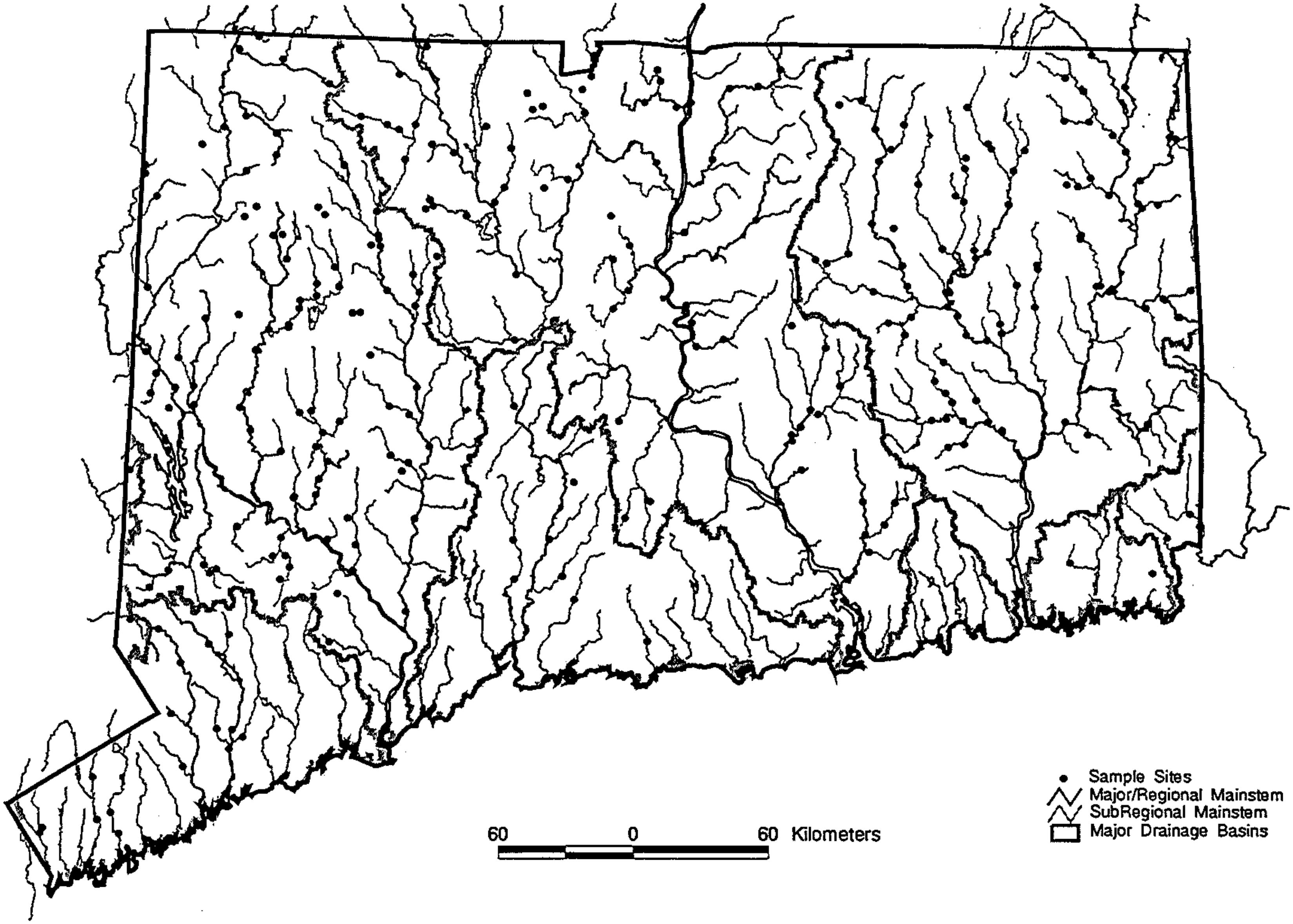
Map 17. Goldfish distribution.



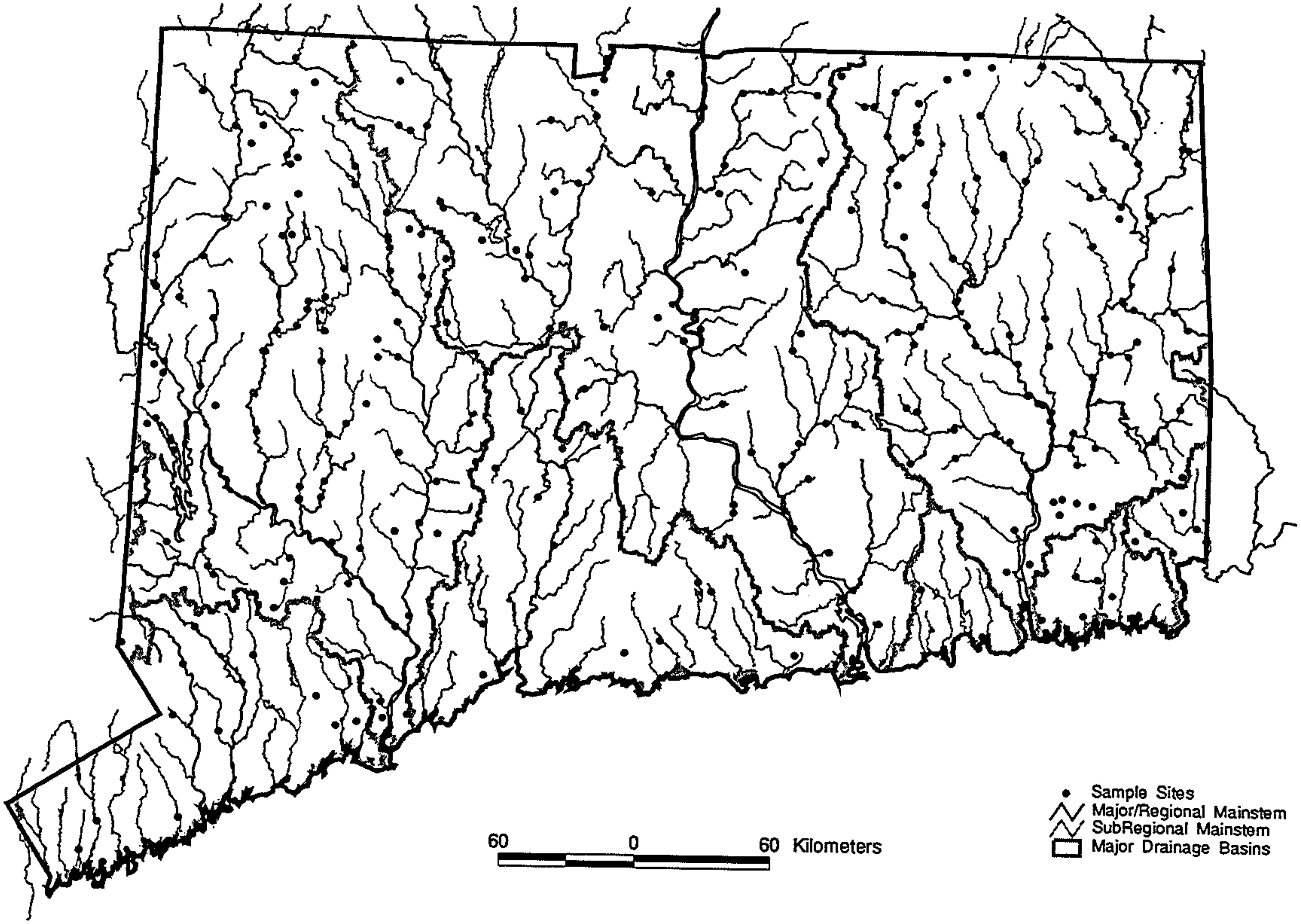
Map 18. Common carp distribution.



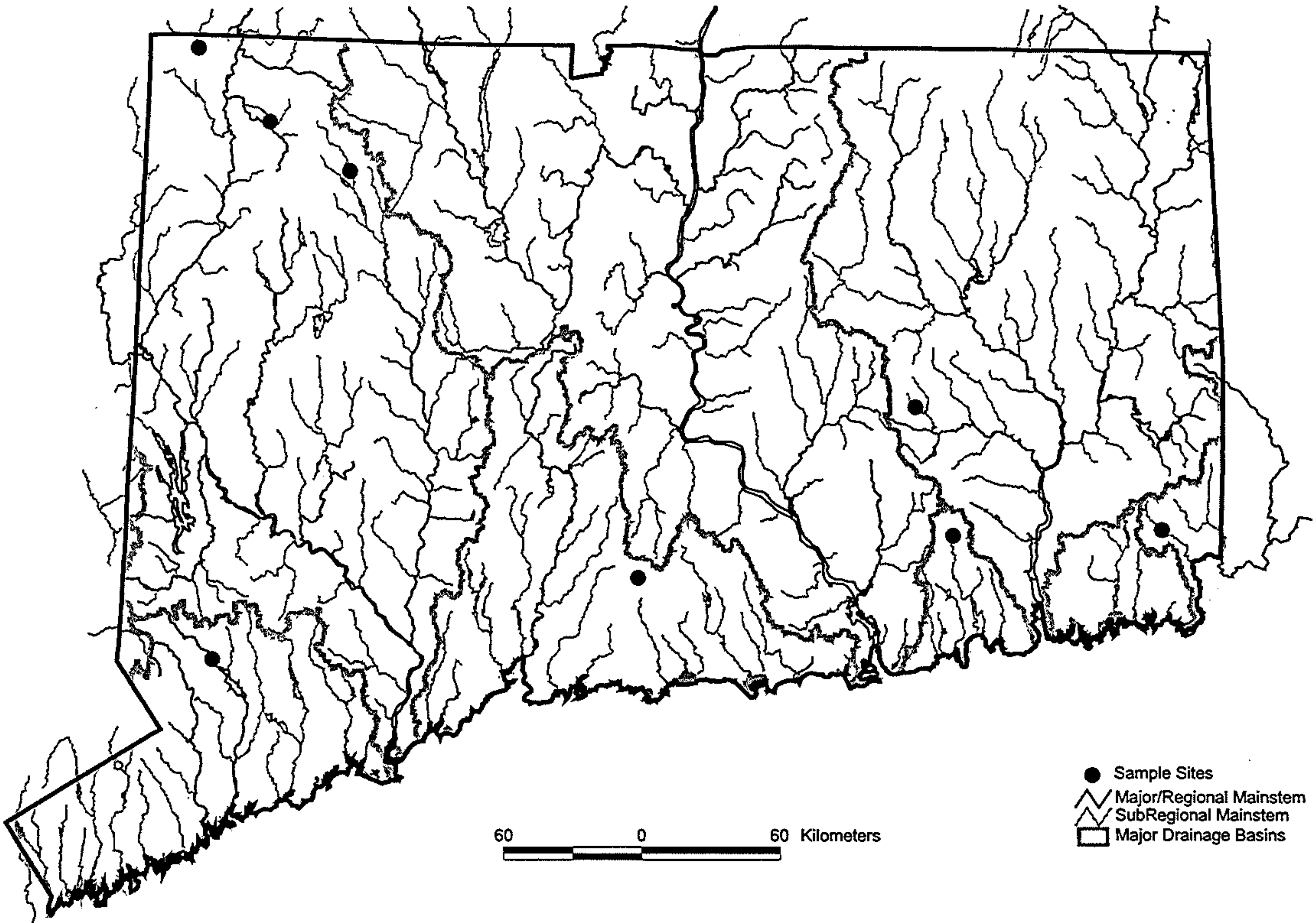
Map 19. Cutlips minnow distribution.



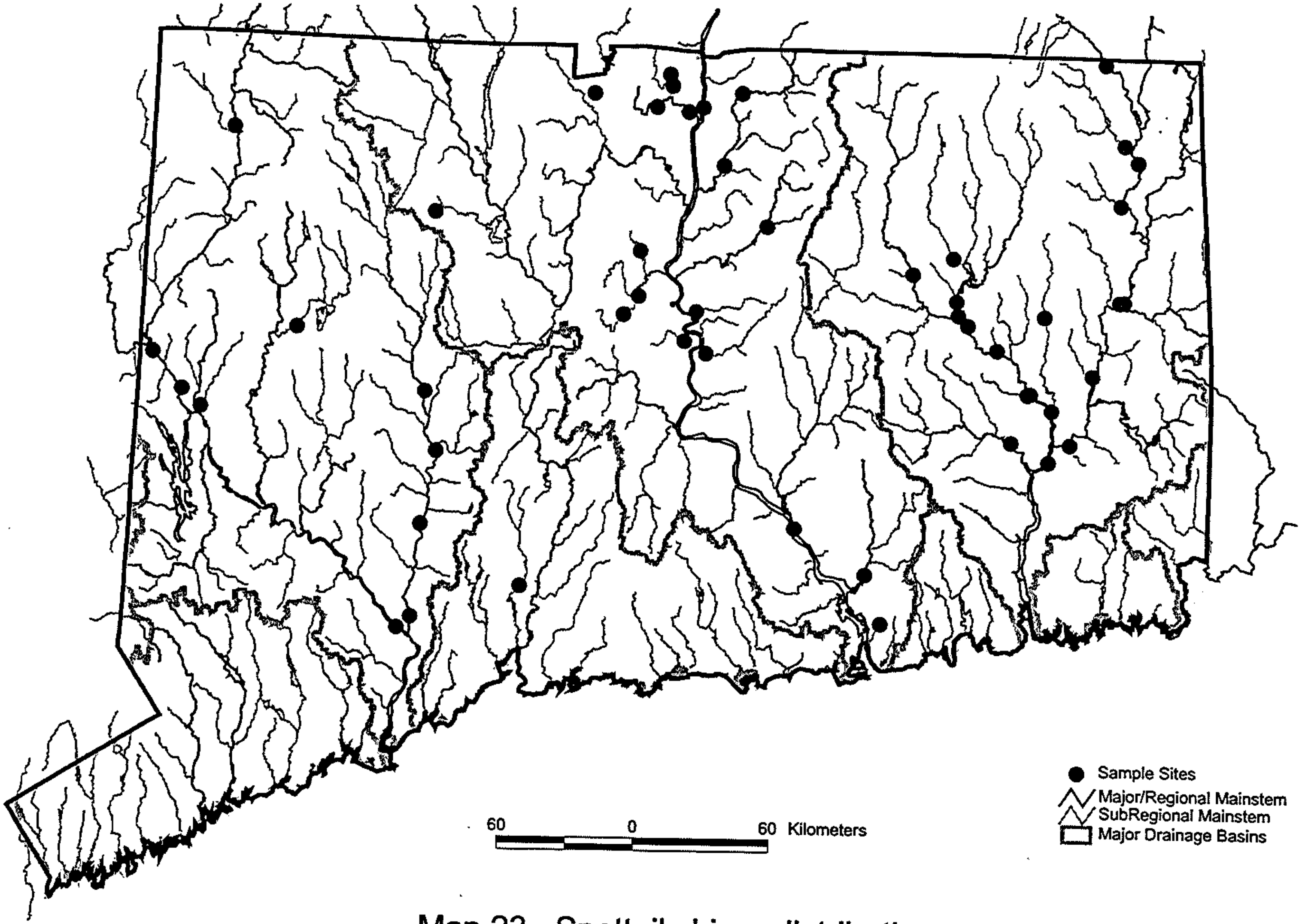
Map 20. Common shiner distribution.



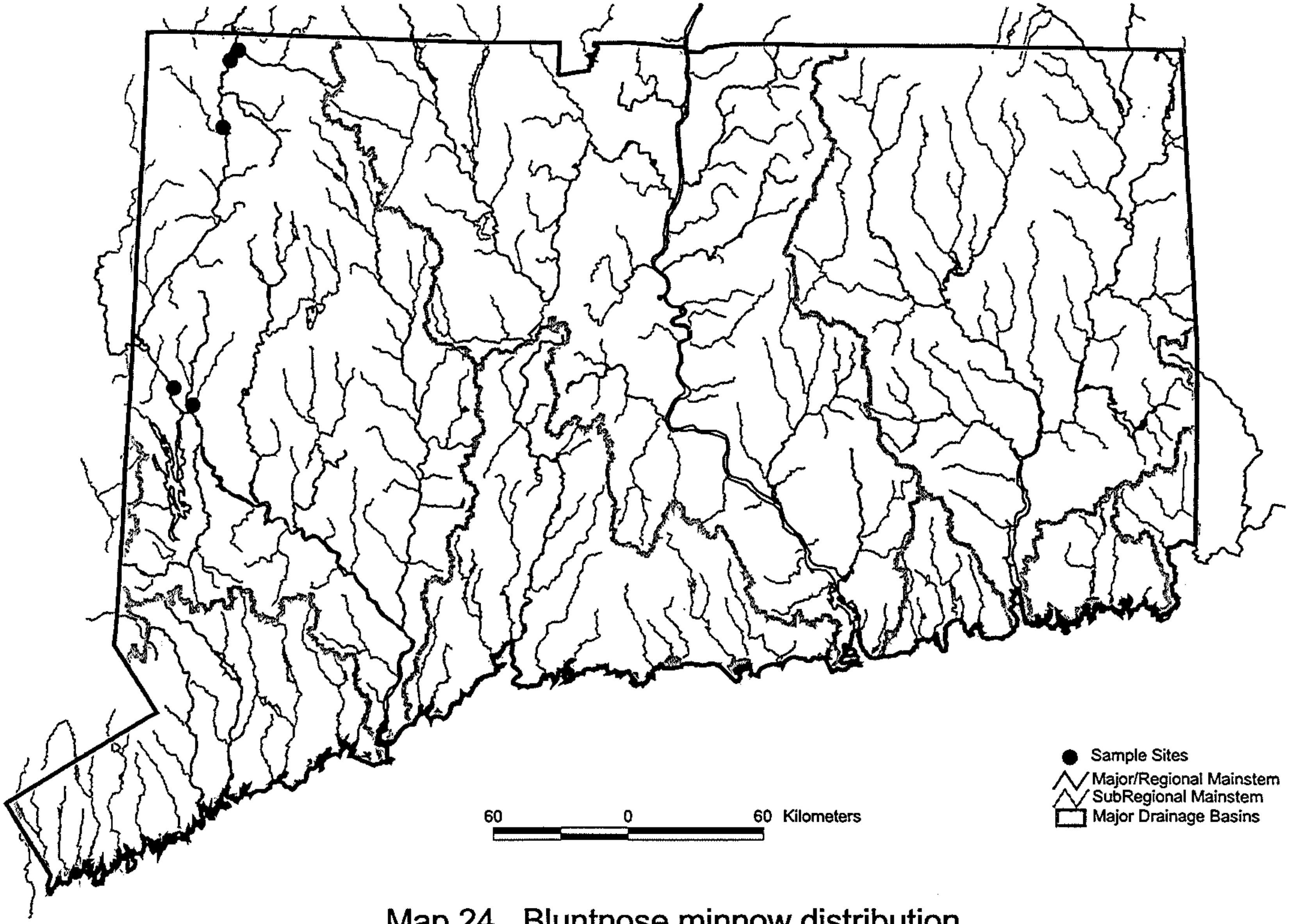
Map 21. Golden shiner distribution.



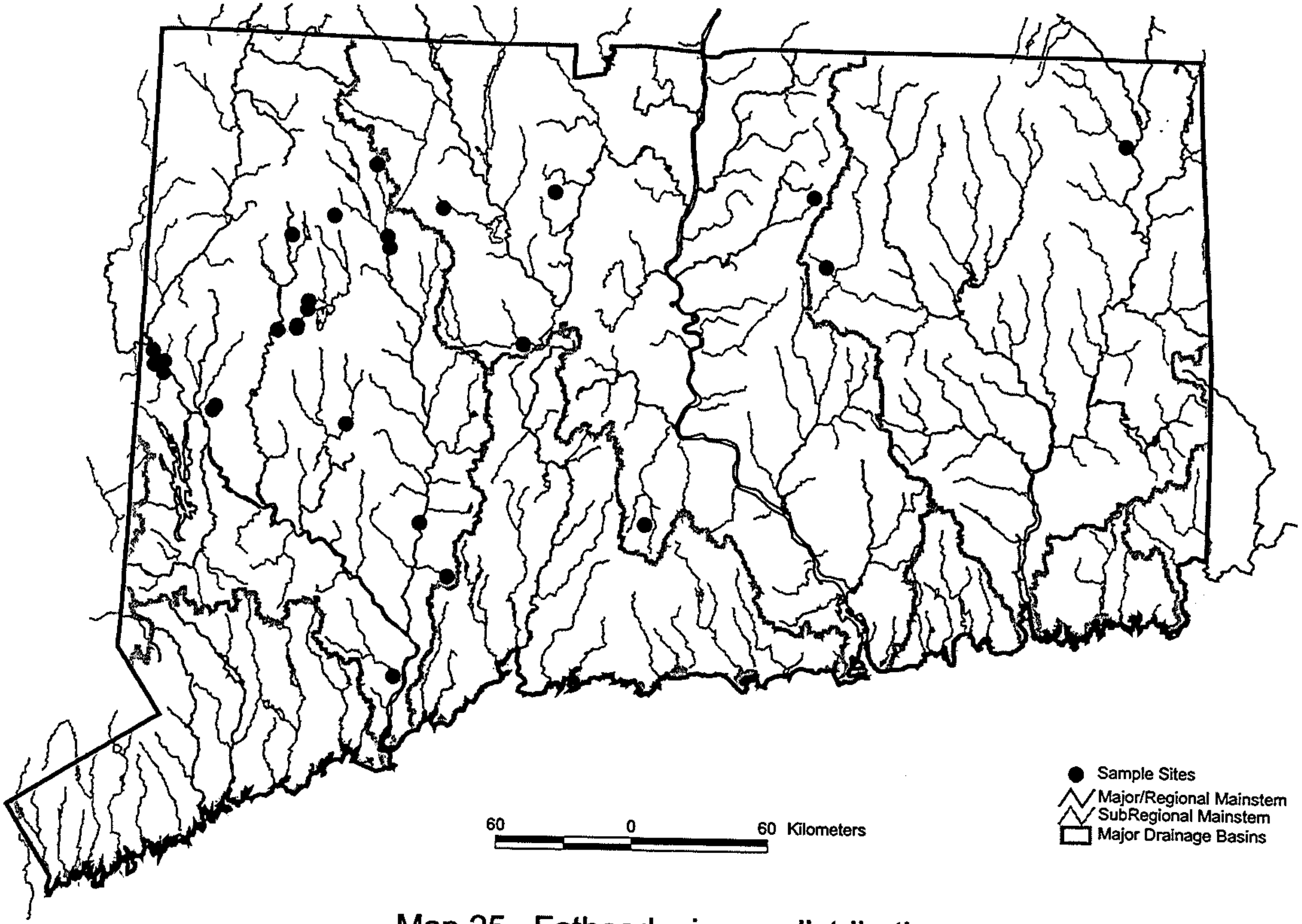
Map 22. Bridled shiner distribution.



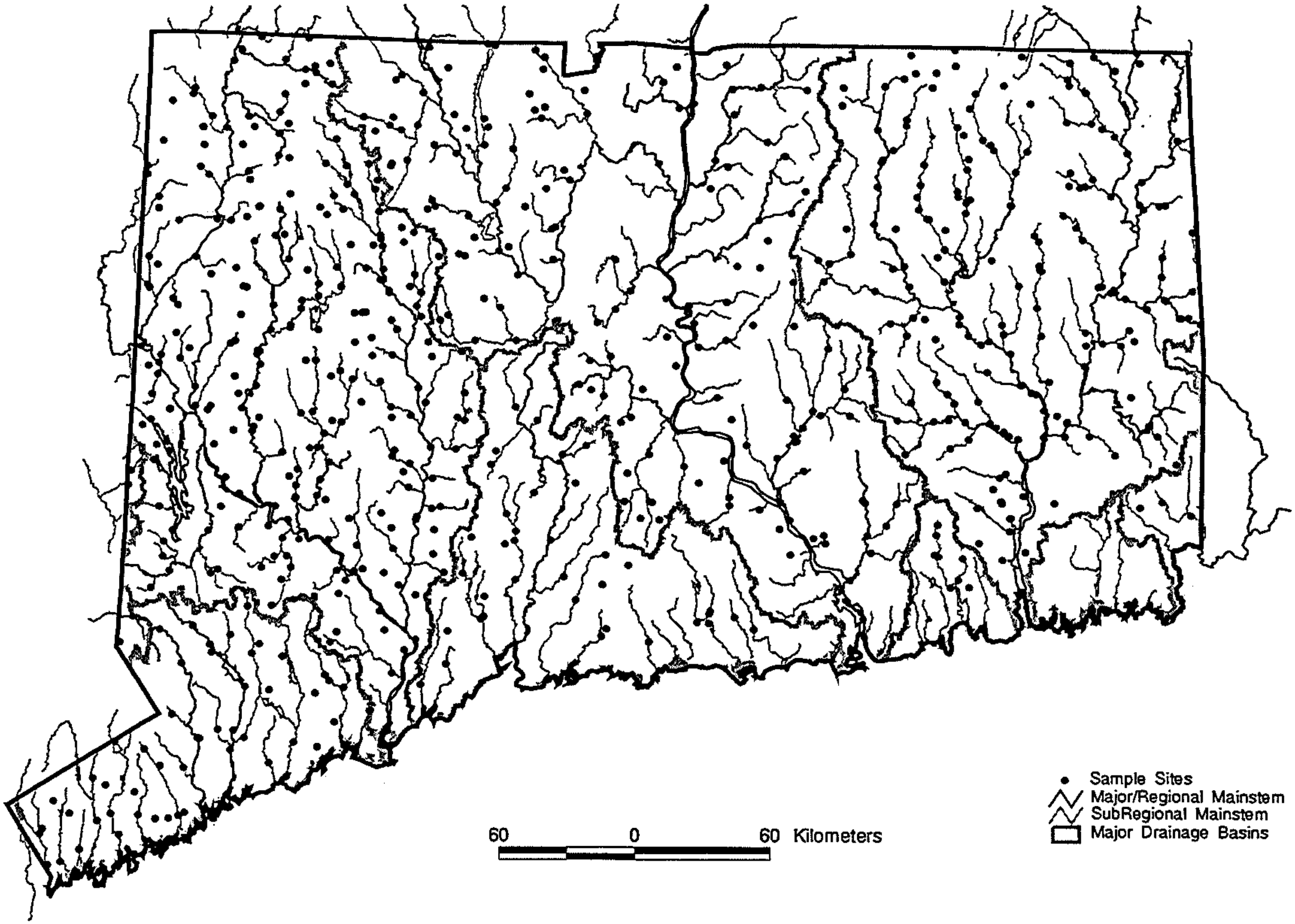
Map 23. Spottail shiner distribution.



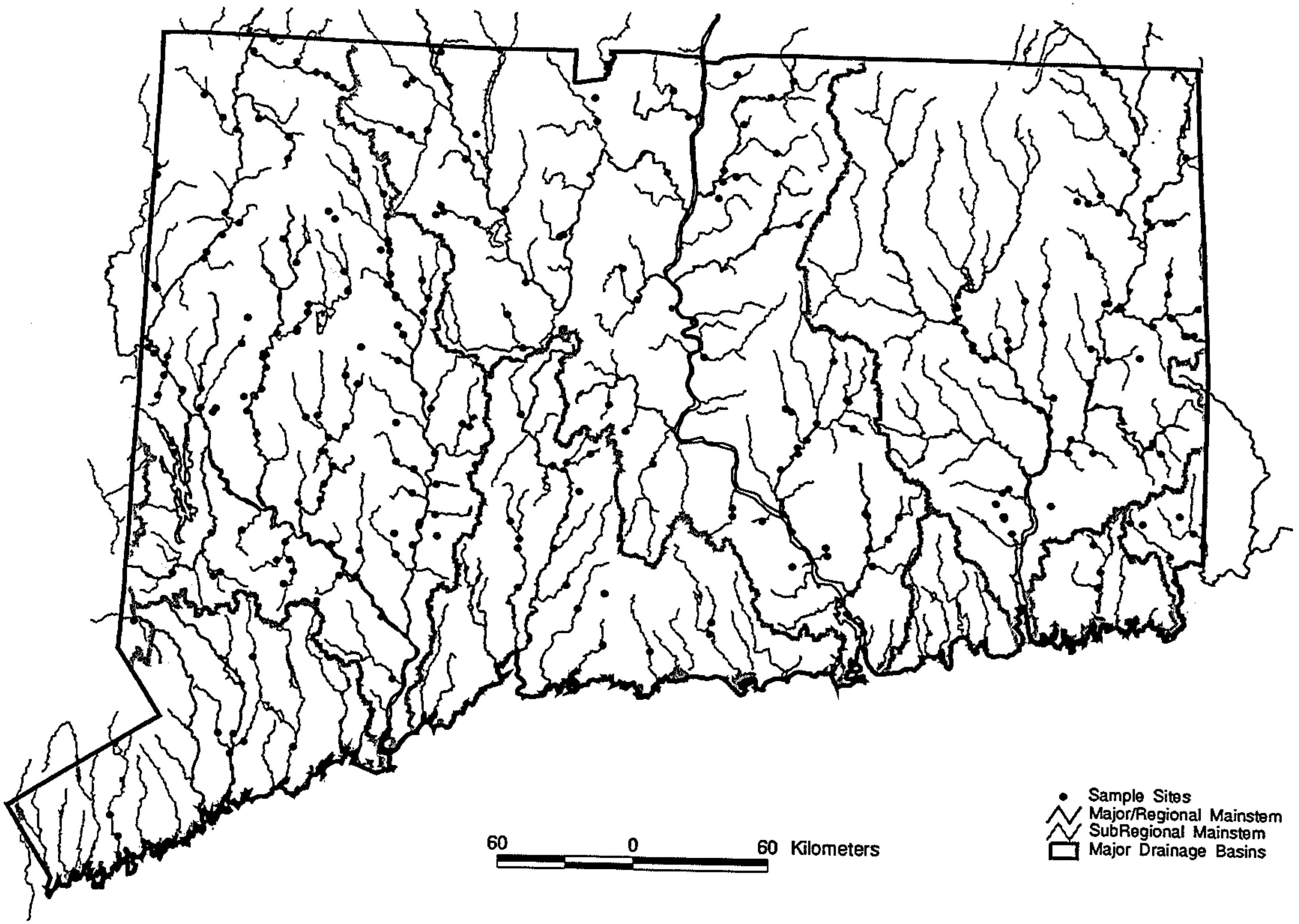
Map 24. Bluntnose minnow distribution.



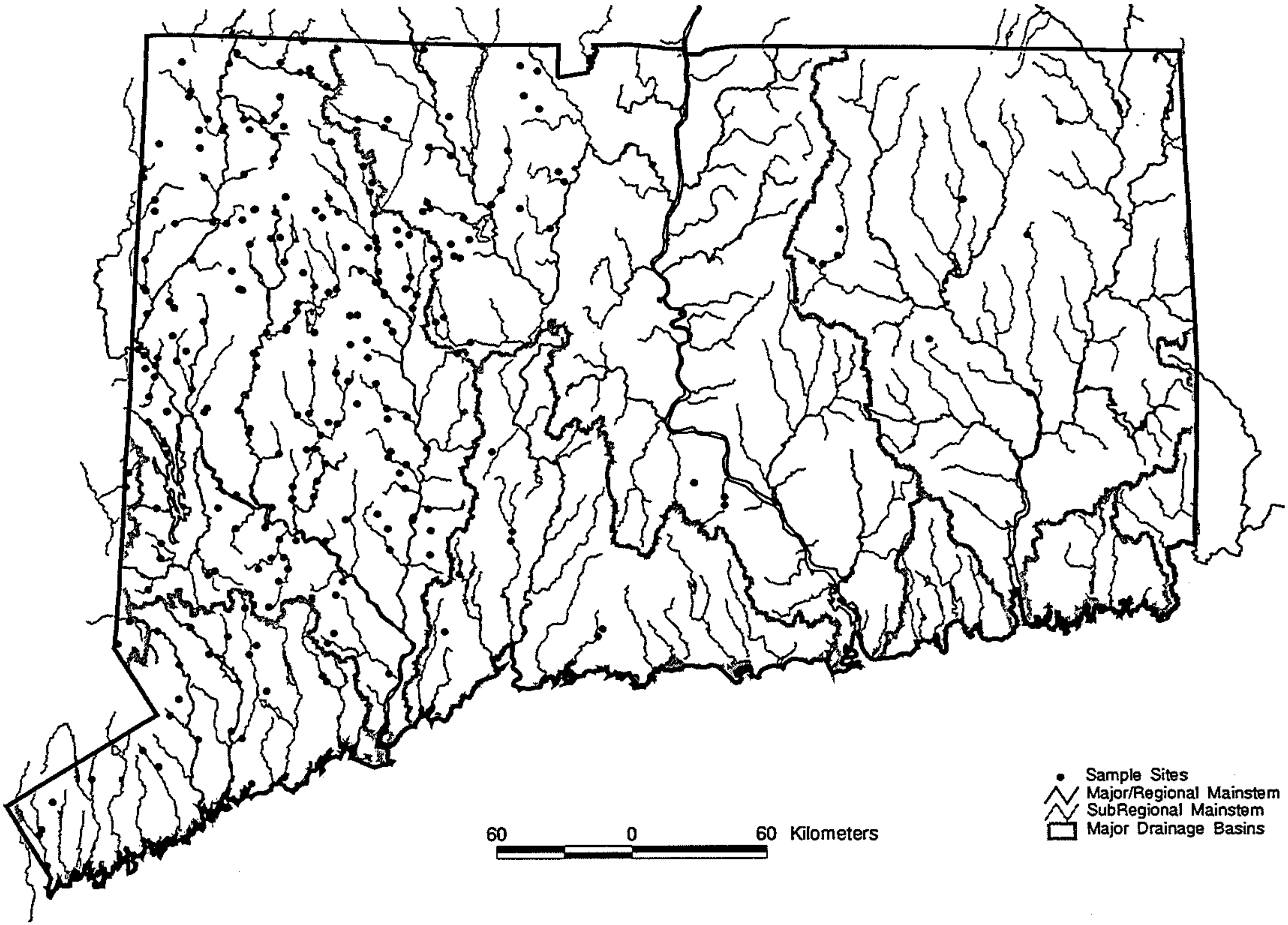
Map 25. Fathead minnow distribution.



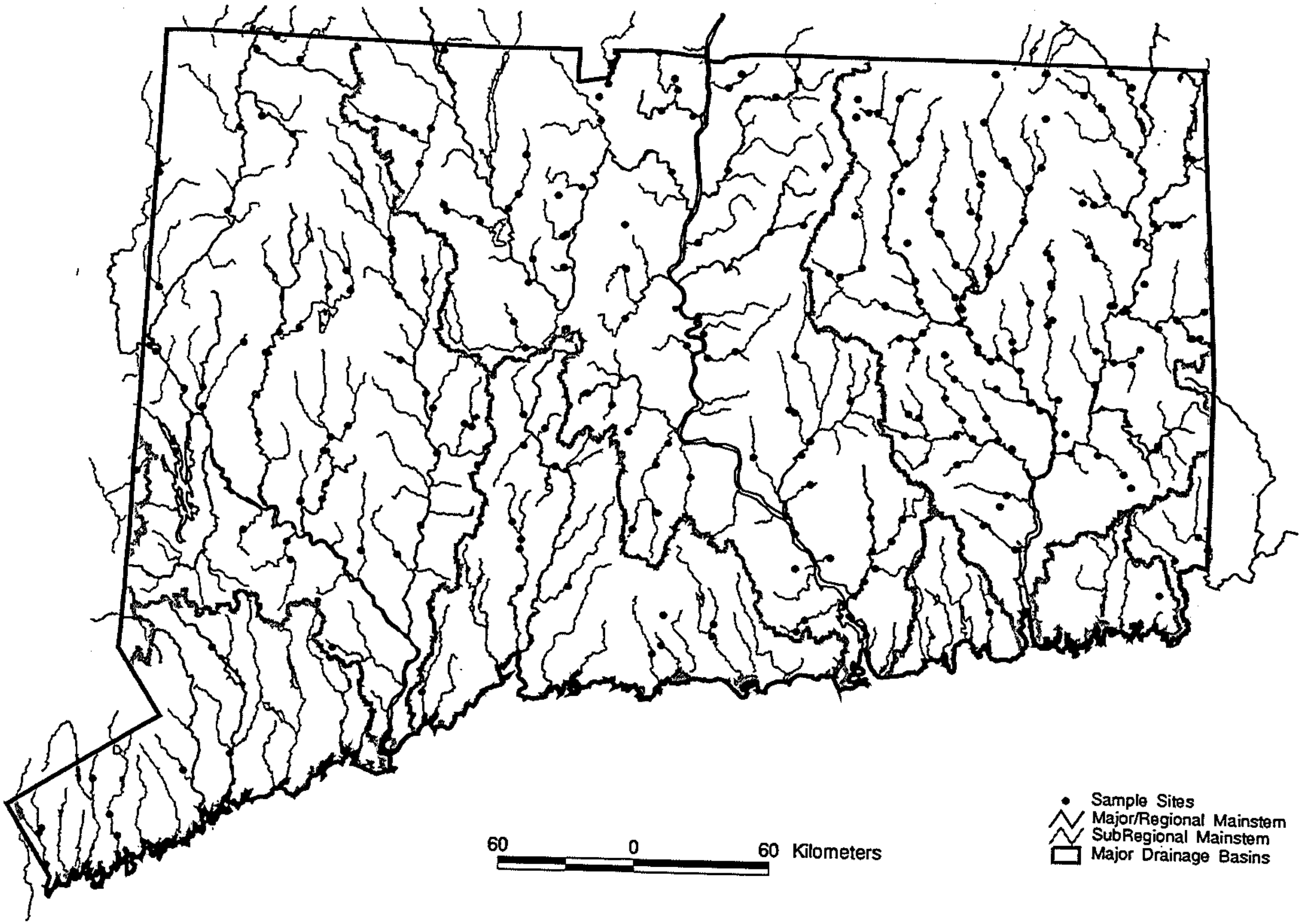
Map 26. Blacknose dace distribution.



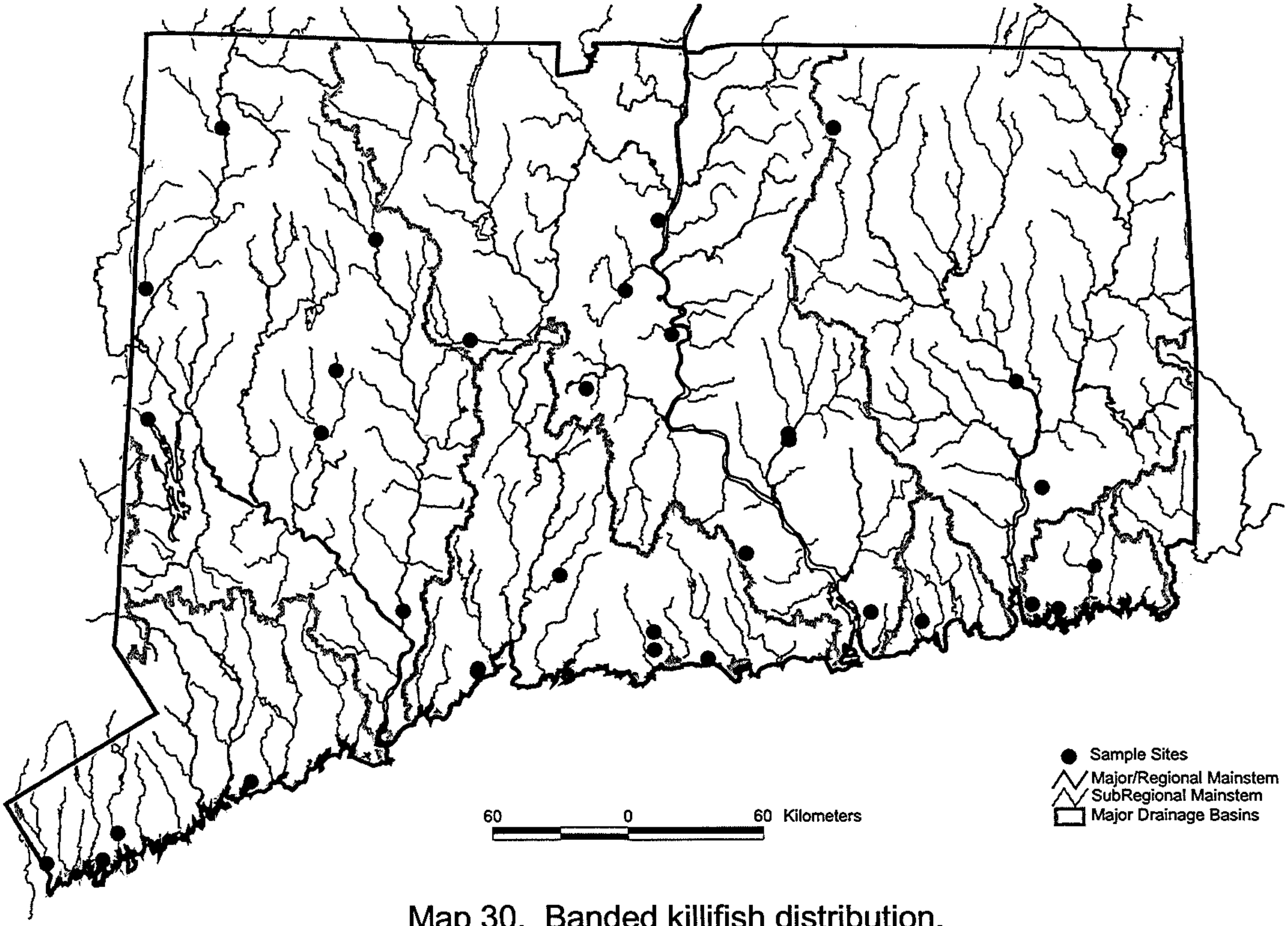
Map 27. Longnose dace distribution.



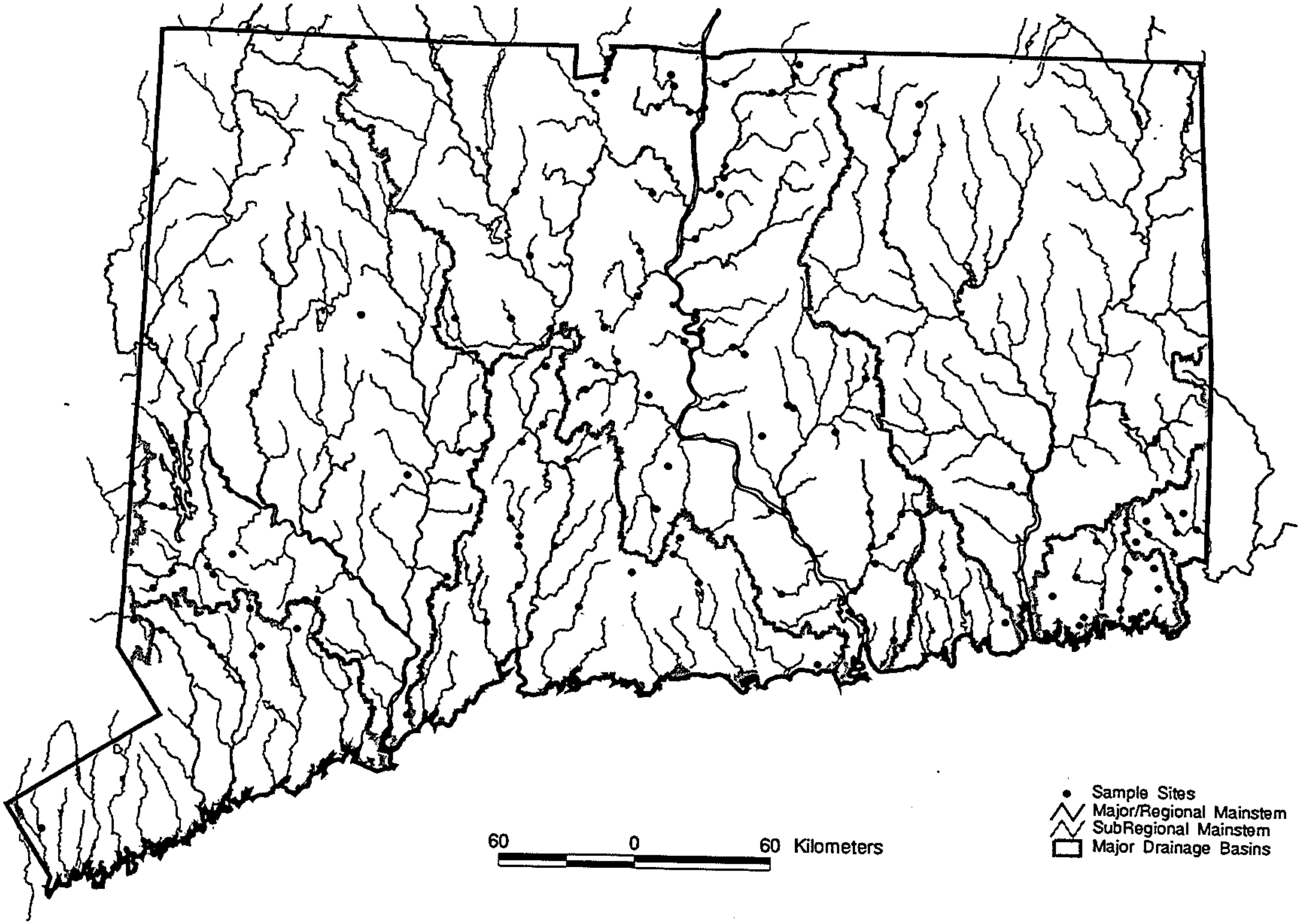
Map 28. Creek chub distribution.



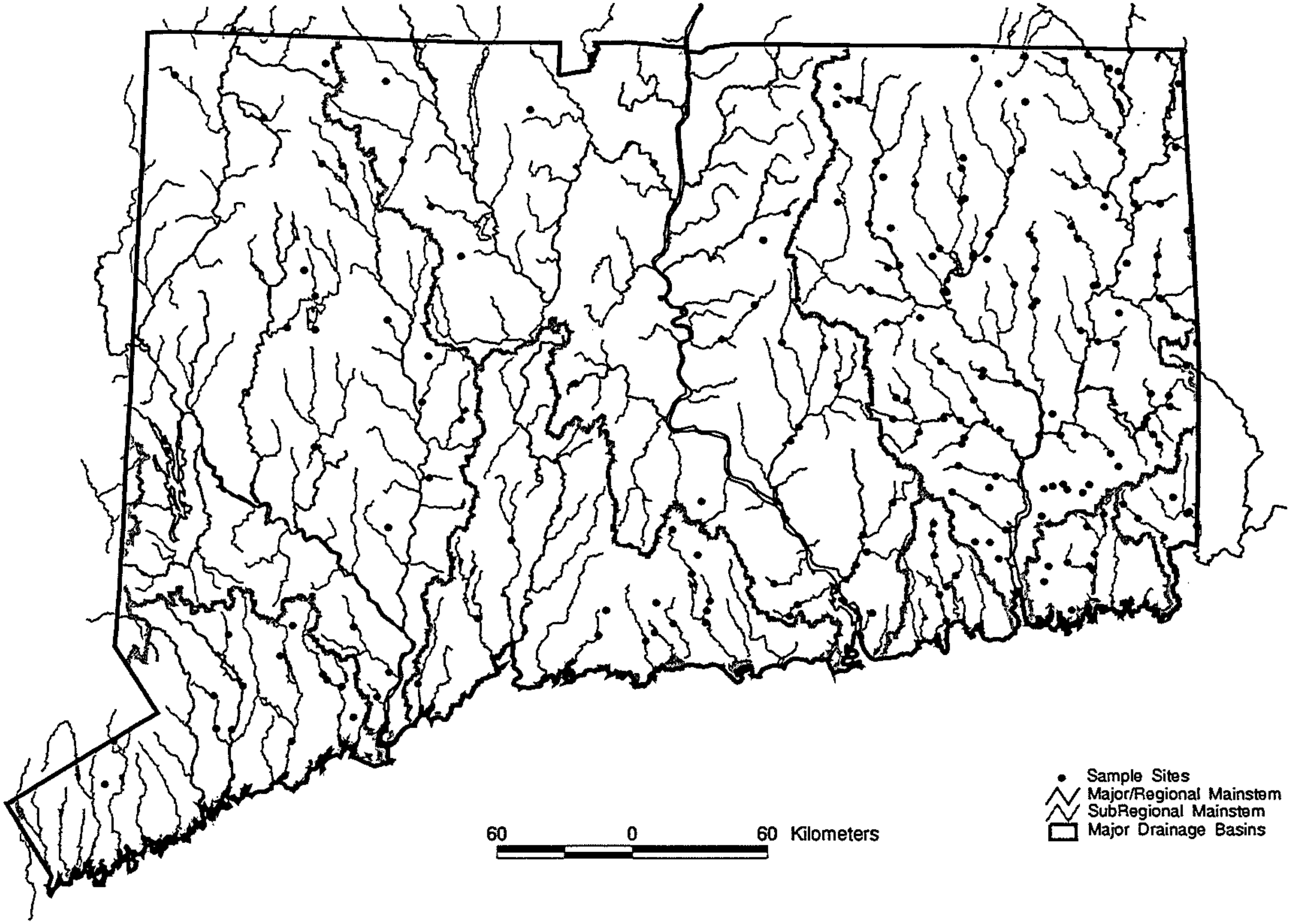
Map 29. Fallfish distribution.



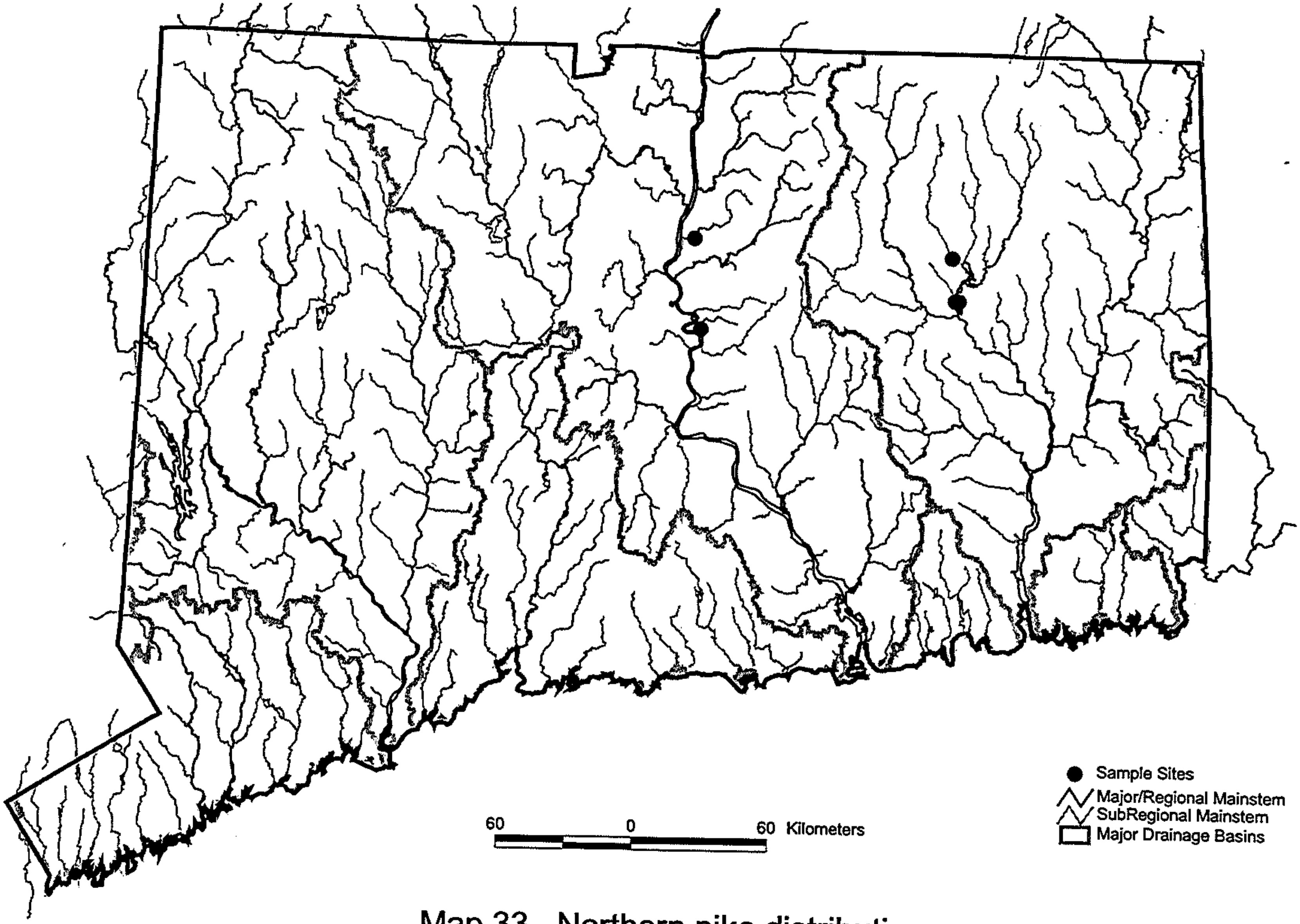
Map 30. Banded killifish distribution.



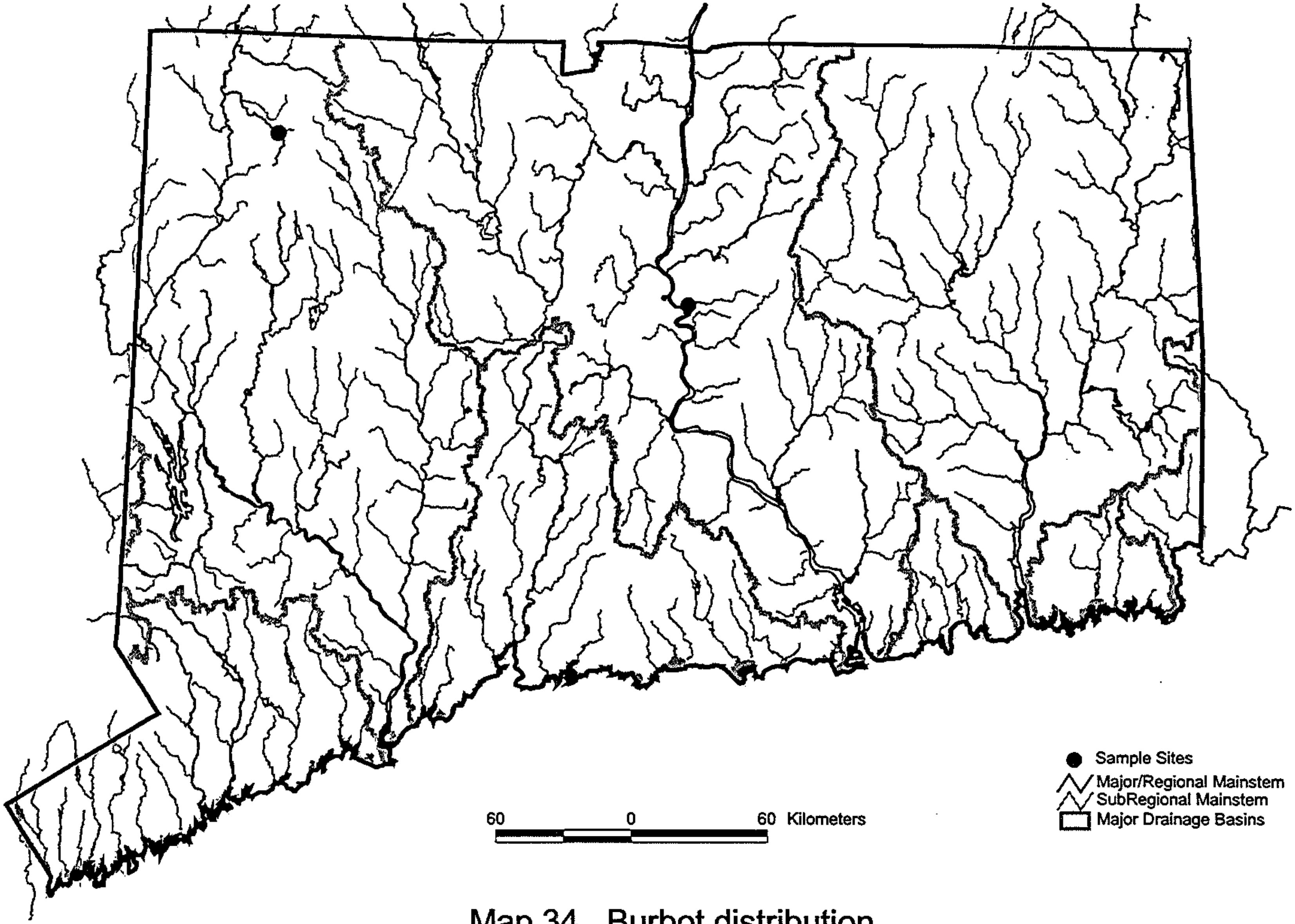
Map 31. Redfin pickerel distribution.



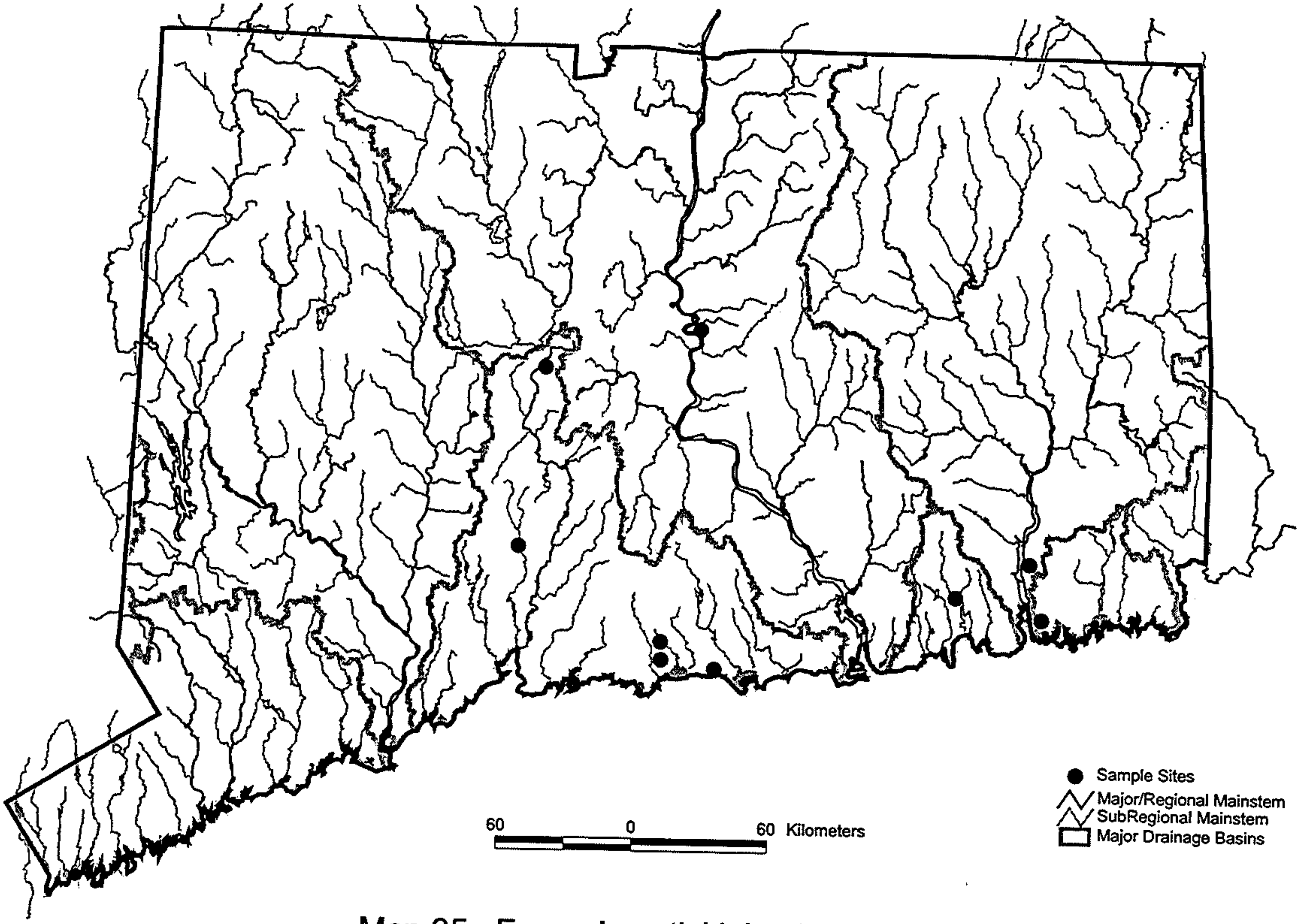
Map 32. Chain pickerel distribution.



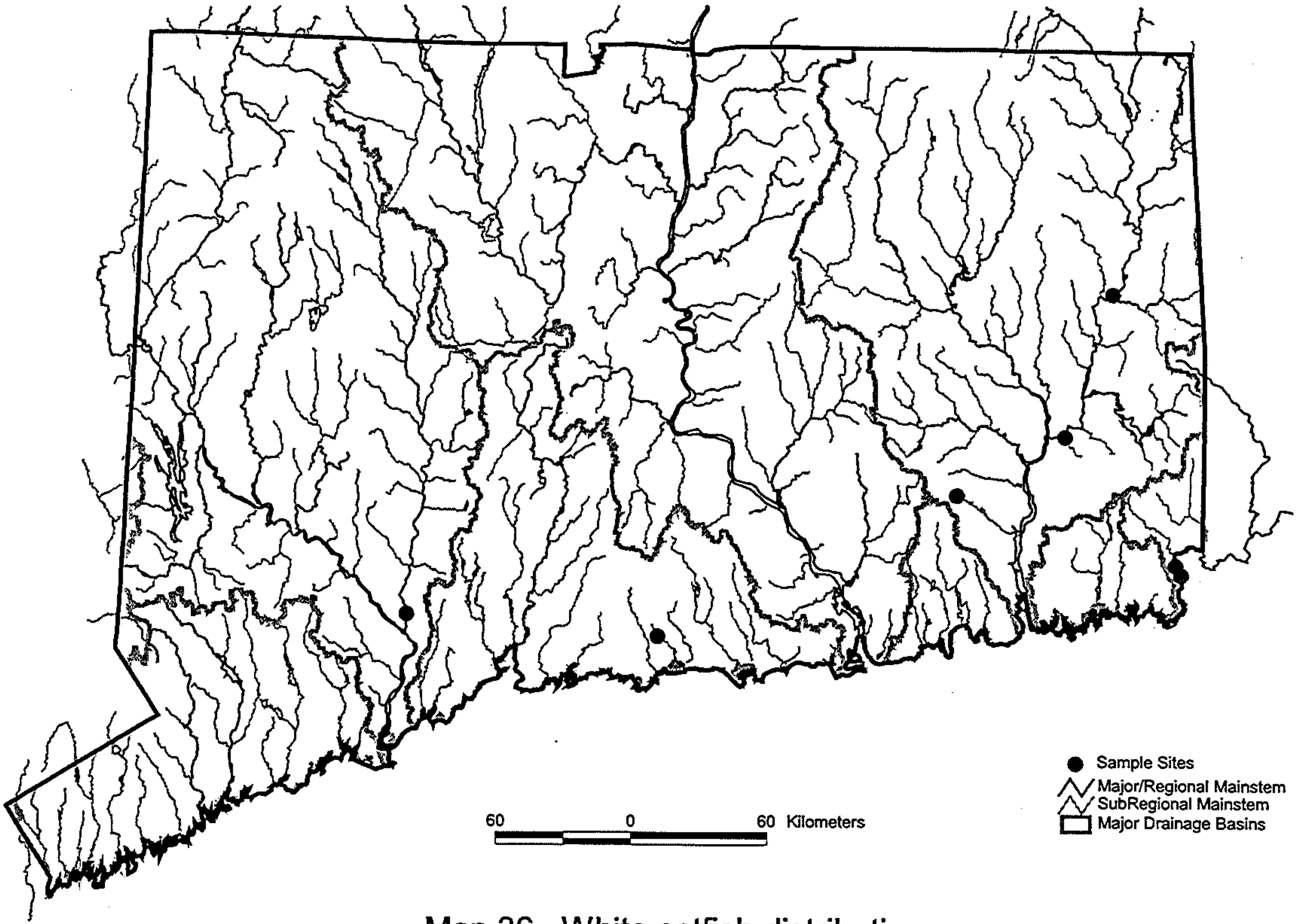
Map 33. Northern pike distribution.



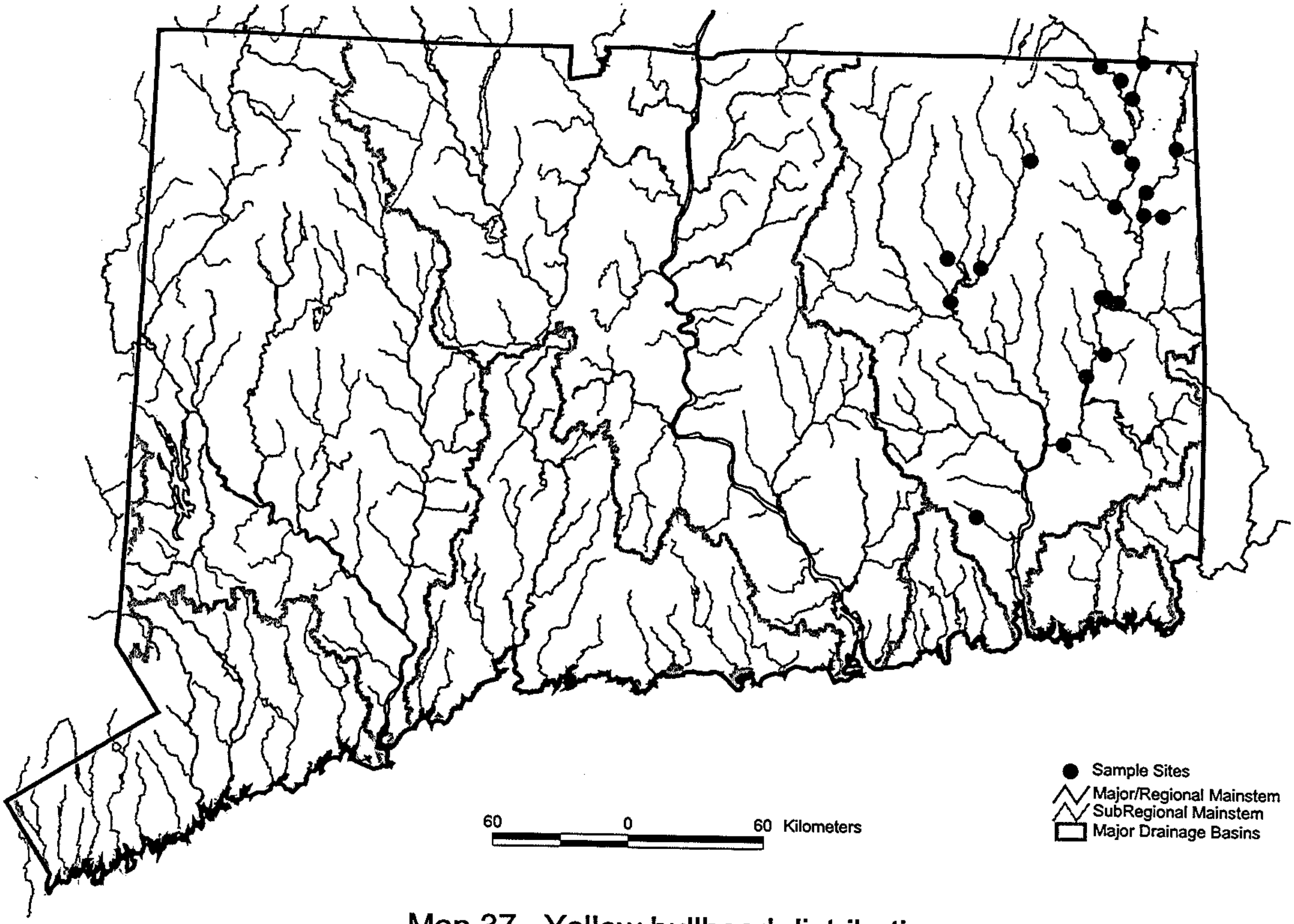
Map 34. Burbot distribution.



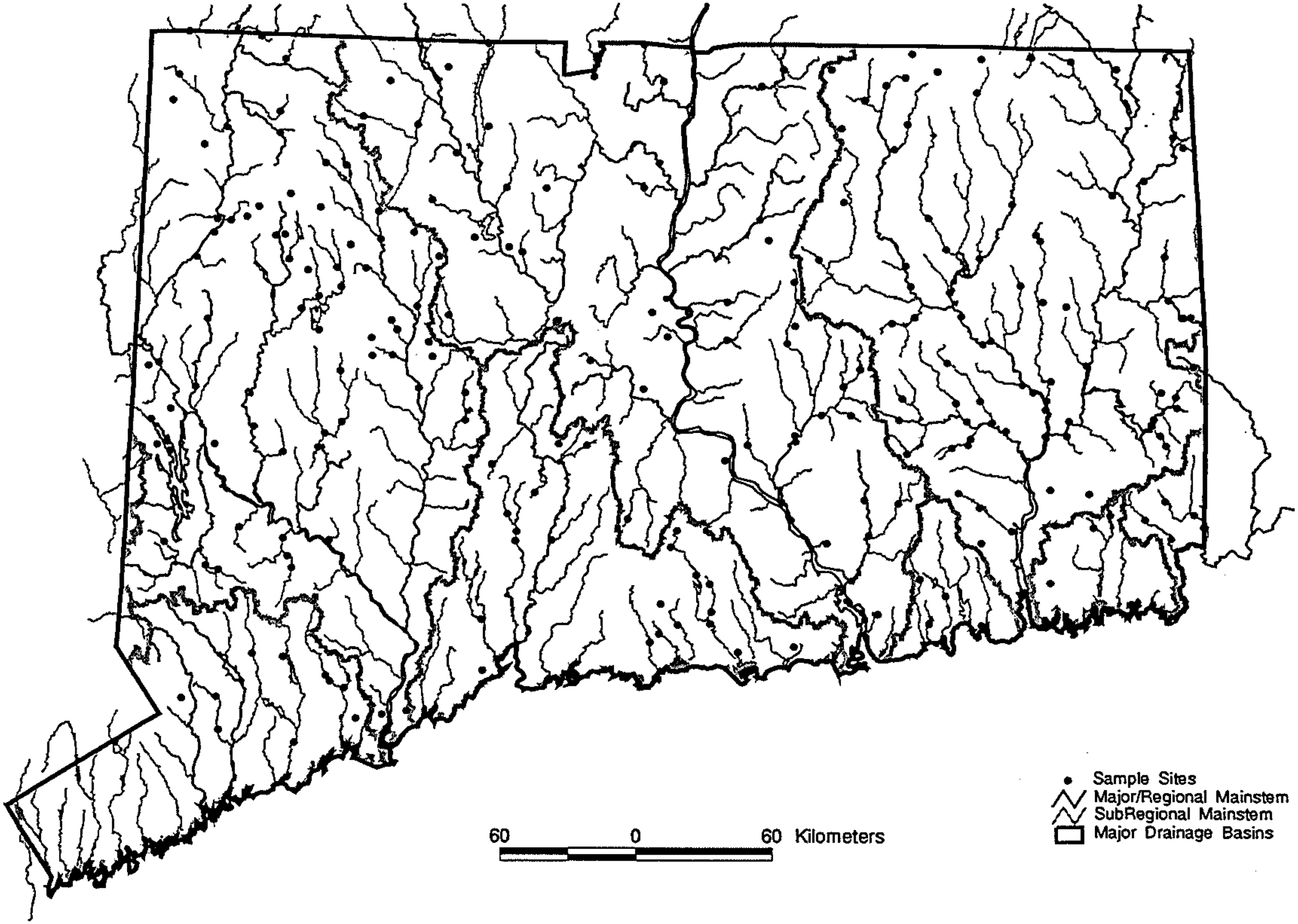
Map 35. Fourspine stickleback distribution.



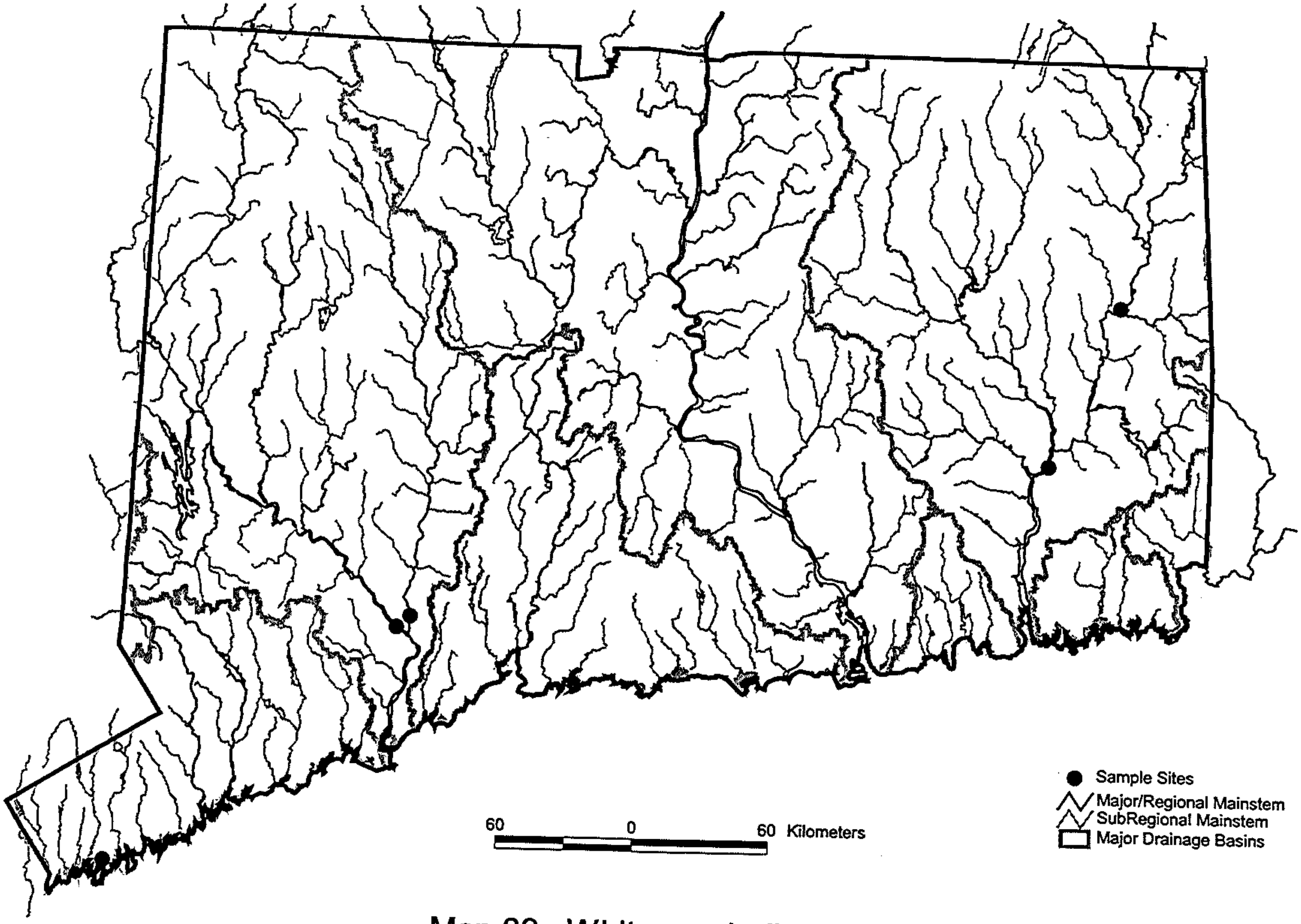
Map 36. White catfish distribution.



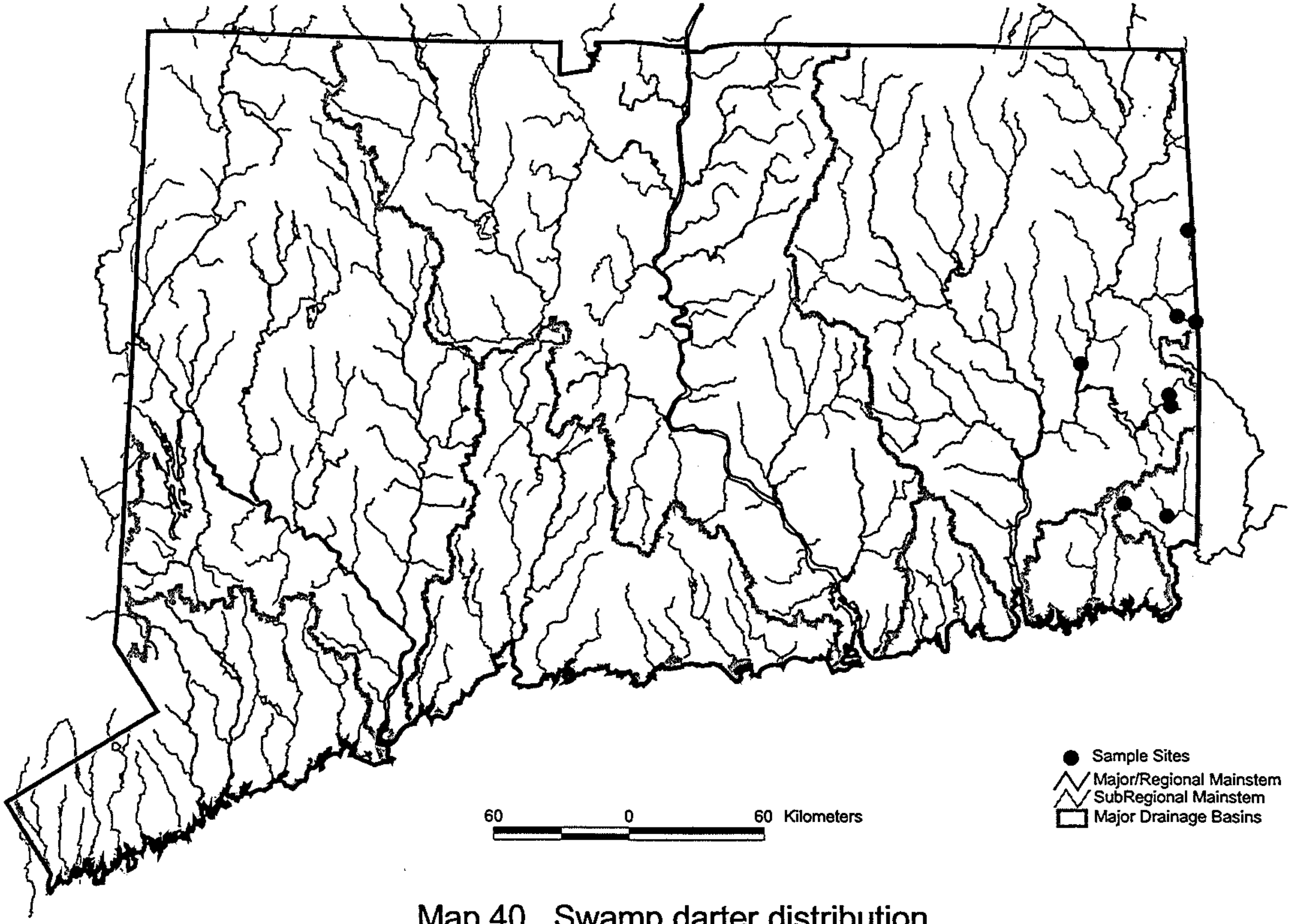
Map 37. Yellow bullhead distribution.



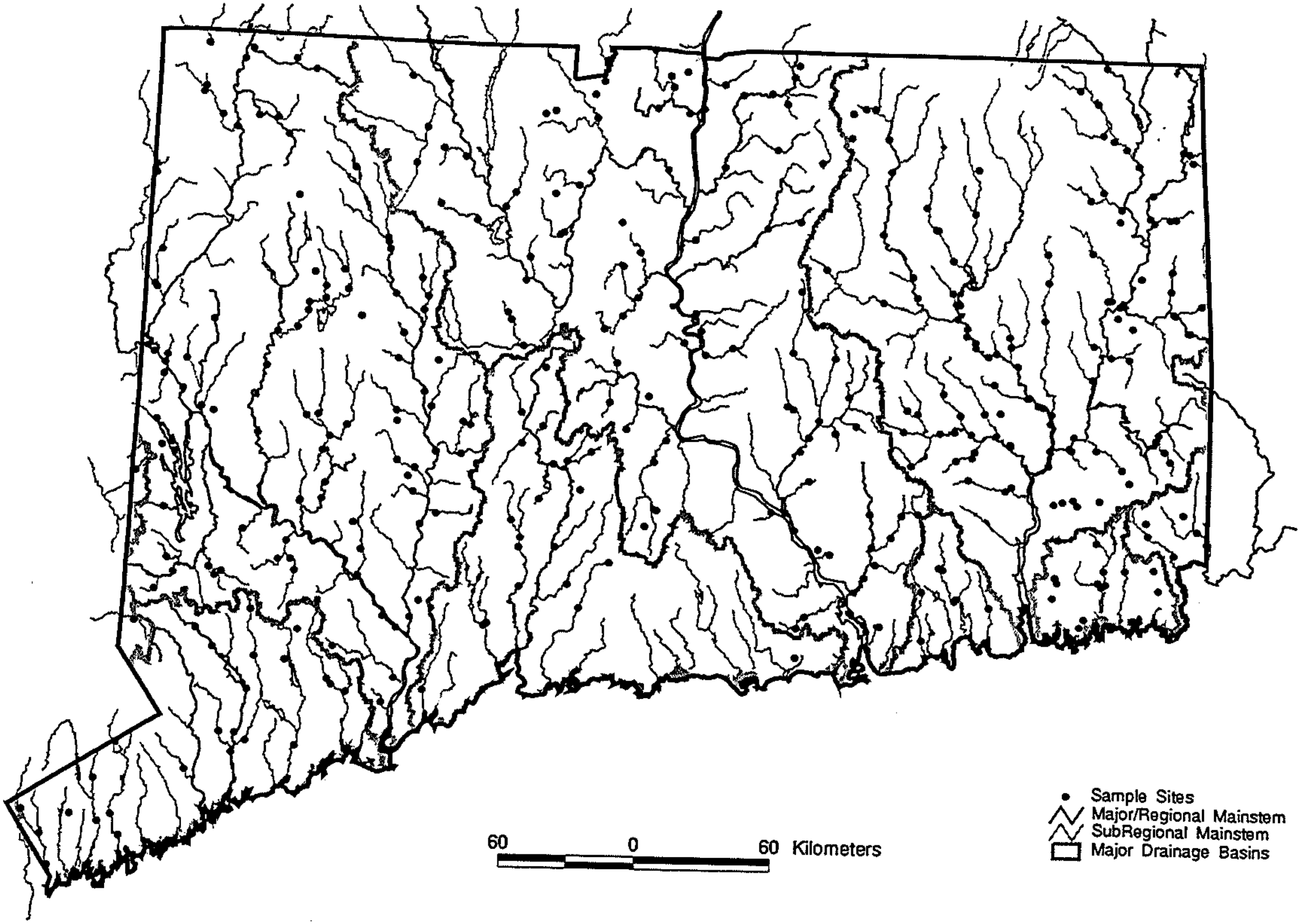
Map 38. Brown bullhead distribution.



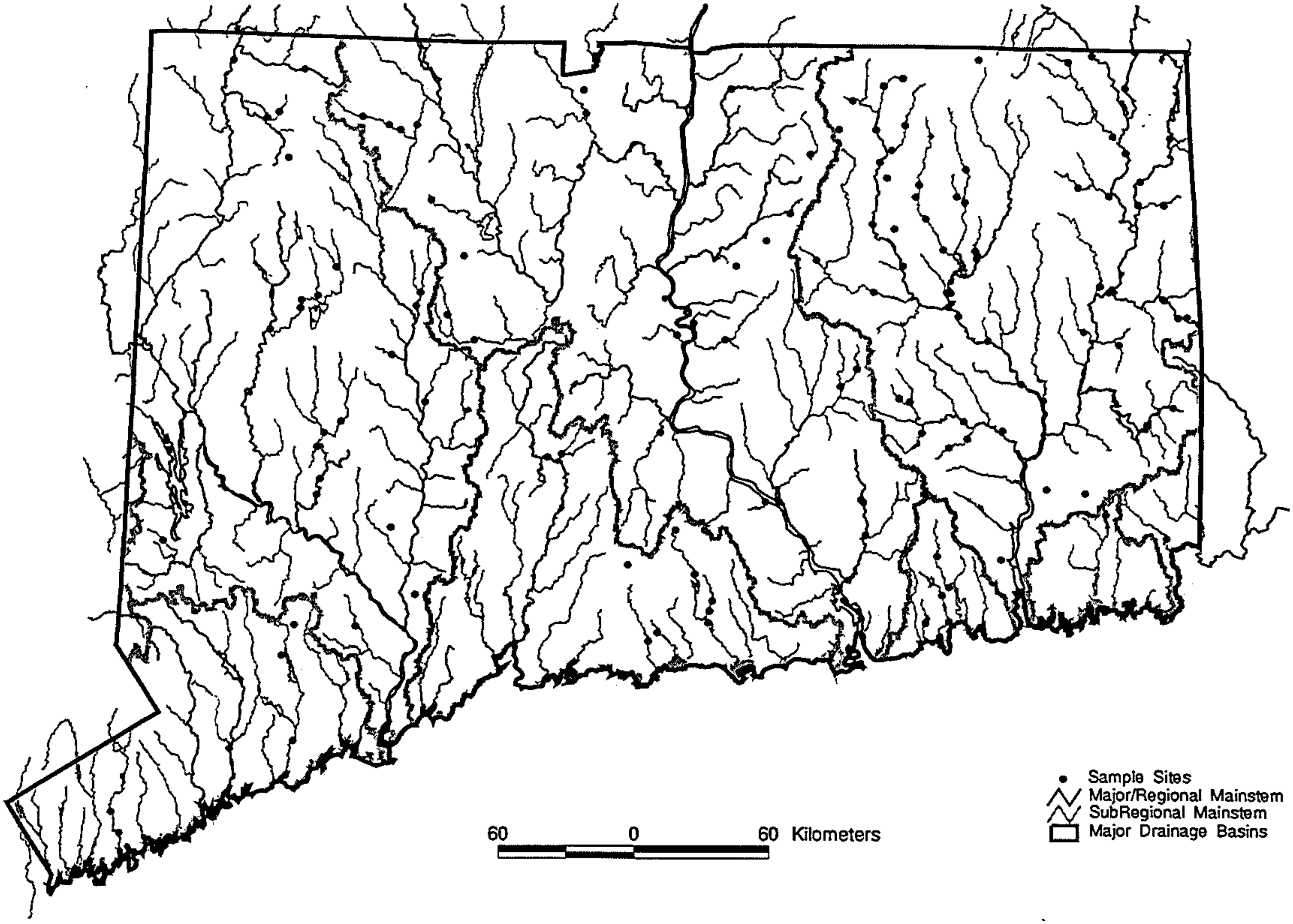
Map 39. White perch distribution.



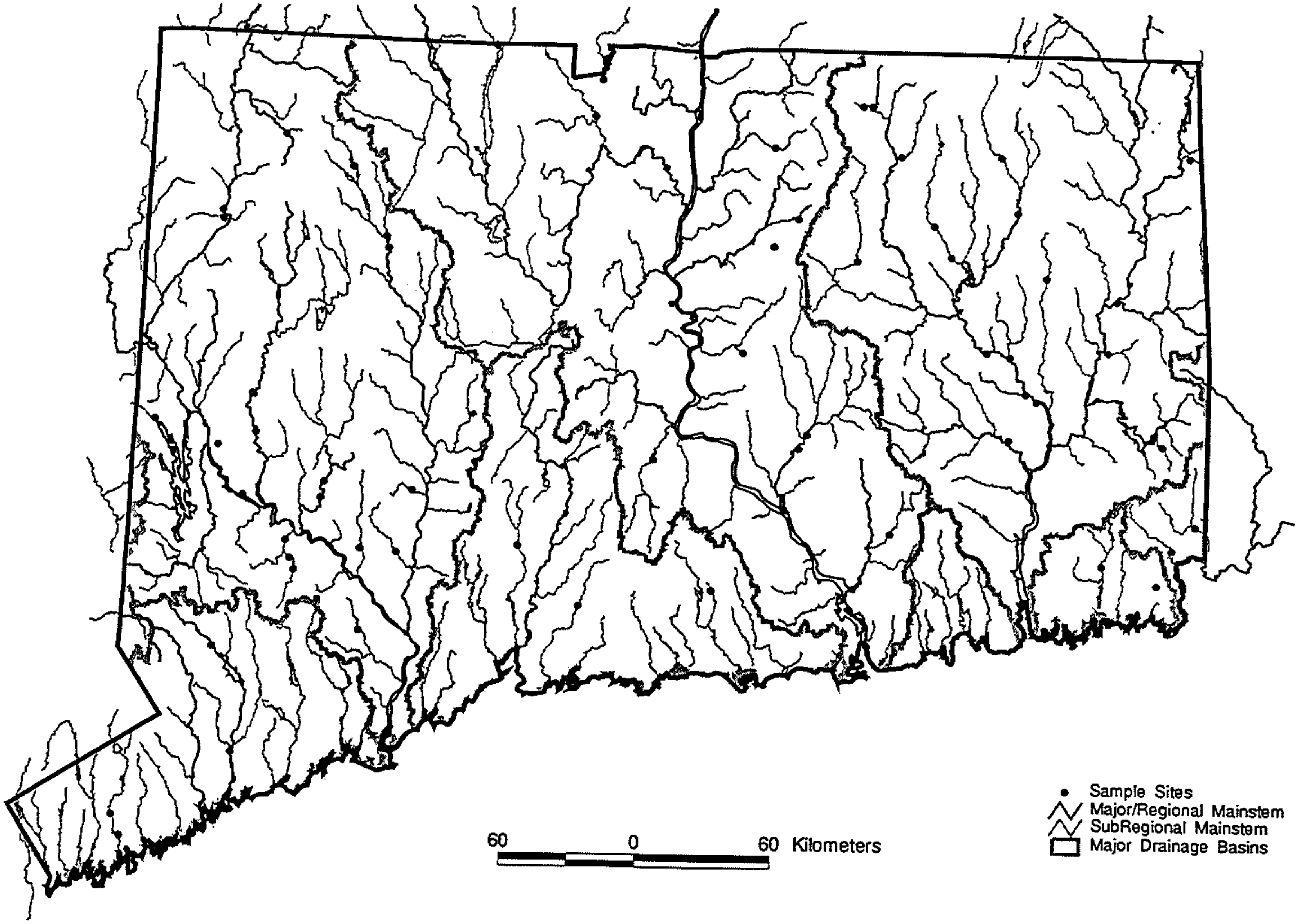
Map 40. Swamp darter distribution.



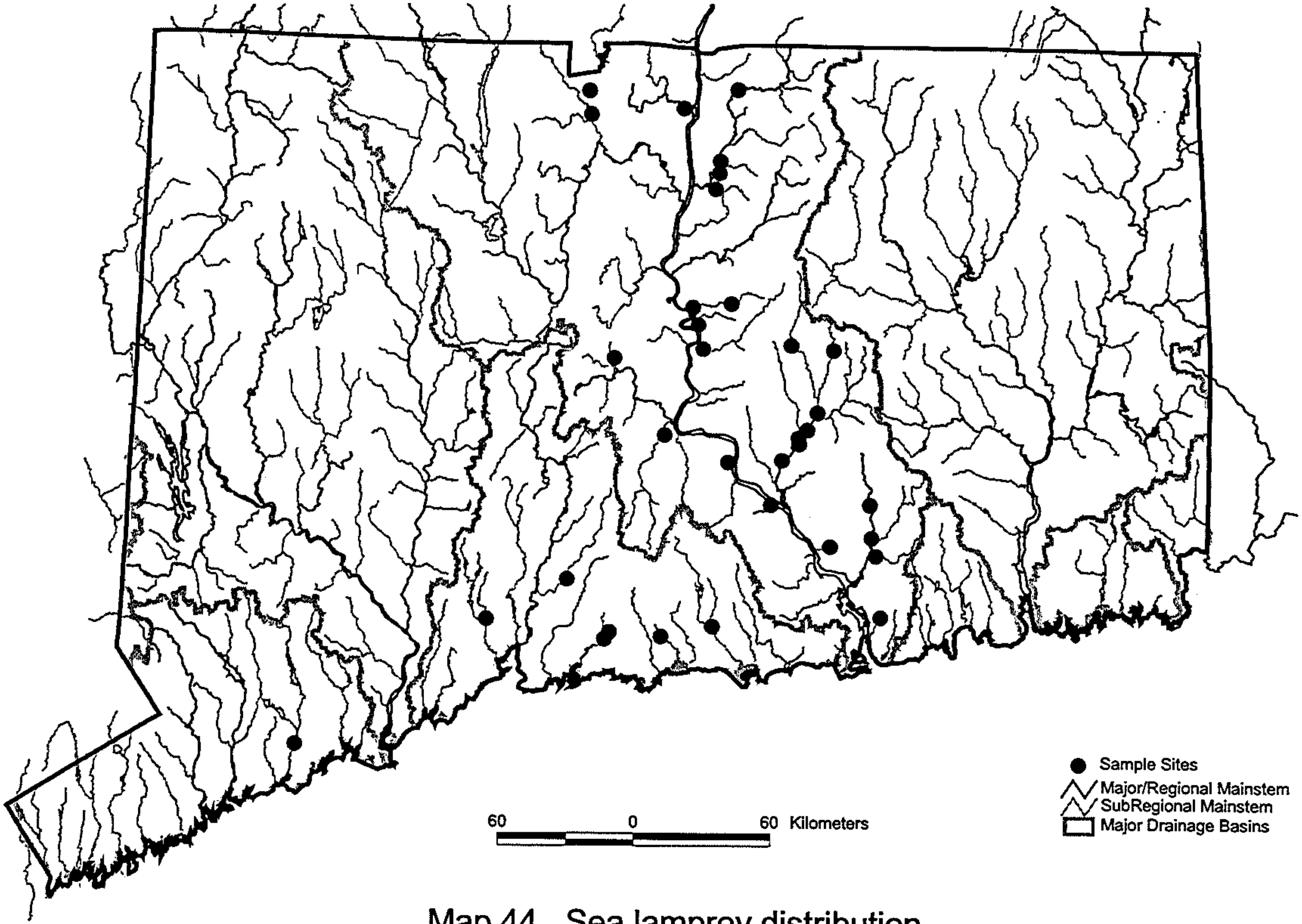
Map 41. Tessellated darter distribution.



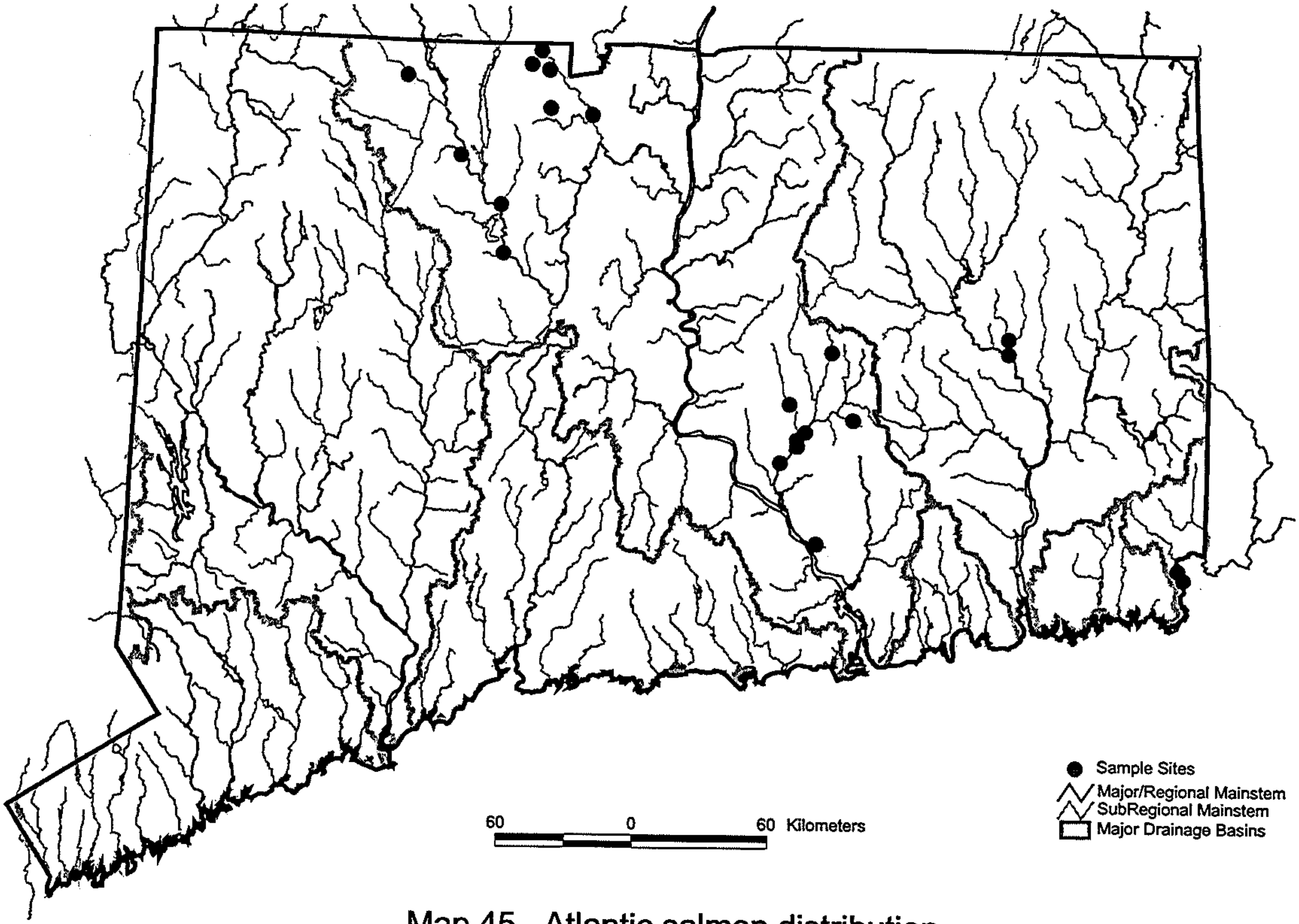
Map 42. Yellow perch distribution.



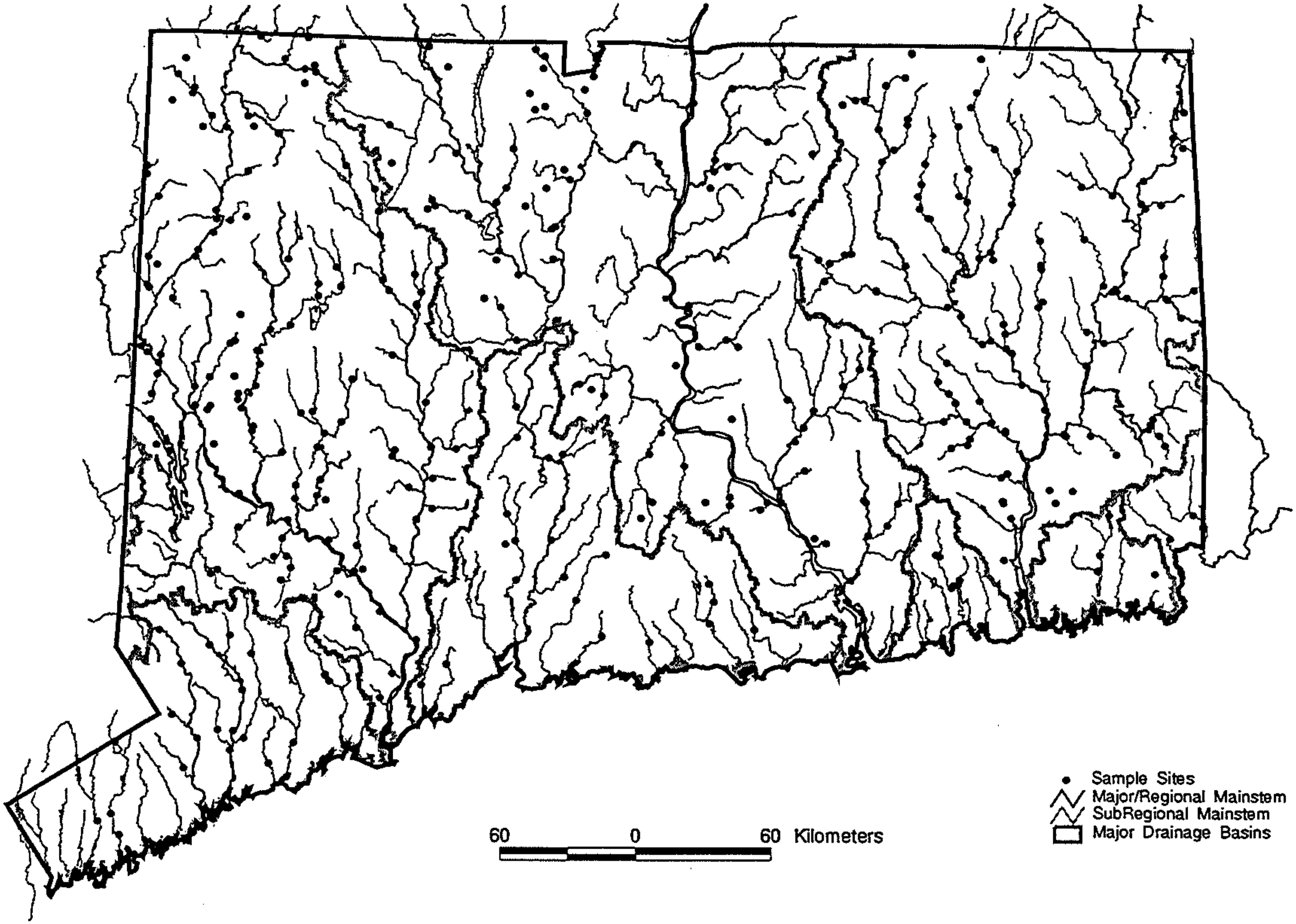
Map 43. Rainbow trout distribution.



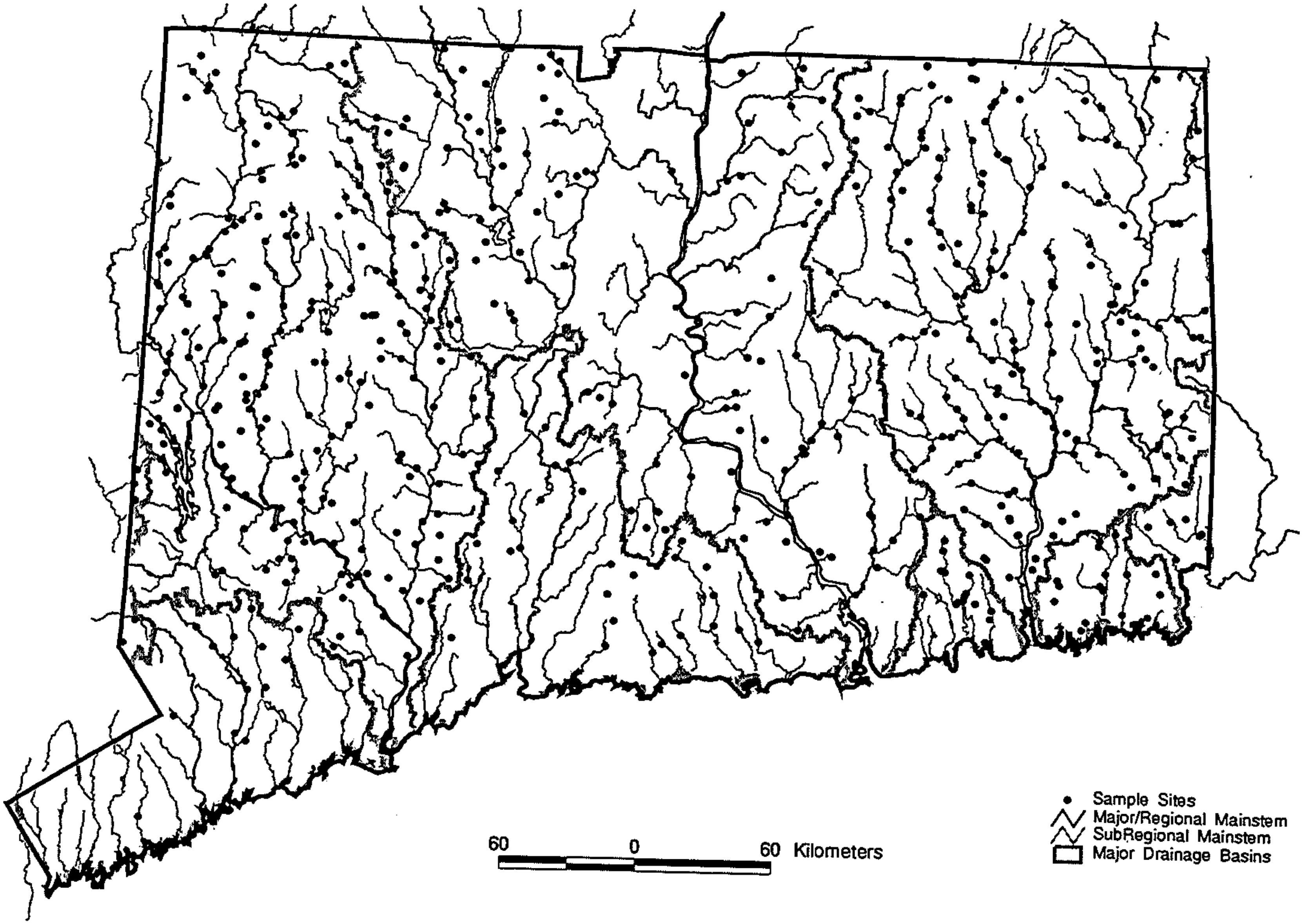
Map 44. Sea lamprey distribution.



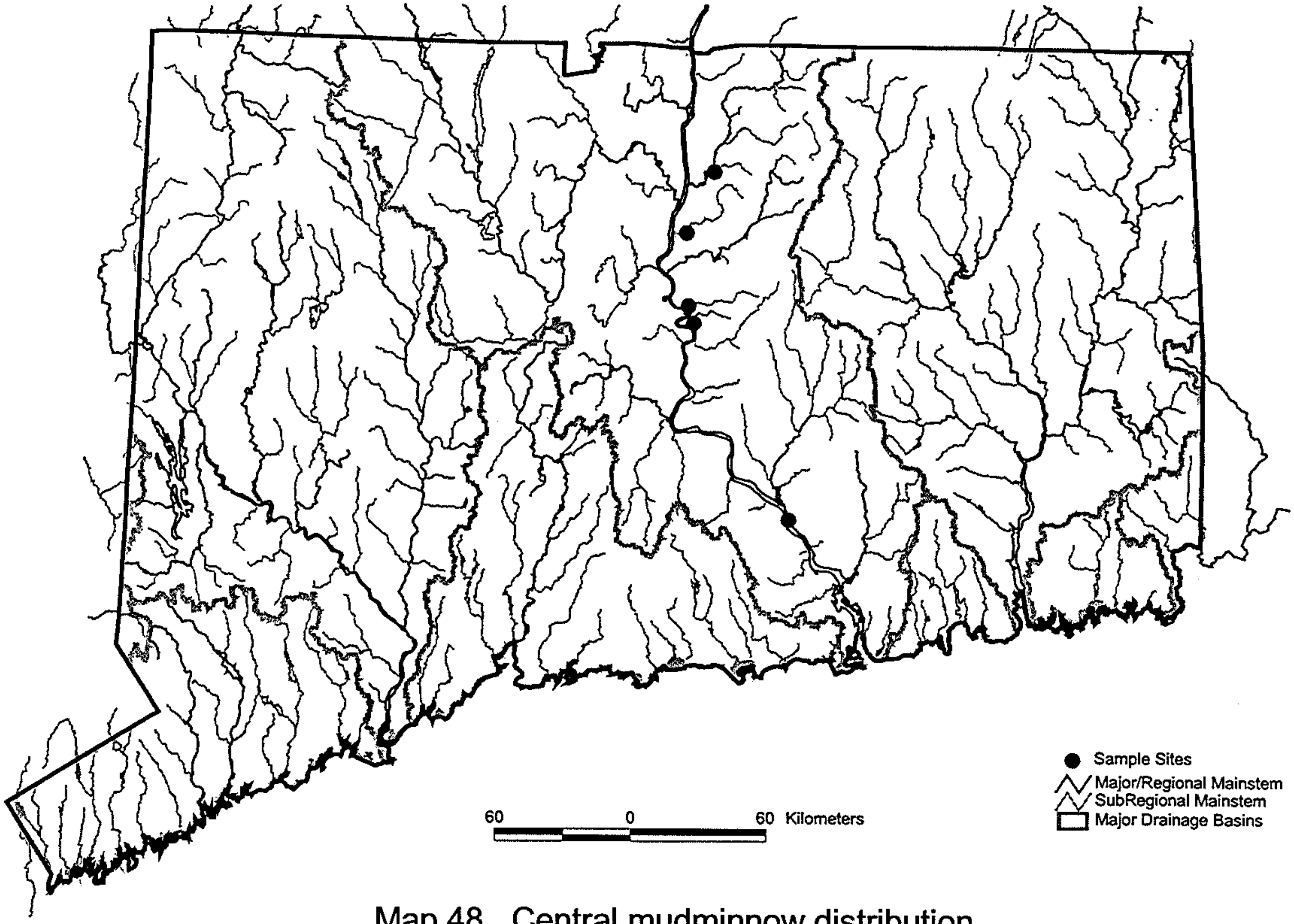
Map 45. Atlantic salmon distribution.



Map 46. Brown trout distribution.



Map 47. Brook trout distribution.



Map 48. Central mudminnow distribution.

Appendix B: Results of correlation analysis using trout population and stream parameters

Table B1.-Results of correlation analysis for class Brook-1 trout populations using number per hectare, biomass, and number per kilometer vs. selected variables.

	Number per ha Age 0	Number per ha Age 1	Number per ha Age 2	Number per ha Age 3	Number per km Age 0	Number per km Age 1	Number per km Age 2	Number per km Age 3
Number per ha	0.98801 0.0001 94 ***	0.46600 0.0001 94 ***	0.21088 0.0413 94 *	-0.05095 0.6258 94	0.79145 0.0001 94 ***	0.14506 0.1630 94	0.02982 0.7754 94	-0.07473 0.4741 94
Biomass	0.52918 0.0001 94 ***	0.66079 0.0001 94 ***	0.35165 0.0005 94 ***	0.22659 0.0281 94 *	0.47417 0.0001 94 ***	0.50725 0.0001 94 ***	0.23851 0.0206 94 *	0.21414 0.0382 94 *
Number per km	0.01677 0.8726 94	0.68826 0.0001 94 ***	0.37222 0.0002 94 ***	0.20843 0.0438 94 *	0.22708 0.0277 94 *	0.95386 0.0001 94 ***	0.51097 0.0001 94 ***	0.20793 0.0443 94 *

	Length at Age 1	Length at Age 2	Length at Age 3	Length at Age 4	Kg per Hectare Age 0	Kg per Hectare Age 1	Kg per Hectare Age 2	Kg per Hectare Age 3
Number per ha	-0.21370 0.0408 92 *	-0.19594 0.0943 74	0.16775 0.6220 11	-0.35052 0.4958 6	0.79383 0.0001 94 ***	0.31432 0.0020 94 **	0.12460 0.2315 94	-0.05082 0.6267 94
Biomass	0.11679 0.2676 92	0.18310 0.1184 74	0.78454 0.0042 11 **	-0.27432 0.5988 6	0.55832 0.0001 94 ***	0.81078 0.0001 94 ***	0.51147 0.0001 94 ***	0.27369 0.0076 94 **
Number per km	-0.17421 0.0967 92	-0.12584 0.2854 74	0.47188 0.1428 11	-0.42062 0.4063 6	-0.04301 0.6806 94	0.58350 0.0001 94 ***	0.38898 0.0001 94 ***	0.21003 0.0422 94 *

	Conductivity at 25^{o}C	Dissolved Oxygen	pH	Water Temp.	Maximum Water Temp.	Alkalinity	Velocity	Stream Discharge Velocity
Number per ha	-0.16524 0.1135 93	0.10872 0.2996 93	-0.13852 0.1854 93	-0.17656 0.0887 94	0.30692 0.1272 26	-0.22610 0.0321 90 *	-0.34156 0.0009 92 ***	-0.18026 0.0855 92
Biomass	-0.01713 0.8706 93	0.07541 0.4725 93	-0.03787 0.7186 93	-0.11349 0.2761 94	-0.07301 0.7230 26	-0.11198 0.2934 90	-0.30740 0.0029 92 **	-0.12288 0.2432 92
Number per km	-0.21223 0.0411 93 *	0.08936 0.3943 93	-0.00634 0.9519 93	-0.13327 0.2004 94	-0.13348 0.5157 26	-0.19289 0.0685 90	-0.24741 0.0174 92 *	0.06123 0.5621 92

	% Silt Substrate	% Sand Substrate	% Gravel Substrate	% Cobble Substrate	% Small Boulder Substrate	% Large Boulder Substrate	% Bedrock Substrate	Mean Embed. Gravel Substrate
Number per ha	0.31916 0.0017 94 **	0.08513 0.4146 94	0.20695 0.0454 94 *	-0.15601 0.1332 94	-0.22445 0.0296 94 *	-0.15123 0.1457 94	-0.06909 0.5425 80	-0.00883 0.9397 76
Biomass	0.07389 0.4791 94	0.17160 0.0982 94	0.24580 0.0169 94 *	-0.20864 0.0436 94 *	-0.12677 0.2234 94	-0.12286 0.2381 94	-0.04529 0.6900 80	0.00287 0.9804 76
Number per km	-0.05980 0.5670 94	-0.01551 0.8821 94	-0.06059 0.5618 94	-0.14205 0.1720 94	0.27741 0.0068 94 **	0.07490 0.4731 94	0.03715 0.7436 80	0.02366 0.8392 76

Table B1.-(cont.)

	Mean Embed. Cobble Substrate	Dominant Substrate Type	Mean Width	Mean Depth	Maximum Depth	Maximum Riffle Length	Maximum Pool Length	Pool to Riffle Ratio
Number per ha	-0.13737 0.1967 90	-0.26061 0.0112 94 *	-0.50224 0.0001 94 ***	-0.37822 0.0002 94 ***	-0.37324 0.0006 80 ***	-0.22629 0.0283 94 *	-0.11008 0.2909 94	0.01281 0.9024 94
Biomass	-0.01105 0.9177 90	-0.16607 0.1097 94	-0.41141 0.0001 94 ***	-0.22569 0.0287 94 *	-0.24170 0.0308 80 *	-0.28394 0.0055 94 **	0.02026 0.8463 94	-0.01159 0.9117 94
Number per km	-0.17599 0.0971 90	0.03320 0.7507 94	0.06691 0.5217 94	-0.05189 0.6194 94	-0.06558 0.5633 80	-0.02295 0.8262 94	0.10191 0.3284 94	-0.06150 0.5560 94

	Gradient	Elevation	Total Length of Cover	Length as Cover-Deep Water	Area as Cover-Deep Water	Length as Cover-Logs	Area as Cover-Logs	Length as Cover-Undercuts
Number per ha	-0.08242 0.4322 93	-0.05731 0.5853 93	-0.28854 0.0048 94 **	-0.22803 0.0271 94 *	-0.17283 0.0958 94	0.00686 0.9477 94	-0.00473 0.9639 94	-0.03990 0.7026 94
Biomass	-0.09704 0.3548 93	-0.23478 0.0235 93 *	-0.15392 0.1386 94	-0.09364 0.3693 94	-0.05128 0.6235 94	-0.02775 0.7906 94	0.08690 0.4049 94	0.12726 0.2216 94
Number per km	0.00637 0.9517 93	0.03458 0.7421 93	-0.06232 0.5507 94	-0.10792 0.3005 94	-0.08241 0.4297 94	-0.02756 0.7921 94	0.02245 0.8299 94	0.07147 0.4936 94

	Area as Cover-Undercuts	Length as Cover-Rocks	Area as Cover-Rocks	% Sample Area as Cover	% Sample Length as Cover	Percent Overhead Canopy	Subjective Fishing Pressure
Number per ha	-0.04664 0.6553 94	-0.28082 0.0061 94 **	-0.23805 0.0209 94 *	-0.10683 0.3054 94	-0.17581 0.0901 94	-0.07207 0.4900 94	-0.32455 0.0014 94 **
Biomass	0.10453 0.3160 94	-0.21175 0.0405 94 *	-0.18908 0.0680 94	0.05364 0.6076 94	-0.08004 0.4432 94	-0.15108 0.1461 94	-0.39248 0.0001 94 ***
Number per km	0.07301 0.4843 94	0.07593 0.4670 94	-0.02383 0.8196 94	-0.01064 0.9189 94	-0.04216 0.6866 94	0.03870 0.7111 94	-0.08294 0.4267 94

Table B2.-Results of correlation analysis for class Brown-1 trout populations using number per hectare, biomass, and number per kilometer vs. selected variables.

	Number per ha Age 0	Number per ha Age 1	Number per ha Age 2	Number per ha Age 3	Number per km Age 0	Number per km Age 1	Number per km Age 2	Number per km Age 3
Number per ha	0.97797 0.0001 21 ***	0.28630 0.2083 21	0.09384 0.6858 21	0.33051 0.1434 21	0.94749 0.0001 21 ***	0.19795 0.3897 21	0.03352 0.8853 21	0.31588 0.1630 21
Biomass	0.23383 0.3076 21	0.42246 0.0564 21	0.82108 0.0001 21 ***	0.59210 0.0047 21 **	0.28809 0.2054 21	0.51867 0.0160 21 *	0.82379 0.0001 21 ***	0.58365 0.0055 21 **
Number per km	0.02401 0.9177 21	0.81342 0.0001 21 ***	0.64307 0.0017 21 **	0.38864 0.0817 21	0.07862 0.7348 21	0.93629 0.0001 21 ***	0.75676 0.0001 21 ***	0.40472 0.0688 21

	Length at Age 1	Length at Age 2	Length at Age 3	Length at Age 4	Kg per Hectare Age 0	Kg per Hectare Age 1	Kg per Hectare Age 2	Kg per Hectare Age 3
Number per ha	0.27523 0.2272 21	0.08764 0.7133 20	0.16681 0.5524 15	. 0	0.83221 0.0001 21 ***	0.40822 0.0662 21	0.00987 0.9661 21	0.29323 0.1970 21
Biomass	0.43955 0.0462 21 *	0.47523 0.0342 20 *	0.64841 0.0089 15 **	. 0	0.19064 0.4078 21	0.66373 0.0010 21 ***	0.88695 0.0001 21 ***	0.81295 0.0001 21 ***
Number per km	0.00559 0.9808 21	-0.04851 0.8391 20	0.17002 0.5447 15	. 0	-0.09940 0.6681 21	0.72150 0.0002 21 ***	0.63450 0.0020 21 **	0.47980 0.0277 21 *

	Conductivity at 25°C	Dissolved Oxygen	pH	Water Temp.	Maximum Water Temp.	Alkalinity	Velocity	Stream Discharge Velocity
Number per ha	-0.00952 0.9673 21	-0.49856 0.0214 21 *	0.20769 0.3663 21	0.38180 0.0877 21	-0.51267 0.1297 10	-0.05874 0.8003 21	0.03175 0.8913 21	-0.24110 0.2924 21
Biomass	0.07962 0.7315 21	-0.38090 0.0885 21	0.30470 0.1793 21	0.59926 0.0041 21 **	0.52832 0.1165 10	0.18496 0.4222 21	0.15188 0.5111 21	0.08696 0.7078 21
Number per km	-0.20989 0.3612 21	-0.45352 0.0389 21 *	-0.13262 0.5666 21	0.36468 0.1041 21	0.50952 0.1325 10	-0.14622 0.5271 21	-0.15721 0.4961 21	0.08153 0.7254 21

	% Silt Substrate	% Sand Substrate	% Gravel Substrate	% Cobble Substrate	% Small Boulder Substrate	% Large Boulder Substrate	% Bedrock Substrate	Mean Embed. Gravel Substrate
Number per ha	0.11032 0.6340 21	-0.13386 0.5629 21	-0.02466 0.9155 21	0.29214 0.1988 21	-0.21382 0.3520 21	-0.15506 0.5021 21	. 17	-0.03754 0.8863 17
Biomass	0.57182 0.0068 21 **	0.03419 0.8830 21	0.49401 0.0228 21 *	-0.21507 0.3491 21	-0.50268 0.0202 21 *	-0.32663 0.1484 21	. 17	0.26376 0.3063 17
Number per km	0.39041 0.0802 21	-0.05452 0.8144 21	0.39686 0.0749 21	-0.19798 0.3896 21	-0.44754 0.0419 21 *	0.07355 0.7514 21	. 17	0.24135 0.3507 17

Table B2.-(cont.)

	Mean Embed. Cobble Substrate	Dominant Substrate Type	Mean Width	Mean Depth	Maximum Depth	Maximum Riffle Length	Maximum Pool Length	Pool to Riffle Ratio
Number per ha	0.08092 0.7273 21	-0.25319 0.2681 21	0.00900 0.9691 21	-0.06212 0.7891 21	-0.15908 0.5420 17	-0.07740 0.7388 21	-0.06596 0.7764 21	-0.32670 0.1483 21
Biomass	0.29644 0.1920 21	-0.48538 0.0257 21 *	0.41038 0.0646 21	0.50094 0.0207 21 *	0.54013 0.0252 17 *	0.01063 0.9635 21	0.22476 0.3273 21	0.00485 0.9834 21
Number per km	0.33490 0.1378 21	-0.25515 0.2643 21	0.56019 0.0083 21 **	0.43932 0.0463 21 *	0.53898 0.0256 17 *	-0.12262 0.5964 21	0.35541 0.1139 21	0.02877 0.9015 21

	Gradient	Elevation	Total Length of Cover	Length as Cover-Deep Water	Area as Cover-Deep Water	Length as Cover-Logs	Area as Cover-Logs	Length as Cover-Undercuts
Number per ha	0.09415 0.6848 21	-0.05369 0.8172 21	-0.14612 0.5274 21	-0.15073 0.5143 21	-0.17297 0.4534 21	0.13144 0.5701 21	0.05302 0.8194 21	-0.21297 0.3540 21
Biomass	-0.40491 0.0686 21	-0.23653 0.3019 21	0.57702 0.0062 21 **	0.66531 0.0010 21 ***	0.64149 0.0017 21 **	0.39011 0.0804 21	0.22954 0.3169 21	0.03829 0.8691 21
Number per km	-0.17925 0.4369 21	0.01816 0.9377 21	0.74028 0.0001 21 ***	0.73171 0.0002 21 ***	0.63703 0.0019 21 **	0.62389 0.0025 21 **	0.42675 0.0537 21	0.21203 0.3562 21

	Area as Cover-Undercuts	Length as Cover-Rocks	Area as Cover-Rocks	% Sample Area as Cover	% Sample Length as Cover	Percent Overhead Canopy	Subjective Fishing Pressure
Number per ha	-0.14125 0.5414 21	-0.32119 0.1557 21	-0.43270 0.0501 21	-0.21788 0.3427 21	-0.27786 0.2226 21	0.14633 0.5268 21	0.08501 0.7141 21
Biomass	0.04274 0.8541 21	-0.40633 0.0676 21	-0.39417 0.0770 21	0.68968 0.0005 21 ***	0.33931 0.1324 21	-0.26524 0.2452 21	0.07966 0.7314 21
Number per km	0.15265 0.5089 21	-0.16913 0.4636 21	-0.18882 0.4124 21	0.59524 0.0044 21 **	0.63327 0.0021 21 **	-0.12798 0.5804 21	0.27337 0.2305 21

Table B3.-Results of correlation analysis for class Brook-1 trout populations using mortality at age class vs. selected variables.

	Number per ha Age 0	Number per ha Age 1	Number per ha Age 2	Number per ha Age 3	Number per km Age 0	Number per km Age 1	Number per km Age 2	Number per km Age 3
Total Mortality	0.52555 0.0001 92 ***	-0.14252 0.1754 92	-0.08881 0.3999 92	-0.23098 0.0267 92 *	0.54768 0.0001 83 ***	-0.31564 0.0037 83 **	-0.25487 0.0201 83 *	-0.21666 0.0491 83 *
Mortality Age 1 and Over	0.17008 0.1050 92	0.31135 0.0025 92 **	-0.65361 0.0001 92 ***	-0.07467 0.4793 92	0.16900 0.1267 83	0.31015 0.0043 83 **	-0.71065 0.0001 83 ***	-0.08552 0.4420 83
Mortality Age 0 to Age 1	0.42145 0.0001 79 ***	-0.31574 0.0046 79 **	-0.05724 0.6163 79	-0.16561 0.1447 79	0.40248 0.0006 70 ***	-0.47329 0.0001 70 ***	-0.20631 0.0866 70	-0.12027 0.3213 70
Mortality Age 1 to Age 2	0.15602 0.1490 87	0.22982 0.0322 87 *	-0.64794 0.0001 87 ***	-0.05247 0.6293 87	0.15952 0.1630 78	0.21169 0.0628 78	-0.71622 0.0001 78 ***	-0.08111 0.4802 78
Mortality Age 2 to Age 3	0.10189 0.3910 73	-0.01005 0.9327 73	0.08515 0.4738 73	-0.72140 0.0001 73 ***	0.08424 0.4979 67	-0.03365 0.7869 67	0.05307 0.6697 67	-0.67919 0.0001 67 ***

	Length at Age 1	Length at Age 2	Length at Age 3	Kg per Hectare Age 0	Kg per Hectare Age 1	Kg per Hectare Age 2	Kg per Hectare Age 3	Conductivity at 25°C
Total Mortality	0.08089 0.4434 92	0.06590 0.5769 74	-0.27731 0.4090 11	0.42059 0.0001 92 ***	-0.33995 0.0009 92 ***	-0.40171 0.0001 92 ***	-0.24938 0.0165 92 *	-0.05447 0.6081 92
Mortality Age 1 and Over	0.01686 0.8732 92	0.22357 0.0555 74	0.18018 0.5960 11	0.25211 0.0153 92 *	0.25179 0.0155 92 *	-0.61141 0.0001 92 ***	-0.09792 0.3531 92	0.00771 0.9422 91
Mortality Age 0 to Age 1	0.14093 0.2154 79	0.10536 0.4151 62	-0.32155 0.3988 9	0.26042 0.0205 79 *	-0.40258 0.0002 79 ***	-0.29944 0.0073 79 **	-0.15976 0.1596 79	-0.07382 0.5207 78
Mortality Age 1 to Age 2	0.13057 0.2280 87	0.38381 0.0011 69 **	0.13692 0.6881 11 *	0.21300 0.0476 87	0.17535 0.1043 87 ***	-0.62441 0.0001 87	-0.09061 0.4039 87	-0.01303 0.9052 86
Mortality Age 2 to Age 3	0.09796 0.4096 73	0.09493 0.4344 70	0.30718 0.3879 10	0.10266 0.3874 73	0.04257 0.7206 73	0.06537 0.5827 73	-0.61941 0.0001 73 ***	0.04887 0.6835 72

Table B3.-(cont.)

	Dissolved Oxygen	pH	Water Temp.	Maximum Water Temp.	Alkalinity	Velocity	Stream Discharge Velocity	% Silt Substrate
Total Mortality	-0.06552 0.5372 91	-0.15458 0.1435 91	-0.01192 0.9102 92	0.40285 0.0459 25 *	-0.15552 0.1479 88	-0.02130 0.8421 90	0.00657 0.9510 90	0.17130 0.1025 92
Mortality Age 1 and Over	-0.08943 0.3992 91	-0.02174 0.8379 91	0.01492 0.8877 92	0.19325 0.3547 25	-0.14784 0.1693 88	-0.13930 0.1904 90	0.00638 0.9524 90	-0.05663 0.5918 92
Mortality Age 0 to Age 1	-0.25647 0.0234 78 *	-0.11855 0.3012 78	0.20147 0.0750 79	0.64464 0.0022 20 **	-0.17524 0.1326 75	-0.07613 0.5105 77	0.03274 0.7774 77	0.23179 0.0398 79 *
Mortality Age 1 to Age 2	-0.04826 0.6590 86	0.05596 0.6088 86	0.13799 0.2025 87	0.07214 0.7436 23	-0.09579 0.3861 84	-0.08716 0.4277 85	0.03936 0.7206 85	-0.07403 0.4956 87
Mortality Age 2 to Age 3	-0.12559 0.2932 72	-0.12547 0.2936 76	0.00180 0.9879 73	0.37950 0.0989 20	0.09500 0.4340 70	0.08734 0.4657 72	0.05298 0.6585 72	0.05260 0.6585 73

	% Sand Substrate	% Gravel Substrate	% Cobble Substrate	% Small Boulder Substrate	% Large Boulder Substrate	% Bedrock Substrate	Mean Embed. Gravel Substrate	Mean Embed. Cobble Substrate
Total Mortality	0.08860 0.4010 92	-0.05192 0.6231 92	0.08682 0.4105 92	-0.20048 0.0554 92	-0.12767 0.2252 92	-0.02478 0.8284 79	-0.05812 0.6228 74	-0.07302 0.4990 88
Mortality Age 1 and Over	0.16071 0.1259 92	0.04245 0.6878 92	0.07962 0.4506 92	-0.23992 0.0212 92 *	-0.13643 0.1947 92	0.05461 0.6326 79	-0.03892 0.7420 74	-0.02718 0.8015 88
Mortality Age 0 to Age 1	0.07412 0.5162 79	0.04991 0.6623 79	-0.01638 0.8861 79	-0.30267 0.0067 79 **	-0.09747 0.3928 79	0.00954 0.9380 69	0.07553 0.5596 62	-0.06103 0.6029 75
Mortality Age 1 to Age 2	0.13982 0.1965 87	0.13108 0.2262 87	0.00172 0.9874 87	-0.18118 0.0931 87	-0.11954 0.2701 87	-0.01709 0.8835 76	-0.14812 0.2211 70	0.10098 0.3637 83
Mortality Age 2 to Age 3	0.00219 0.9853 73	-0.05612 0.6373 73	0.16012 0.1760 73	-0.17884 0.1301 73	-0.05404 0.6498 73	0.04844 0.7132 60	-0.15065 0.2547 59	-0.17647 0.1410 71

Table B3.-(cont.)

	Dominant Substrate Type	Mean Width	Mean Depth	Maximum Depth	Maximum Riffle Length	Maximum Pool Length	Pool to Riffle Ratio	Gradient
Total Mortality	-0.14492 0.1681 92	-0.22804 0.0288 92 *	-0.30307 0.0033 92 **	-0.25749 0.0220 79 *	-0.07361 0.4856 92	-0.08972 0.3950 92	0.08500 0.4205 92	-0.05639 0.5955 91
Mortality Age 1 and Over	-0.13816 0.1891 92	-0.19062 0.0687 92	-0.33094 0.0013 92 **	-0.35410 0.0014 79 **	-0.18593 0.0760 92	-0.02154 0.8385 92	0.10642 0.3127 92	-0.10014 0.3449 91
Mortality Age 0 to Age 1	-0.17679 0.1191 79	-0.05123 0.6539 79	-0.02263 0.8431 79	-0.06153 0.6155 69	-0.03760 0.7422 79	0.05720 0.6166 79	0.05911 0.6048 79	-0.11273 0.3258 78
Mortality Age 1 to Age 2	-0.16343 0.1304 87	-0.15577 0.1497 87	-0.29069 0.0063 87 **	-0.19818 0.0861 76	-0.06316 0.5611 87	-0.07931 0.4653 87	0.10031 0.3552 87	-0.12092 0.2674 86
Mortality Age 2 to Age 3	-0.14756 0.2128 73	0.00252 0.9831 73	-0.00456 0.9695 73	0.06524 0.6204 60	0.09142 0.4418 73	0.06884 0.5628 73	-0.03950 0.7400 73	-0.13395 0.2620 72

	Elevation	Stream Order	Total Length of Cover	Length as Cover-Deep Water	Area as Cover-Deep Water	Length as Cover-Logs	Area as Cover-Logs	Length as Cover-Undercuts
Total Mortality	-0.10636 0.3157 91	-0.09024 0.3923 92	-0.17623 0.0929 92	-0.06633 0.5299 92	0.01398 0.8948 92	-0.06381 0.5456 92	-0.02668 0.8007 92	-0.08736 0.4076 92
Mortality Age 1 and Over	-0.26412 0.0114 91 *	0.09171 0.3846 92	-0.35580 0.0005 92 ***	-0.42303 0.0001 92 ***	-0.44027 0.0001 92 ***	-0.23820 0.0222 92 *	-0.20970 0.0448 92 *	-0.08563 0.4170 92
Mortality Age 0 to Age 1	-0.03703 0.7475 78	0.00755 0.9474 79	0.05018 0.6605 79	0.17723 0.1182 79	0.18460 0.1034 79	0.12816 0.2603 79	0.09982 0.3814 79	-0.05523 0.6288 79
Mortality Age 1 to Age 2	-0.36327 0.0006 86 ***	0.21937 0.0412 87 *	-0.39984 0.0001 87 ***	-0.42421 0.0001 87 ***	-0.43695 0.0001 87 ***	-0.35100 0.0009 87 ***	-0.36665 0.0005 87 ***	-0.16119 0.1358 87
Mortality Age 2 to Age 3	-0.01643 0.8911 72	0.07649 0.5201 73	0.07996 0.5013 73	0.04438 0.7093 73	0.05988 0.6148 73	0.08868 0.4556 73	0.06384 0.5915 73	0.03905 0.7429 73

	Area as Cover-Undercuts	Length as Cover-Rocks	Area as Cover-Rocks	% Sample Area as Cover	% Sample Length as Cover	Percent Overhead Canopy	Subjective Fishing Pressure
Total Mortality	-0.02678 0.8000 92	-0.21173 0.0428 92 *	-0.18664 0.0749 92	-0.04770 0.6516 92	-0.09231 0.3815 92	0.06913 0.5126 92	-0.19282 0.0655 92
Mortality Age 1 and Over	-0.17485 0.0955 92	-0.14883 0.1568 92	-0.11311 0.2830 92	-0.36004 0.0004 92 ***	-0.31219 0.0024 92 **	0.12938 0.2190 92	-0.06153 0.5601 92
Mortality Age 0 to Age 1	0.02023 0.8596 79	-0.13709 0.2283 79	-0.07856 0.4913 79	0.15728 0.1663 79	0.09258 0.4171 79	-0.00419 0.9708 79	-0.14636 0.1981 79
Mortality Age 1 to Age 2	-0.29621 0.0053 87 **	-0.21997 0.0406 87 *	-0.23926 0.0256 87 *	-0.35806 0.0007 87 ***	-0.35831 0.0007 87 ***	0.14880 0.1690 87	-0.06212 0.5676 87
Mortality Age 2 to Age 3	0.05490 0.6445 73	0.00217 0.9855 73	0.05349 0.6531 73	0.08912 0.4534 73	0.05589 0.6386 73	-0.01128 0.9245 73	0.04833 0.6847 73

Table B4.-Results of correlation analysis for class Brown-1 trout populations using mortality at age class vs. selected variables.

	Number per ha Age 0	Number per ha Age 1	Number per ha Age 2	Number per ha Age 3	Number per ha Age 4	Number per km Age 0	Number per km Age 1	Number per km Age 2
Total Mortality.	0.82035 0.0001 21 ***	-0.25592 0.2628 21	-0.26984 0.2368 21	0.01802 0.9382 21	-0.03982 0.8639 21	0.74042 0.0002 20 ***	-0.35760 0.1216 20	-0.43913 0.0527 20
Mortality Age 1 and Over	-0.10452 0.6521 21	0.32031 0.1569 21	-0.56028 0.0083 21 **	-0.72735 0.0002 21 ***	-0.24412 0.2862 21	0.06456 0.7869 20	0.13062 0.5831 20	-0.55438 0.0112 20 *
Mortality Age 0 to Age 1	0.74651 0.0009 16 ***	-0.25210 0.3462 16	-0.07051 0.7953 16	0.19985 0.4580 16	-0.05512 0.8393 16	0.68573 0.0048 15 **	-0.11691 0.6782 15	-0.11237 0.6901 15
Mortality Age 1 to Age 2	0.22179 0.3615 19	0.19677 0.4194 19	-0.69107 0.0011 19 **	-0.15164 0.5354 19	0.20646 0.3964 19	0.23711 0.3284 19	0.12629 0.6064 19	-0.60633 0.0059 19 **
Mortality Age 2 to Age 3	0.26765 0.2990 17	-0.40582 0.1060 17	-0.05676 0.8287 17	-0.69340 0.0020 17 **	-0.73865 0.0007 17 ***	0.25057 0.3320 17	-0.33769 0.1850 17	-0.09304 0.7225 17
Mortality Age 3 to Age 4	-0.03421 0.9205 11	-0.02388 0.9444 11	0.25279 0.4533 11	0.20696 0.5415 11	-0.93891 0.0001 11 ***	-0.32416 0.3608 10	0.04874 0.8936 10	0.11622 0.7492 10

	Number per km Age 3	Number per km Age 4	Length at Age 1	Length at Age 2	Length at Age 3	Length at Age 4	Kg per Hectare Age 0	Kg per Hectare Age 1
Total Hortality	-0.29071 0.2137 20	-0.00483 0.9839 20	0.30264 0.1824 21	0.21638 0.3595 20	0.11036 0.6954 15	0.26455 0.5664 7	0.68597 0.0006 21 ***	-0.35513 0.1142 21
Mortality Age 1 and Over	-0.56305 0.0097 20 **	-0.43279 0.0567 20	-0.25810 0.2586 21	-0.33115 0.1538 20	-0.24112 0.3867 15	0.00029 0.9995 7	-0.04556 0.8445 21	0.06106 0.7926 21
Mortality Age 0 to Age 1	0.04402 0.8762 15	0.09477 0.7369 15	0.17459 0.5178 16	0.21583 0.4398 15	0.39967 0.2233 11	0.84218 0.0735 5	0.68300 0.0035 16 **	0.06955 0.7980 16
Mortality Age 1 to Age 2	-0.11035 0.6529 19	0.15587 0.5240 19	-0.42303 0.0711 19	-0.39194 0.1077 18	-0.21647 0.4775 13	-0.04549 0.9318 6	0.10709 0.6626 19	-0.01931 0.9375 19
Mortality Age 2 to Age 3	-0.66461 0.0036 17 **	-0.65950 0.0040 17 **	0.33130 0.1939 17	0.37496 0.1524 16	0.35985 0.2770 11	0.83735 0.0768 5	0.38835 0.1235 17	-0.05683 0.8285 17
Mortality Age 3 to Age 4	-0.09960 0.7843 10	-0.88986 0.0006 10 ***	0.37374 0.2575 11	-0.05120 0.8812 11	-0.09246 0.7869 11	0.77090 0.0727 6	-0.24749 0.4631 11	0.07579 0.8247 11

Table B4.-(cont.)

	Kg per Hectare Age 2	Kg per Hectare Age 3	Kg per Hectare Age 4	Conductivity at 25°C	Dissolved Oxygen	pH	Water Temp.	Maximum Water Temp.
Total Mortality	-0.41497 0.0614 21	-0.17578 0.4460 21	-0.10685 0.6448 21	0.14817 0.5215 21	-0.30211 0.1832 21	0.30335 0.1813 21	0.17391 0.4509 21	-0.69357 0.0261 10 *
Mortality Age 1 and Over	-0.42718 0.0534 21	-0.66402 0.0010 21	-0.34394 0.1269 21	-0.20228 0.3792 21	-0.29274 0.1978 21	-0.45181 0.0398 21 *	-0.10971 0.6359 21	-0.36132 0.3050 10
Mortality Age 0 to Age 1	-0.00098 0.9971 16	0.31887 0.2287 16	0.20258 0.4518 16	-0.13252 0.6247 16	-0.33778 0.2007 16	0.21181 0.4310 16	0.16922 0.5310 16	-0.47417 0.2352 8
Mortality Age 1 to Age 2	-0.46113 0.0469 19 *	-0.16365 0.5032 19	0.05807 0.8133 19	-0.33851 0.1563 19	-0.14865 0.5436 19	-0.44032 0.0592 19	-0.10736 0.6618 19	-0.36386 0.3756 8
Mortality Age 2 to Age 3	-0.11918 0.6487 17	-0.36633 0.1481 17	-0.37327 0.1400 17	0.42207 0.0915 17	-0.19317 0.4576 17	0.36343 0.1516 17	-0.01088 0.9669 17	-0.55810 0.1929 7
Mortality Age 3 to Age 4	-0.02812 0.9346 11	-0.17095 0.6153 11	-0.76611 0.0060 11 **	-0.09862 0.7730 11	-0.15003 0.6597 11	0.15372 0.6518 11	0.17039 0.6164 11	0.14338 0.7591 7

	Alkalinity	Velocity	Stream Doscharge Velocity	% Silt Substrate	% Sand Substrate	% Gravel Substrate	% Cobble Substrate	% Small Boulder Substrate
Total Mortality	0.02549 0.9127 21	0.10022 0.6656 21	-0.22698 0.3225 21	-0.09095 0.6950 21	-0.01943 0.9334 21	-0.06050 0.7945 21	0.19620 0.3940 21	0.03269 0.8881 21
Mortality Age 1 and Over	-0.28929 0.2034 21	-0.62179 0.0026 21 **	-0.11511 0.6193 21	-0.27747 0.2233 21	-0.04983 0.8301 21	-0.06931 0.7653 21	0.07744 0.7387 21	0.11423 0.6220 21
Mortality Age 0 to Age 1	-0.24858 0.3532 16	0.39178 0.1334 16	0.36384 0.1659 16	0.10133 0.7089 16	-0.02333 0.9317 16	0.14560 0.5905 16	0.12596 0.6421 16	-0.27233 0.3075 16
Mortality Age 1 to Age 2	-0.31089 0.1951 19	-0.35230 0.1391 19	0.20875 0.3911 19	-0.30662 0.2017 19	-0.29016 0.2282 19	-0.16092 0.5104 19	0.28456 0.2377 19	0.08042 0.7435 19
Mortality Age 2 to Age 3	0.20316 0.4342 17	-0.02931 0.9111 17	-0.23299 0.3682 17	-0.01502 0.9544 17	0.19876 0.4444 17	-0.10418 0.6907 17	0.11253 0.6672 17	0.13397 0.6082 17
Mortality Age 3 to Age 4	-0.33313 0.3168 11	-0.11090 0.7455 11	0.11655 0.7329 11	-0.46431 0.1502 11	-0.43528 0.1809 11	-0.31755 0.3413 11	0.40135 0.2212 11	0.10579 0.7569 11

Table B4.-(cont.)

	% Large Boulder Substrate	% Bedrock Substrate	Mean Embed. Gravel Substrate	Mean Embed. Cobble Substrate	Dominant Substrate Type	Mean Width	Mean Depth	Maximum Depth
Total Mortality	-0.26009 0.2549 21	. 17	-0.16530 0.5261 17	-0.11943 0.6061 21	-0.22394 0.3291 21	-0.35844 0.1106 21	-0.27388 0.2296 21	-0.51410 0.0348 17 *
Mortality Age 1 and Over	0.11479 0.6203 21	. 17	0.02729 0.9172 17	0.01953 0.9330 21	0.00010 0.9997 21	-0.40407 0.0693 21	-0.60664 0.0035 21 **	-0.46795 0.0582 17
Mortality Age 0 to Age 1	-0.45750 0.0748 16	. 13	-0.09479 0.7472 14	-0.03909 0.8857 16	-0.45139 0.0793 16	0.18601 0.4903 16	0.22104 0.4107 16	-0.00964 0.9751 13
Mortality Age 1 to Age 2	0.21179 0.3841 19	. 16	-0.56997 0.0265 15 *	-0.29200 0.2251 19	0.04452 0.8564 19	-0.16262 0.5059 19	-0.36865 0.1204 19	-0.23416 0.3827 16
Mortality Age 2 to Age 3	-0.66610 0.0035 17 **	. 14	0.57036 0.0418 13 *	0.38860 0.1232 17	-0.18946 0.4664 17	-0.17132 0.5109 17	-0.30091 0.2405 17	-0.23864 0.4113 14
Mortality Age 3 to Age 4	-0.17324 0.6105 11	. 9	0.47656 0.1638 10	0.35710 0.2810 11	0.35311 0.2868 11	-0.30708 0.3583 11	-0.22535 0.5053 11	0.01625 0.9669 9

	Maximum Riffle Length	Maximum Pool Length	Pool to Riffle Ratio	Gradient	Elevation	Stream Order	Total Length of Cover	Length as Cover-Deep Water
Total Mortality	-0.11437 0.6216 21	-0.23212 0.3113 21	-0.06017 0.7956 21	0.05679 0.8068 21	-0.20905 0.3631 21	-0.12170 0.5992 21	-0.49672 0.0220 21 *	-0.47485 0.0296 21 *
Mortality Age 1 and Over	-0.35281 0.1167 21	-0.10308 0.6566 21	0.16199 0.4830 21	0.00864 0.9704 21	0.13880 0.5485 21	-0.02806 0.9039 21	-0.34512 0.1255 21	-0.35137 0.1183 21
Mortality Age 0 to Age 1	0.21864 0.4159 16	0.02651 0.9224 16	-0.12928 0.6332 16	-0.15324 0.5710 16	-0.55409 0.0259 16 *	0.18143 0.5013 16	-0.08118 0.7650 16	0.12636 0.6410 16
Mortality Age 1 to Age 2	0.24857 0.3048 19	-0.24672 0.3085 19	-0.16523 0.4990 19	0.21272 0.3819 19	0.07468 0.7613 19	0.17187 0.4817 19	-0.29305 0.2234 19	-0.25604 0.2900 19
Mortality Age 2 to Age 3	-0.39894 0.1127 17	-0.00533 0.9838 17	0.15397 0.5552 17	-0.10986 0.6747 17	-0.38011 0.1323 17	-0.14142 0.5882 17	-0.18970 0.4659 17	-0.18980 0.4656 17
Mortality Age 3 to Age 4	-0.11361 0.7394 11	-0.38476 0.2426 11	0.01216 0.9717 11	0.39202 0.2331 11	-0.17610 0.6045 11	-0.13450 0.6934 11	0.00753 0.9825 11	-0.10306 0.7630 11

Table B4.-(cont.)

	Area as Cover-Deep Water	Length as Cover-Logs	Area as Cover-Logs	Length as Cover-Undercuts	Area as Cover-Undercuts	Length as Cover-Rocks	Area as Cover-Rocks	% Sample Area as Cover
Total Mortality	-0.41854 0.0590 21	-0.23625 0.3025 21	-0.24974 0.2749 21	-0.23485 0.3055 21	-0.15948 0.4899 21	-0.32013 0.1571 21	-0.30499 0.1788 21	-0.40061 0.0719 21
Mortality Age 1 and Over	-0.38330 0.0863 21	-0.05486 0.8133 21	0.02316 0.9206 21	0.09354 0.6867 21	0.11083 0.6325 21	0.16614 0.4717 21	0.02349 0.9195 21	-0.34888 0.1211 21
Mortality Age 0 to Age 1	0.15465 0.5674 16	-0.05753 0.8324 16	-0.09554 0.7249 16	-0.19689 0.4649 16	-0.20101 0.4554 16	-0.42098 0.1044 16	-0.40353 0.1212 16	-0.07408 0.7851 16
Mortality Age 1 to Age 2	-0.23250 0.3381 19	-0.11929 0.6267 19	0.05279 0.8300 19	-0.18492 0.4485 19	-0.05593 0.8201 19	0.17267 0.4796 19	-0.20146 0.4082 19	-0.29496 0.2202 19
Mortality Age 2 to Age 3	-0.22061 0.3948 17	0.01506 0.9543 17	0.08793 0.7372 17	0.18397 0.4797 17	0.11721 0.6542 17	-0.29670 0.2475 17	-0.09690 0.7114 17	-0.25336 0.3265 17
Mortality Age 3 to Age 4	-0.13810 0.6855 11	-0.38236 0.2458 11	-0.23351 0.4895 11	0.15682 0.6452 11	0.20163 0.5522 11	0.25411 0.4508 11	0.27744 0.4088 11	0.05181 0.8798 11

	% Sample Length as Cover	Percent Overhead Canopy	Subjective Fishing Pressure
Total Mortality	-0.52573 0.0144 21 *	0.13771 0.5517 21	-0.12849 0.5788 21
Mortality Age 1 and Over	-0.22152 0.3345 21	0.16328 0.4794 21	0.21113 0.3583 21
Mortality Age 0 to Age 1	-0.19187 0.4765 19	0.19894 0.4601 16	0.21380 0.4266 16
Mortality Age 1 to Age 2	-0.15236 0.5335 19	0.67071 0.0017 19 **	0.07781 0.7515 19
Mortality Age 2 to Age 3	-0.25073 0.3317 17	-0.35350 0.1639 17	-0.15959 0.5406 17
Mortality Age 3 to Age 4	-0.06019 0.8604 11	0.12493 0.7144 11	-0.01295 0.9698 11

Table B5.-Results of correlation analysis for class Brook-1 trout populations using biomass by age class vs. selected variables.

	Number per ha Age 0	Number per ha Age 1	Number per ha Age 2	Number per ha Age 3	Number per km Age 0	Number per km Age 1	Number per km Age 2	Number per km Age 3
Kg per Hectare Age 0	0.82901 0.0001 94 ***	0.15063 0.1473 94	-0.03143 0.7636 94	-0.07673 0.4623 94	0.75509 0.0001 94 ***	-0.00706 0.9461 94	-0.11333 0.2768 94	-0.08187 0.4328 94
Kg per Hectare Age 1	0.21220 0.0400 94 *	0.79114 0.0001 94 ***	0.02076 0.8425 94	0.14514 0.1628 94	0.18794 0.0697 94	0.67573 0.0001 94 ***	-0.04612 0.6589 94	0.12669 0.2237 94
Kg per Hectare Age 2	0.05511 0.5978 94	0.20608 0.0463 94 *	0.86446 0.0001 94 ***	0.18880 0.0684 94	0.03951 0.7053 94	0.16838 0.1048 94	0.77428 0.0001 94 ***	0.18189 0.0793 94
Kg per Hectare Age 3	-0.07881 0.4502 94	0.10725 0.3035 94	0.07673 0.4623 94	0.92110 0.0001 94 ***	-0.07366 0.4804 94	0.17286 0.0957 94	0.10270 0.3246 94	0.96262 0.0001 94 ***

	Length at Age 1	Length at Age 2	Length at Age 3	Length at Age 4	Kg per Hectare Age 0	Kg per Hectare Age 1	Kg per Hectare Age 2	Kg per Hectare Age 3
Kg per Hectare Age 0	0.04427 0.6752 92	0.09750 0.4086 74	0.38135 0.2472 11	-0.26416 0.6130 6	1.00000 0.0000 94	0.19627 0.0580 94	-0.04896 0.6394 94	-0.05960 0.5683 94
Kg per Hectare Age 1	0.20601 0.0488 92 *	0.31784 0.0058 74 **	0.75742 0.0069 11 **	-0.23609 0.6524 6	0.19627 0.0580 94	1.00000 0.0000 94	0.18016 0.0823 94	0.18309 0.0773 94
Kg per Hectare age 2	-0.09347 0.3755 92	-0.15761 0.1799 74	0.43066 0.1861 11	-0.59747 0.2104 6	-0.04896 0.6394 94	0.18016 0.0823 94	1.00000 0.0000 94	0.20675 0.0456 94 *
Kg per Hectare Age 3	0.03260 0.7577 92	0.07297 0.5367 74	0.30584 0.3604 11	0.00000 1.0000 6	-0.05960 0.5683 94	0.18309 0.0773 94	0.20675 0.0456 94 *	1.00000 0.0000 94

	Conductivity at 25°C	Dissolved Oxygen	pH	Water Temp.	Maximum Water Temp.	Alkalinity	Velocity	Stream Discharge Velocity
Kg per Hectare Age 0	-0.10372 0.3225 93	0.06303 0.5483 93	-0.11231 0.2838 93	-0.03310 0.7515 94	0.26407 0.1924 26	-0.11843 0.2663 90	-0.18687 0.0745 92	-0.11311 0.2830 92
Kg per Hectare Age 1	0.05221 0.6191 93	-0.02653 0.8007 93	0.01261 0.9045 93	-0.04770 0.6480 94	-0.10062 0.6248 26	-0.10535 0.3230 90	-0.23280 0.0255 92 *	-0.02689 0.7992 92
Kg per Hectare Age 2	-0.00178 0.9865 93	0.13140 0.2093 93	-0.00766 0.9419 93	-0.16878 0.1039 94	-0.05176 0.8017 26	0.02996 0.7792 90	-0.17662 0.0921 92	-0.13172 0.2107 92
Kg per Hectare Age 3	-0.01480 0.8880 93	0.10340 0.3240 93	0.08679 0.4081 93	-0.00812 0.9381 94	-0.25852 0.2022 26	-0.02444 0.8191 90	-0.04825 0.6479 92	-0.01702 0.8720 92

Table B5.-(cont.)

	% Silt Substrate	% Sand Substrate	% Gravel Substrate	% Cobble Substrate	% Small Boulder Substrate	% Large Boulder Substrate	% Bedrock Substrate	Mean Embed. Gravel Substrate
Kg per Hectare Age 0	0.11420 0.2731 94	0.11160 0.2842 94	0.28811 0.0049 94 **	-0.12536 0.2286 94	-0.21426 0.0381 94 *	-0.18461 0.0749 94	-0.04185 0.7124 80	-0.03025 0.7953 76
Kg per Hectare Age 1	-0.01663 0.8736 94	0.23167 0.0247 94 *	0.20426 0.0483 94 *	-0.18413 0.0756 94	-0.15192 0.1438 94	-0.11948 0.2514 94	0.01786 0.8750 80	-0.06302 0.5886 76
Kg per Hectare Age 2	0.08458 0.4177 94	-0.07891 0.4496 94	-0.06560 0.5299 94	-0.03848 0.7127 94	0.18750 0.0704 94	0.04716 0.6517 94	-0.10568 0.3509 80	0.12920 0.2660 76
Kg per Hectare Age 3	-0.01931 0.8534 94	0.05676 0.5869 94	0.10384 0.3192 94	-0.19003 0.0666 94	-0.07086 0.4973 94	0.17944 0.0835 94	-0.00919 0.9355 80	0.08436 0.4687 76

	Mean Embed. Cobble Substrate	Dominant Substrate Type	Mean Width	Mean Depth	Maximum Depth	Maximum Riffle Length	Maximum Pool Length	Pool to Riffle Ratio
Kg per Hectare Age 0	-0.04765 0.6556 90	-0.19865 0.0549 94	-0.30025 0.0033 94 **	-0.24800 0.0160 94 *	-0.22257 0.0472 80	-0.18117 0.0805 94	-0.01659 0.8739 94	0.01668 0.8732 94
Kg per Hectare Age 1	-0.03187 0.7656 90	-0.13922 0.1808 94	-0.35255 0.0005 94 ***	-0.21657 0.0360 94 *	-0.23324 0.0373 80 *	-0.25930 0.0116 94 *	0.00116 0.9912 94	0.03575 0.7323 94
Kg per Hectare Age 2	0.04725 0.6583 90	-0.00357 0.9728 94	-0.13400 0.1979 94	0.02780 0.7903 94	0.04572 0.6872 80	-0.07407 0.4780 94	0.07321 0.4832 94	-0.09937 0.3406 94
Kg per Hectare Age 3	0.11992 0.2602 90	0.14006 0.1782 94	0.02227 0.8313 94	0.13306 0.2011 94	0.21858 0.0514 80	-0.07450 0.4755 94	-0.01995 0.8486 94	-0.02037 0.8455 94

	Gradient	Elevation	Total Length of Cover	Length as Cover-Deep Water	Area as Cover-Deep Water	Length as Cover-Logs	Area as Cover-Logs	Length as Cover-Undercuts
Kg per Hectare Age 0	-0.15625 0.1347 93	-0.20199 0.0522 93	-0.18188 0.0793 94	-0.13319 0.2006 94	-0.08812 0.3984 94	-0.00126 0.9904 94	0.03756 0.7193 94	-0.02211 0.8324 94
Kg per Hectare Age 1	-0.08483 0.4188 93	-0.30459 0.0030 93 **	-0.18754 0.0703 94	-0.16046 0.1224 94	-0.13010 0.2114 94	-0.14625 0.1596 94	-0.04408 0.6731 94	0.10242 0.3260 94
Kg per Hectare Age 2	0.07547 0.4722 93	0.11690 0.2645 93	0.12024 0.2484 94	0.16094 0.1212 94	0.18075 0.0813 94	0.17875 0.0847 94	0.25718 0.0123 94 *	0.17498 0.0916 94
Kg per Hectare Age 3	-0.02272 0.8289 93	0.03512 0.7382 93	-0.00100 0.9924 94	0.04310 0.6800 94	-0.00930 0.9291 94	-0.06253 0.5494 94	-0.05144 0.6225 94	0.03006 0.7737 94

Table B5.-(cont.)

	Area as Cover-Undercuts	Length as Cover-Rocks	Area as Cover-Rocks	% Sample Area as Cover	% Sample Length as Cover	Percent Overhead Canopy	Subjective Fishing Pressure
Kg per Hectare Age 0	-0.00502 0.9617 94	-0.19930 0.0541 94	-0.14830 0.1537 94	-0.08608 0.4094 94	-0.16017 0.1231 94	-0.09002 0.3882 94	-0.24161 0.0190 94 *
Kg per Hectare Age 1	0.03097 0.7670 94	-0.18898 0.0681 94	-0.16099 0.1211 94	-0.01126 0.9142 94	-0.11783 0.2580 94	-0.01884 0.8570 94	-0.30063 0.0032 94 **
Kg per Hectare Age 2	0.22232 0.0313 94 *	-0.00784 0.9402 94	-0.04188 0.6886 94	0.24696 0.0164 94 *	0.14112 0.1749 94	-0.20928 0.0429 94 *	-0.21267 0.0396 94 *
Kg per Hectare Age 3	-0.01372 0.8956 94	0.02056 0.8441 94	-0.02635 0.8010 94	0.01716 0.8696 94	0.11181 0.2833 94	-0.13761 0.1859 94	-0.06833 0.5129 94

Table B6.-Results of correlation analysis for class Brown-1 trout populations using biomass by age class vs. selected variables.

	Number per ha Age 0	Number per ha Age 1	Number per ha Age 2	Number per ha Age 3	Number per km Age 0	Number per km Age 1	Number per km Age 2	Number per km Age 3
Kg per Hectare Age 0	0.88209 0.0001 21 ***;49;0	-0.03491 0.8806 21	-0.09003 0.6980 21	0.03952 0.8649 21	0.83053 0.0001 21 ***	-0.08517 0.7136 21	-0.15488 0.5026 21	0.04290 0.8535 21
Kg per Hectare Age 1	0.25616 0.2624 21	0.78267 0.0001 21 ***	0.48211 0.0269 21 *	0.05975 0.7970 21	0.22959 0.3168 21	0.77273 0.0001 21 ***	0.44887 0.0412 21 *	0.03080 0.8946 21
Kg per Hectare Age 2	-0.11816 0.6100 21	0.29485 0.1945 21	0.94159 0.0001 21 ***	0.44554 0.0430 21 *	-0.08927 0.7004 21	0.40230 0.0706 21	0.92424 0.0001 21 ***	0.42712 0.0535 21
Kg per Hectare Age 3	0.21764 0.3433 21	0.08884 0.7018 21	0.61957 0.0027 21 **	0.90118 0.0001 21 ***	0.32107 0.1559 21	0.18890 0.4122 21	0.65671 0.0012 21 **	0.90563 0.0001 21 ***
Kg per Hectare Age 4	0.02537 0.9131 21	0.02780 0.9048 21	0.06461 0.7808 21	0.23104 0.3136 21	0.18211 0.4295 21	0.18974 0.4101 21	0.20901 0.3632 21	0.29399 0.1958 21

	Length at Age 1	Length at Age 2	Length at Age 3	Length at Age 4	Kg per Hectare Age 0	Kg per Hectare Age 1	Kg per Hectare Age 2	Kg per Hectare Age 3
Kg per Hectare Age 0	0.44796 0.0417 21 *	0.28228 0.2279 20	0.24379 0.3813 15	. 0	1.00000 0.0000 21	0.21454 0.3504 21	-0.09590 0.6792 21	0.06196 0.7896 21
Kg per Hectare Age 1	0.36636 0.1024 21	0.19249 0.4162 20	0.39246 0.1479 15	. 0	0.21454 0.3504 21	1.00000 0.0000 21	0.49117 0.0238 21 *	0.22585 0.3249 21
Kg per Hectare Age 2	0.40577 0.0680 21	0.41082 0.0720 20	0.46149 0.0833 15	. 0	-0.09590 0.6792 21	0.49117 0.0238 21 *	1.00000 0.0000 21	0.67053 0.0009 21 ***
Kg per Hectare Age 3	0.20227 0.3792 21	0.35253 0.1274 20	0.48436 0.0673 15	. 0	0.06196 0.7896 21	0.22585 0.3249 21	0.67053 0.0009 21 ***	1.00000 0.0000 21
Kg per hectare Age 4	-0.05883 0.8000 21	0.34158 0.1405 20	0.44920 0.0930 15	. 0	0.02654 0.9091 21	-0.02826 0.9032 21	0.21278 0.3544 21	0.41540 0.0611 21

Table B6.-(cont.)

	Conductivity at 25°C	Dissolved Oxygen	pH	Water Temp.	Maximum Water Temp.	Alkalinity	Velocity	Stream Discharge Velocity
Kg per Hectare Age 0	0.26415 0.2472 21	-0.36207 0.1068 21	0.24329 0.2879 21	0.26740 0.2413 21	-0.88252 0.0007 10 ***	0.19237 0.4035 21	0.14552 0.5291 21	-0.23497 0.3052 21
Kg per Hectare Age 1	-0.04415 0.8493 21	-0.68291 0.0006 21 ***	0.04375 0.8506 21	0.66618 0.0010 21 ***	0.19012 0.5988 10	-0.09893 0.6696 21	-0.32825 0.1463 21	0.00802 0.9725 21
Kg per Hectare Age 2	0.10050 0.6647 21	-0.21317 0.3535 21	0.33160 0.1420 21	0.47193 0.0308 21 *	0.57596 0.0814 10	0.20287 0.3778 21	0.18917 0.4115 21	0.05783 0.8034 21
Kg per Hectare Age 3	-0.00465 0.9840 21	-0.02572 0.9119 21	0.29942 0.1873 21	0.30273 0.1822 21	0.47928 0.1610 10	0.15752 0.4953 21	0.32259 0.1538 21	0.16812 0.4663 21
Kg per hectare Age 4	0.09296 0.6886 21	0.00286 0.9902 21	-0.08013 0.7299 21	0.11293 0.6260 21	0.24925 0.4874 10	0.30792 0.1745 21	0.25369 0.2671 21	0.24133 0.2919 21

	% Silt Substrate	% Sand Substrate	% Gravel Substrate	% Cobble Substrate	% Small Boulder Substrate	% Large Boulder Substrate	% Bedrock Substrate	Mean Embed. Gravel Substrate
Kg per Hectare Age 0	0.09749 0.6742 21	-0.00701 0.9759 21	0.07710 0.7397 21	0.16905 0.4638 21	-0.20304 0.3774 21	-0.34977 0.1201 21	. 17	-0.06434 0.8062 17
Kg per Hectare Age 1	0.28267 0.2144 21	-0.07765 0.7380 21	0.24568 0.2831 21	0.03096 0.8940 21	-0.38322 0.0864 21	-0.22667 0.3231 21	. 17	0.41854 0.0945 17
Kg per Hectare Age 2	0.49504 0.0225 21 *	0.15233 0.5098 21	0.53034 0.0134 21 *	-0.36078 0.1081 21	-0.43291 0.0500 21 *	-0.27668 0.2247 21	. 17	0.37358 0.1397 17
Kg per Hectare Age 3	0.41777 0.0595 21	-0.08978 0.6987 21	0.29653 0.1918 21	-0.09058 0.6962 21	-0.30575 0.1777 21	-0.19629 0.3938 21	. 17	-0.04789 0.8552 17
Kg per Hectare Age 4	0.67941 0.0007 21 ***	0.17962 0.4359 21	0.38252 0.0870 21	-0.38482 0.0850 21	-0.29055 0.2014 21	-0.01696 0.9418 21	. 17	-0.24302 0.3473 17

Table B6.-(cont.)

	Mean Embed. Cobble Substrate	Dominant Substrate Type	Mean Width	Mean Depth	Maximum Depth	Maximum Riffle Length	Maximum Pool Length	Pool to Riffle Ratio
Kg per Hectare Age 0	-0.03595 0.8771 21	-0.31705 0.1614 21	-0.05339 0.8182 21	-0.09499 0.6821 21	-0.23382 0.3664 17	0.02051 0.9297 21	-0.07923 0.7328 21	-0.32839 0.1461 21
Kg per Hectare Age 1	0.53217 0.0130 21 *	-0.32355 0.1525 21	0.16132 0.4848 21	0.06101 0.7928 21	0.19093 0.4629 17	-0.25172 0.2710 21	0.14705 0.5247 21	0.00876 0.9699 21
Kg per Hectare Age 2	0.35534 0.1139 21	-0.41771 0.0595 21	0.32448 0.1513 21	0.50170 0.0205 21 *	0.55315 0.0213 17 *	-0.07219 0.7558 21	0.23945 0.2958 21	0.18747 0.4158 21
Kg per Hectare Age 3	-0.04861 0.8343 21	-0.26785 0.2404 21	0.39345 0.0776 21	0.50756 0.0188 21 *	0.67032 0.0032 17 **	0.22300 0.3312 21	0.08003 0.7302 21	-0.08284 0.7211 21
Kg per Hectare Age 4	-0.16774 0.4674 21	-0.34905 0.1209 21	0.58032 0.0058 21 **	0.60991 0.0033 21 **	0.41587 0.0969 17	0.34846 0.1216 21	0.39013 0.0804 21	-0.08227 0.7229 21

	Gradient	Elevation	Total Length of Cover	Length as Cover-Deep Water	Area as Cover-Deep Water	Length as Cover-Logs	Area as Cover-Logs	Length as Cover-Undercuts
Kg per Hectare Age 0	-0.06331 0.7851 21	-0.15322 0.5073 21	-0.31530 0.1639 21	-0.25299 0.2685 21	-0.24167 0.2912 21	-0.09774 0.6734 21	-0.10048 0.6647 21	-0.16492 0.4750 21
Kg per Hectare Age 1	-0.25914 0.2567 21	-0.17948 0.4363 21	0.28996 0.2023 21	0.32648 0.1486 21	0.25765 0.2595 21	0.38297 0.0866 21	0.30506 0.1787 21	0.20782 0.3660 21
Kg per Hectare Age 2	-0.45885 0.0364 21 *	-0.20181 0.3804 21	0.64266 0.0017 21 **	0.70877 0.0003 21 ***	0.68168 0.0007 21 ***	0.37302 0.0958 21	0.17177 0.4566 21	0.14842 0.5208 21
Kg per Hectare Age 3	-0.11767 0.6115 21	-0.13713 0.5534 21	0.50310 0.0201 21 *	0.55777 0.0086 21 **	0.57097 0.0069 21 **	0.18952 0.4106 21	0.08460 0.7154 21	-0.18632 0.4187 21
Kg per Hectare Age 4	-0.44698 0.0422 21 *	-0.09894 0.6696 21	0.34378 0.1270 21	0.48331 0.0264 21 *	0.52328 0.0149 21 *	0.29570 0.1931 21	0.28053 0.2180 21	-0.06160 0.7908 21

	Area as Cover-Undercuts	Length as Cover-Rocks	Area as Cover-Rocks	% Sample Area as Cover	% Sample Length as Cover	Percent Overhead Canopy	Subjective Fishing Pressure
Kg per Hectare Age 0	-0.10127 0.6623 21	-0.34273 0.1283 21	-0.36963 0.0991 21	-0.33370 0.1393 21	-0.47212 0.0307 21	-0.00478 0.9836 21	0.29396 0.1959 21
Kg per Hectare Age 1	0.20402 0.3750 21	-0.24640 0.2816 21	-0.32503 0.1505 21	0.30668 0.1763 21	0.13481 0.5602 21	-0.14868 0.5201 21	0.28561 0.2095 21
Kg per Hectare Age 2	0.09831 0.6716 21	-0.36272 0.1061 21	-0.22884 0.3184 21	0.79324 0.0001 21 ***	0.43991 0.0460 21 *	-0.46541 0.0335 21 *	0.01733 0.9406 21
Kg per Hectare Age 3	-0.13067 0.5724 21	-0.23643 0.3022 21	-0.28303 0.2138 21	0.60668 0.0035 21 **	0.33118 0.1425 21	0.00739 0.9746 21	-0.20319 0.3770 21
Kg per Hectare Age 4	-0.06194 0.7897 21	-0.17768 0.4410 21	-0.21725 0.3442 21	0.35209 0.1175 21	0.28411 0.2120 21	0.00017 0.9994 21	0.10371 0.6546 21

Table B7.-Results of correlation analysis for class Brook-1 trout populations using number per hectare by age class vs. selected variables.

	Number per ha Age 0	Number per ha Age 1	Number per ha Age 2	Number per ha Age 3	Number per km Age 0	Number per km Age 1	Number per km Age 2	Number per km Age 3
Number per ha Age 0	1.00000 0.0000 94	0.33170 0.0011 94 **	0.13829 0.1838 94	-0.08627 0.4084 94	0.81329 0.0001 94 ***	0.03124 0.7650 94	-0.02588 0.8045 94	-0.10101 0.3327 94
Number per ha Age 1	0.33170 0.0011 94 **	1.00000 0.0000 94	0.22142 0.0320 94 *	0.13799 0.1847 94	0.19506 0.0596 94	0.74984 0.0001 94 ***	0.08796 0.3992 94	0.08217 0.4311 94
Number per ha Age 2	0.13829 0.1838 94	0.22142 0.0320 94 *	1.00000 0.0000 94	0.11896 0.2535 94	0.08833 0.3972 94	0.13406 0.1977 94	0.82727 0.0001 94 ***	0.08346 0.4238 94
Number per ha Age 3	-0.08627 0.4084 94	0.13799 0.1847 94	0.11896 0.2535 94	1.00000 0.0000 94	-0.09116 0.3822 94	0.16287 0.1168 94	0.12736 0.2212 94	0.95064 0.0001 94 ***

	Length at Age 1	Length at Age 2	Length at Age 3	Length at Age 1	Kg per Hectare Age 0	Kg per Hectare Age 1	Kg per Hectare Age 2	Kg per Hectare Age 3
Number per ha Age 0	-0.17174 0.1016 92	-0.16367 0.1635 74	0.08286 0.8086 11	-0.33896 0.5110 6	0.82901 0.0001 94 ***	0.21220 0.0400 94 *	0.05511 0.5978 94	-0.07881 0.4502 94
Number per ha Age 1	-0.25074 0.0159 92 *	-0.12194 0.3007 74	0.39666 0.2271 11	-0.32383 0.5312 6	0.15063 0.1473 94	0.79114 0.0001 94 ***	0.20608 0.0463 94	0.10725 0.3035 94
Number per ha Age 2	-0.33635 0.0010 92 ***	-0.48247 0.0001 74 ***	-0.00041 0.9990 11	-0.92769 0.0077 6 **	-0.03143 0.7636 94	0.02076 0.8425 94	0.86446 0.0001 94 ***	0.07673 0.4623 94
Number per ha Age 3	-0.05448 0.6060 92	-0.05363 0.6499 74	0.03092 0.9281 11	. 6	-0.07673 0.4623 94	0.14514 0.1628 94	0.18880 0.0684 94	0.92110 0.0001 94 ***

	Conductivity at 25°C	Dissolved Oxygen	pH	Water Temp.	Maximum Water Temp.	Alkalinity	Velocity	Stream Discharge Velocity
Number per ha Age 0	-0.15435 0.1396 93	0.09575 0.3612 93	-0.14315 0.1711 93	-0.15585 0.1336 94	0.39210 0.0476 26 *	-0.20852 0.0486 90 *	-0.29408 0.0044 92 **	-0.16439 0.1174 92
Number per ha Age 1	-0.10095 0.3356 93	0.07554 0.4717 93	-0.02616 0.8034 93	-0.15517 0.1353 94	-0.05245 0.7991 26	-0.18549 0.0801 90	-0.38256 0.0002 92 ***	-0.14359 0.1721 92
Number per ha Age 2	-0.13269 0.2048 93	0.16248 0.1197 93	-0.03204 0.7604 93	-0.17224 0.0969 94	-0.03033 0.8831 26	-0.10424 0.3282 90	-0.23276 0.0256 92 *	-0.12419 0.2382 92
Number per ha Age 3	0.00168 0.9873 93	0.10311 0.3254 93	0.08753 0.4041 93	-0.03006 0.7736 94	-0.35667 0.0737 26	-0.00559 0.9583 90	-0.06591 0.5325 92	0.01588 0.8806 92

Table B7.-(cont.)

	% Silt Substrate	% Sand Substrate	% Gravel Substrate	% Cobble Substrate	% Small Boulder Substrate	% Large Boulder Substrate	% Bedrock Substrate	Mean Embed. Gravel Substrate
Number per ha Age 0	0.33404 0.0010 94 ***	0.07842 0.4525 94	0.21198 0.0403 94 *	-0.13674 0.1888 94	-0.25378 0.0136 94 *	-0.16135 0.1203 94	-0.07064 0.5335 80	-0.00765 0.9477 76
Number per ha Age 1	0.00300 0.9771 94	0.11209 0.2821 94	0.10543 0.3118 94	-0.15692 0.1309 94	-0.01574 0.8803 94	-0.03394 0.7454 94	0.00363 0.9745 80	-0.02712 0.8161 76
Number per ha Age 2	0.14370 0.1670 94	-0.09032 0.3866 94	-0.13661 0.1892 94	-0.10005 0.3373 94	0.29987 0.0033 94 **	0.07842 0.4525 94	-0.08968 0.4289 80	0.04632 0.6911 76
Number per ha Age 3	-0.04166 0.6902 94	0.03341 0.7492 94	0.14320 0.1686 94	-0.18786 0.0698 94	-0.01220 0.9071 94	0.11740 0.2598 94	-0.02635 0.8165 80	0.04909 0.6737 76

	Mean Embed. Cobble Substrate	Dominant Substrate Type	Mean Width	Mean Depth	Maximum Depth	Maximum Riffle Length	Maximum Pool Length	Pool to Riffle Ratio
Number per ha Age 0	-0.11983 0.2606 90	-0.26628 0.0095 94 **	-0.45166 0.0001 94 ***	-0.34444 0.0007 94 ***	-0.34349 0.0018 80 **	-0.19889 0.0546 94	-0.09847 0.3451 94	0.02207 0.8328 94
Number per ha Age 1	-0.14772 0.1647 90	-0.08707 0.4040 94	-0.48548 0.0001 94 ***	-0.36546 0.0003 94 ***	-0.33267 0.0026 80 **	-0.24950 0.0153 94 *	-0.12569 0.2274 94	-0.02562 0.8064 94
Number per ha Age 2	-0.04470 0.6757 90	0.00463 0.9647 94	-0.20726 0.0450 94 *	-0.08461 0.4175 94	0.01874 0.8689 80	-0.08556 0.4122 94	0.00197 0.9850 94	-0.08073 0.4392 94
Number per ha Age 3	0.13694 0.1981 90	0.09204 0.3776 94	-0.01546 0.8824 94	0.11788 0.2578 94	0.14692 0.1934 80	-0.07037 0.5003 94	-0.01192 0.9092 94	-0.02687 0.7971 94

	Gradient	Elevation	Total Length of Cover	Length as Cover-Deep Water	Area as Cover-Deep Water	Length as Cover-Logs	Area as Cover-Logs	Length as Cover-Undercuts
Number per ha Age 0	-0.10706 0.3071 93	-0.06516 0.5349 93	-0.25544 0.0130 94 *	-0.19906 0.0544 94	-0.14713 0.1570 94	0.03443 0.7418 94	0.01236 0.9059 94	-0.03573 0.7324 94
Number per ha Age 1	0.06956 0.5076 93	-0.06199 0.5550 93	-0.34278 0.0007 94 ***	-0.29519 0.0039 94 **	-0.25155 0.0145 94 *	-0.21078 0.0414 94 *	-0.14694 0.1576 94	-0.05809 0.5781 94
Number per ha Age 2	0.13998 0.1808 93	0.24711 0.0169 93 *	-0.00640 0.9512 94	0.00951 0.9275 94	0.02069 0.8431 94	0.11322 0.2772 94	0.10713 0.3041 94	0.03551 0.7340 94
Number per ha Age 3	-0.00478 0.9637 93	0.09581 0.3610 93	-0.02587 0.8045 94	0.02890 0.7822 94	-0.01432 0.8910 94	-0.07971 0.4450 94	-0.06506 0.5333 94	0.03359 0.7479 94

Table B7.-(cont.)

	Area as Cover-Undercuts	Length as Cover-Rocks	Area as Cover-Rocks	% Sample Area as Cover	% Sample Length as Cover	Percent Overhead Canopy	Subjective Fishing Pressure
Number per ha Age 0	-0.03885 0.7101 94	-0.27620 0.0070 94 **	-0.22453 0.0296 94 *	-0.09150 0.3804 94	-0.14736 0.1564 94	-0.09556 0.3596 94	-0.28976 0.0046 94 **
Number per ha Age 1	-0.09644 0.3552 94	-0.16897 0.1035 94	-0.18122 0.0805 94	-0.18164 0.0798 94	-0.28533 0.0053 94 **	0.14049 0.1768 94	-0.31822 0.0018 94 **
Number per ha Age 2	0.07269 0.4862 94	0.02980 0.7756 94	-0.04170 0.6899 94	0.09868 0.3440 94	0.05811 0.5780 94	-0.05855 0.5751 94	-0.15694 0.1309 94
Number per ha Age 3	0.00656 0.9499 94	0.00660 0.9496 94	-0.03722 0.7218 94	0.01367 0.8960 94	0.06452 0.5367 94	-0.09553 0.3597 94	-0.05712 0.5845 94

Table B8.-Results of correlation analysis for class Brown-1 trout populations using number per hectare by age class vs. selected variables.

	Number per ha Age 0	Number per ha Age 1	Number per ha Age 2	Number per ha Age 3	Number per km Age 0	Number per km Age 1	Number per km Age 2	Number per km Age 3
Number per ha Age 0	1.00000 0.0000 21	0.09651 0.6773 21	-0.04416 0.8493 21	0.26479 0.2461 21	0.96907 0.0001 21 ***	0.01159 0.9602 21	-0.10413 0.6533 21	0.25928 0.2564 21
Number per ha Age 1	0.09651 0.6773 21	1.00000 0.0000 21	0.34502 0.1256 21	0.06792 0.7699 21	0.06130 0.7918 21	0.92502 0.0001 21 ***	0.34410 0.1267 21	0.02713 0.9071 21
Number per ha Age 2	-0.04416 0.8493 21	0.34502 0.1256 21	1.00000 0.0000 21	0.50497 0.0196 21 *	-0.02970 0.8983 21	0.40547 0.0682 21	0.93786 0.0001 21 ***	0.46932 0.0318 21 *
Number per ha Age 3	0.26479 0.2461 21	0.06792 0.7699 21	0.50497 0.0196 21 *	1.00000 0.0000 21	0.36234 0.1065 21	0.11185 0.6293 21	0.51072 0.0180 21 *	0.98501 0.0001 21 ***
Number per ha Age 4	0.06503 0.7794 21	0.14715 0.5244 21	-0.01240 0.9575 21	0.24890 0.2766 21	0.19854 0.3883 21	0.20307 0.3773 21	0.08795 0.7046 21	0.28483 0.2108 21

	Length at Age 1	Length at Age 2	Length at Age 3	Length at Age 4	Kg per Hectare Age 0	Kg per Hectare Age 1	Kg per Hectare Age 2	Kg per Hectare Age 3
Number per ha Age 0	0.27804 0.2223 21	0.12504 0.5994 20	0.16785 0.5499 15	. 0	0.88209 0.0001 21 ***	0.25616 0.2624 21	-0.11816 0.6100 21	0.21764 0.3433 21
Number per ha Age 1	-0.07554 0.7448 21	-0.29384 0.2086 20	-0.11131 0.6929 15	. 0	-0.03491 0.8806 21	0.78267 0.0001 21 ***	0.29485 0.1945 21	0.08884 0.7018 21
Number per ha Age 2	0.37316 0.0957 21	0.20665 0.3820 20	0.23474 0.3997 15	. 0	-0.09003 0.6980 21	0.48211 0.0269 21 *	0.94159 0.0001 21 ***	0.61957 0.0027 21 **
Number per ha Age 3	0.04239 0.8552 21	0.06553 0.7837 20	0.10563 0.7079 15	. 0	0.03952 0.8649 21	0.05975 0.7970 21	0.44554 0.0430 21 *	0.90118 0.0001 21 ***
Number per ha Age 4	-0.19659 0.3931 21	0.16006 0.5002 20	0.22414 0.4219 15	. 0	0.00822 0.9718 21	-0.08707 0.7075 21	0.10843 0.6399 21	0.35644 0.1127 21

	Conductivity at 25°C	Dissolved Oxygen	pH	Water Temp.	Maximum Water Temp.	Alkalinity	Velocity	Stream Discharge Velocity
Number per ha Age 0	0.04314 0.8527 21	-0.42965 0.0519 21	0.22543 0.3258 21	0.28851 0.2047 21	-0.56386 0.0896 10	-0.02266 0.9223 21	0.08242 0.7225 21	-0.24227 0.2900 21
Number per ha Age 1	-0.29410 0.1956 21	-0.49815 0.0215 21 *	-0.22039 0.3371 21	0.44571 0.0429 21 *	0.20761 0.5649 10	-0.26223 0.2508 21	-0.39748 0.0744 21	-0.06835 0.7685 21
Number per ha Age 2	0.03972 0.8643 21	-0.14744 0.5236 21	0.37990 0.0894 21	0.45863 0.0365 21 *	0.57652 0.0811 10	0.08821 0.7038 21	0.18508 0.4219 21	-0.02927 0.8998 21
Number per ha Age 3	-0.08576 0.7117 21	0.14546 0.5293 21	0.24057 0.2935 21	0.07795 0.7370 21	0.34914 0.3227 10	0.02055 0.9295 21	0.25667 0.2614 21	0.08386 0.7178 21
Number per ha Age 4	-0.01675 0.9425 21	0.04602 0.8430 21	-0.17266 0.4542 21	0.04562 0.8443 21	0.13455 0.7109 10	0.24109 0.2924 21	0.12611 0.5859 21	0.11340 0.6245 21

Table B8.-(cont.)

	% Silt Substrate	% Sand Substrate	% Gravel Substrate	% Cobble Substrate	% Small Boulder Substrate	% Large Boulder Substrate	% Bedrock Substrate	Mean Embed. Gravel Substrate
Number per ha Age 0	0.06682 0.7735 21	-0.10491 0.6509 21	-0.08085 0.7276 21	0.30515 0.1786 21	-0.13990 0.5453 21	-0.19997 0.3848 21	. 17	-0.07703 0.7689 17
Number per ha Age 1	0.08871 0.7022 21	-0.20225 0.3793 21	0.13593 0.5569 21	0.08749 0.7061 21	-0.27821 0.2220 21	0.25812 0.2586 21	. 17	0.11763 0.6530 17
Numnber per ha Age 2	0.34848 0.1216 21	0.10663 0.6455 21	0.39632 0.0753 21	-0.23341 0.3085 21	-0.41548 0.0611 21	-0.16082 0.4862 21	. 17	0.39681 0.1148 17
Number per ha Age 3	0.20154 0.3810 21	-0.17484 0.4484 21	0.11337 0.6246 21	0.04429 0.8488 21	-0.19586 0.3948 21	0.01349 0.9537 21	. 17	-0.18633 0.4740 17
Number per ha Age 4	0.57158 0.0068 21 **	0.04679 0.8404 21	0.27030 0.2360 21	-0.25066 0.2731 21	-0.19662 0.3930 21	0.17887 0.4379 21	. 17	-0.36665 0.1477 17

	Mean Embed. Cobble Substrate	Dominant Substrate Type	Mean Width	Mean Depth	Maximum Depth	Maximum Riffle Length	Maximum Pool Length	Pool to Riffle Ratio
Number per ha Age 0	0.01594 0.9453 21	-0.21729 0.3441 21	-0.04454 0.8480 21	-0.10717 0.6438 21	-0.24879 0.3356 17	-0.04639 0.8417 21	-0.11011 0.6347 21	-0.33449 0.1383 21
Number per ha Age 1	0.28367 0.2127 21	-0.14427 0.5327 21	0.13091 0.5716 21	-0.00830 0.9715 21	0.18706 0.4722 17	-0.18606 0.4194 21	0.12128 0.6005 21	-0.07145 0.7583 21
Number per ha Age 2	0.41954 0.0583 21	-0.29375 0.1962 21	0.27196 0.2330 21	0.44811 0.0416 21 *	0.48367 0.0492 17 *	-0.14152 0.5406 21	0.23809 0.2987 21	0.16099 0.4857 21
Number per ha Age 3	-0.16471 0.4756 21	-0.05347 0.8180 21	0.30497 0.1789 21	0.34929 0.1207 21	0.57445 0.0159 17 *	0.14987 0.5167 21	0.06982 0.7636 21	-0.12096 0.6015 21
Number per ha Age 4	-0.33876 0.1331 21	-0.27247 0.2321 21	0.39143 0.0793 21	0.43276 0.0501 21	0.30886 0.2277 17	0.30633 0.1768 21	0.29131 0.2001 21	-0.11540 0.6184 21

Table B8.-(cont.)

	Gradient	Elevation	Total Length of Cover	Length as Cover-Deep Water	Area as Cover-Deep Water	Length as Cover-Logs	Area as Cover-Logs	Length as Cover-Undercuts
Number per ha Age 0	0.13001 0.5743 21	-0.08176 0.7246 21	-0.25839 0.2581 21	-0.25743 0.2599 21	-0.26229 0.2507 21	0.02127 0.9271 21	-0.01957 0.9329 21	-0.24696 0.2805 21
Number per ha Age 1	-0.09928 0.6685 21	0.20019 0.3843 21	0.30340 0.1812 21	0.27643 0.2251 21	0.19942 0.3861 21	0.48189 0.0270 21 *	0.33383 0.1392 21	0.12612 0.5859 21
Number per ha Age 2	-0.29419 0.1955 21	-0.16177 0.4836 21	0.58019 0.0058 21 **	0.58166 0.0057 21 **	0.51975 0.0157 21 *	0.40517 0.0684 21	0.20867 0.3640 21	0.17164 0.4569 21
Number per ha Age 3	0.19759 0.3906 21	-0.02141 0.9266 21	0.36769 0.1010 21	0.32253 0.1539 21	0.29233 0.1985 21	0.08079 0.7277 21	0.02134 0.9268 21	-0.22567 0.3253 21
Number per ha Age 4	-0.34398 0.1268 21	0.11941 0.6062 21	0.23593 0.3032 21	0.31881 0.1590 21	0.36199 0.1068 21	0.32061 0.1565 21	0.25797 0.2589 21	-0.19635 0.3936 21

	Area as Cover-Undercuts	Length as Cover-Rocks	Area as Cover-Rocks	% Sample Area as Cover	% Sample Length as Cover	Percent Overhead Canopy	Subjective Fishing Pressure
Number per ha Age 0	-0.16700 0.4694 21	-0.29822 0.1892 21	-0.39761 0.0743 21	-0.32215 0.1544 21	-0.37421 0.0947 21	0.17648 0.4441 21	0.03681 0.8741 21
Number per ha Age 1	0.11457 0.6210 21	-0.06340 0.7848 21	-0.19317 0.4015 21	0.20958 0.3619 21	0.25874 0.2574 21	-0.01140 0.9609 21	0.33101 0.1427 21
Number per ha Age 2	0.09052 0.6964 21	-0.35697 0.1122 21	-0.21694 0.3449 21	0.66501 0.0010 21 ***	0.41738 0.0598 21	-0.43433 0.0491 21 *	0.01015 0.9652 21
Number per ha Age 3	-0.16944 0.4628 21	-0.10152 0.6615 21	-0.17581 0.4459 21	0.36710 0.1016 21	0.26165 0.2519 21	0.16280 0.4808 21	-0.21242 0.3553 21
Number per ha Age 4	-0.14995 0.5165 21	-0.12062 0.6025 21	-0.18503 0.4220 21	0.23769 0.2995 21	0.21260 0.3548 21	0.04666 0.8408 21	0.03204 0.8903 21

Table B9.-Results of correlation analysis for class Brook-1 trout populations using number per kilometer by age class vs. selected variables.

	Number per ha Age 0	Number per ha Age 1	Number per ha Age 2	Number per ha Age 3	Number per km Age 0	Number per km Age 1	Number per km Age 2	Number per km Age 3
Number per km Age 0	0.81329 0.0001 94 ***	0.19506 0.0596 94	0.08833 0.3972 94	-0.09116 0.3822 94	1.00000 0.0000 94	0.23757 0.0211 94 *	0.06748 0.5181 94	-0.08387 0.4216 94
Number per km Age 1	0.03124 0.7650 94	0.74984 0.0001 94 ***	0.13406 0.1977 94	0.16287 0.1168 94	0.23757 0.0211 94 *	1.00000 0.0000 94	0.23068 0.0253 94 *	0.16118 0.1207 94
Number per km Age 2	-0.02588 0.8045 94	0.08796 0.3992 94	0.82727 0.0001 94 ***	0.12736 0.2212 94	0.06748 0.5181 94	0.23068 0.0253 94 *	1.00000 0.0000 94	0.12610 0.2259 94
Number per km Age 3	-0.10101 0.3327 94	0.08217 0.4311 94	0.08346 0.4238 94	0.95064 0.0001 94 ***	-0.08387 0.4216 94	0.16118 0.1207 94	0.12610 0.2259 94	1.00000 0.0000 94

	Length at Age 1	Length at Age 2	Length at Age 3	Length at Age 4	Kg per Hectare Age 0	Kg per Hectare Age 1	Kg per Hectare Age 2	Kg per Hectare Age 3
Number per km Age 0	-0.05176 0.6241 92	-0.06868 0.5609 74	0.19911 0.5572 11	-0.36888 0.4718 6	0.75509 0.0001 94 ***	0.18794 0.0697 94	0.03951 0.7053 94	-0.07366 0.4804 94
Number per km Age 1	-0.11236 0.2863 92	-0.00530 0.9642 74	0.56282 0.0715 11	-0.36026 0.4830 6	-0.00706 0.9461 94	0.67573 0.0001 94 ***	0.16838 0.1048 94	0.17286 0.0957 94
Number per km Age 2	-0.24183 0.0202 92 *	-0.39296 0.0005 74 ***	-0.11973 0.7259 11	-0.90553 0.0130 6 *	-0.11333 0.2768 94	-0.04612 0.6589 94	0.77428 0.0001 94 ***	0.10270 0.3246 94
Number per km Age 3	-0.01589 0.8805 92	-0.00263 0.9823 74	0.17739 0.6018 11	. 6	-0.08187 0.4328 94	0.12669 0.2237 94	0.18189 0.0793 94	0.96262 0.0001 94 ***

	Conductivity at 25°C	Dissolved Oxygen	pH	Water Temp.	Maximum Water Temp.	Alkalinity	Velocity	Stream Discharge Velocity
Number per km Age 0	-0.20812 0.0453 93 *	0.03309 0.7528 93	-0.14562 0.1637 93	-0.07418 0.4773 94	0.24569 0.2264 26	-0.23456 0.0261 90 *	-0.22303 0.0326 92 *	-0.00057 0.9957 92
Number per km Age 1	-0.16674 0.1102 93	0.03754 0.7209 93	0.01007 0.9237 93	-0.10305 0.3230 94	-0.16002 0.4349 26	-0.18234 0.0854 90	-0.22979 0.0276 92 *	0.07312 0.4885 92
Number per km Age 2	-0.21354 0.0399 93 *	0.17439 0.0946 93	-0.05678 0.5888 93	-0.13789 0.1850 94	0.02376 0.9083 26	-0.10371 0.3307 90	-0.14181 0.1775 92	-0.01337 0.8993 92
Number per km Age 3	-0.01910 0.8558 93	0.11315 0.2802 93	0.08150 0.4374 93	-0.02388 0.8193 94	-0.31414 0.1181 26	-0.04206 0.6939 90	-0.05934 0.5742 92	0.03280 0.7562 92

Table B9.-(cont.)

	% Silt Substrate	% Sand Substrate	% Gravel Substrate	% Cobble Substrate	% Small Boulder Substrate	% Large Boulder Substrate	% Bedrock Substrate	Mean Embed. Gravel Substrate
Number per km Age 0	0.25876 0.0118 94 *	0.01216 0.9074 94	0.12087 0.2459 94	-0.03812 0.7152 94	-0.16214 0.1184 94	-0.16788 0.1058 94	-0.02051 0.8567 80	-0.04929 0.6724 76
Number per km Age 1	-0.08397 0.4210 94	0.01285 0.9022 94	-0.02351 0.8220 94	-0.10538 0.3121 94	0.17768 0.0867 94	0.03742 0.7203 94	0.05145 0.6504 80	-0.00760 0.9481 76
Number per km Age 2	0.04958 0.6351 94	-0.09241 0.3757 94	-0.14115 0.1748 94	-0.14506 0.1630 94	0.40078 0.0001 94 ***	0.12346 0.2358 94	-0.04103 0.7178 80	0.08292 0.4764 76
Number per km Age 3	-0.03913 0.7081 94	0.04852 0.6423 94	0.11097 0.2870 94	-0.18736 0.0706 94	-0.03216 0.7583 94	0.15807 0.1281 94	-0.02890 0.7992 80	0.07539 0.5175 76

	Mean Embed. Cobble Substrate	Dominant Substrate Type	Mean Width	Mean Depth	Maximum Depth	Maximum Riffle Length	Maximum Pool Length	Pool to Riffle Ratio
Number per km Age 0	-0.14210 0.1815 90	-0.23222 0.0243 94 *	-0.06180 0.5540 94	-0.20326 0.0494 94 *	-0.21799 0.0521 80	-0.07598 0.4667 94	0.13866 0.1826 94	0.02545 0.8076 94
Number per km Age 1	-0.16774 0.1140 90	-0.00458 0.9650 94	0.03894 0.7094 94	-0.10673 0.3059 94	-0.12055 0.2868 80	-0.02645 0.8002 94	0.06075 0.5608 94	-0.03996 0.7022 94
Number per km Age 2	-0.10309 0.3336 90	0.11198 0.2826 94	0.09998 0.3377 94	0.12471 0.2311 94	0.17758 0.1151 80	0.00766 0.9416 94	0.15941 0.1249 94	-0.08419 0.4198 94
Number per km Age 3	0.11930 0.2627 90	0.11190 0.2829 94	0.07959 0.4457 94	0.14164 0.1733 94	0.20997 0.0616 80	-0.07294 0.4848 94	-0.00224 0.9829 94	-0.02592 0.8041 94

	Gradient	Elevation	Total Length of Cover	Length as Cover-Deep Water	Area as Cover-Deep Water	Length as Cover-Logs	Area as Cover-Logs	Length as Cover-Undercuts
Number per km Age 0	-0.17815 0.0876 93	-0.08787 0.4023 93	-0.13216 0.2042 94	-0.11024 0.2902 94	-0.04404 0.6734 94	0.12340 0.2360 94	0.13367 0.1990 94	0.01824 0.8615 94
Number per km Age 1	-0.01044 0.9209 93	-0.05532 0.5985 93	-0.14066 0.1763 94	-0.18473 0.0747 94	-0.16075 0.1217 94	-0.11902 0.2532 94	-0.06387 0.5408 94	0.03139 0.7639 94
Number per km Age 2	0.05515 0.5996 93	0.26511 0.0102 93 *	0.20121 0.0518 94	0.17517 0.0913 94	0.19422 0.0607 94	0.25813 0.0120 94 *	0.26240 0.0106 94 *	0.13915 0.1810 94
Number per km Age 3	-0.04583 0.6627 93	0.08738 0.4049 93	0.00105 0.9920 94	0.03970 0.7041 94	-0.00986 0.9248 94	-0.05635 0.5896 94	-0.04820 0.6446 94	0.05335 0.6096 94

Table B9.-(cont.)

	Area as Cover-Undercuts	Length as Cover-Rocks	Area as Cover-Rocks	% Sample Area as Cover	% Sample Length as Cover	Percent Overhead Canopy	Subjective Fishing Pressure
Number	0.05987	-0.19594	-0.18388	-0.01121	-0.05007	-0.10944	-0.12702
per km	0.5665	0.0584	0.0761	0.9146	0.6317	0.2937	0.2225
Age 0	94	94	94	94	94	94	94
Number	-0.00030	0.03001	-0.04787	-0.08915	-0.11938	0.08753	-0.08801
per km	0.9977	0.7740	0.6468	0.3928	0.2518	0.4015	0.3990
Age 1	94	94	94	94	94	94	94
Number	0.23784	0.15944	0.06215	0.22100	0.19810	-0.11538	-0.01768
per km	0.0210	0.1248	0.5518	0.0323	0.0556	0.2681	0.8657
Age 2	94	94	94	94	94	94	94
	*			*			
Number	0.02901	0.03491	-0.02466	0.01421	0.08764	-0.11120	-0.00685
per km	0.7814	0.7384	0.8135	0.8919	0.4009	0.2859	0.9477
Age 3	94	94	94	94	94	94	94

Table B10.-Results of correlation analysis for class Brown-1 trout populations using numbers per kilometer by age class vs. selected variables.

	Number per ha Age 0	Number per ha Age 1	Number per ha Age 2	Number per ha Age 3	Number per km Age 0	Number per km Age 1	Number per km Age 2	Number per km Age 3
Number per km Age 0	0.96907 0.0001 21 ***	0.06130 0.7918 21	-0.02970 0.8983 21	0.36234 0.1065 21	1.00000 0.0000 21	0.03201 0.8904 21	-0.04754 0.8378 21	0.37730 0.0918 21
Number per km Age 1	0.01159 0.9602 21	0.92502 0.0001 21 ***	0.40547 0.0682 21	0.11185 0.6293 21	0.03201 0.8904 21	1.00000 0.0000 21	0.51482 0.0169 21 *	0.12246 0.5969 21
Number per km Age 2	-0.10413 0.6533 21	0.34410 0.1267 21	0.93786 0.0001 21 ***	0.51072 0.0180 21 *	-0.04754 0.8378 21	0.51482 0.0169 21 *	1.00000 0.0000 21	0.52487 0.0146 21 *
Number per km Age 3	0.25928 0.2564 21	0.02713 0.9071 21	0.46932 0.0318 21	0.98501 0.0001 21 ***	0.37730 0.0918 21	0.12246 0.5969 21	0.52487 0.0146 21 *	1.00000 0.0000 21
Number per km Age 4	0.08368 0.7184 21	0.07902 0.7335 21	0.02085 0.9285 21	0.24841 0.2776 21	0.24095 0.2927 21	0.19272 0.4026 21	0.14202 0.5392 21	0.30374 0.1807 21

	Length at Age 1	Length at Age 2	Length at Age 3	Length at Age 4	Kg per Hectare Age 0	Kg per Hectare Age 1	Kg per Hectare Age 2	Kg per Hectare Age 3
Number per km Age 0	0.23042 0.3150 21	0.18694 0.4300 20	0.23243 0.4045 15	. 0	0.83053 0.0001 21 ***	0.22959 0.3168 21	-0.08927 0.7004 21	0.32107 0.1559 21
Number per km Age 1	-0.08277 0.7213 21	-0.16824 0.4783 20	0.05493 0.8458 15	. 0	-0.08517 0.7136 21	0.77273 0.0001 21 ***	0.40230 0.0706 21	0.18890 0.4122 21
Number per km Age 2	0.26009 0.2549 21	0.21590 0.3606 20	0.29851 0.2798 15	. 0	-0.15488 0.5026 21	0.44887 0.0412 21 *	0.92424 0.0001 21 ***	0.65671 0.0012 21 **
Number per km Age 3	0.01467 0.9497 21	0.07723 0.7462 20	0.12355 0.6609 15	. 0	0.04290 0.8535 21	0.03080 0.8946 21	0.42712 0.0535 21	0.90563 0.0001 21 ***
Number per km Age 4	-0.12793 0.5805 21	0.27420 0.2420 20	0.34764 0.2042 15	. 0	0.05626 0.8086 21	-0.04314 0.8527 21	0.16015 0.4880 21	0.39582 0.0757 21

	Conductivity at 25°C	Dissolved Oxygen	pH	Water Temp.	Maximum Water Temp.	Alkalinity	Velocity	Stream Discharge Velocity
Number per km Age 0	0.04335 0.8520 21	-0.36288 0.1059 21	0.16327 0.4795 21	0.21241 0.3553 21	-0.46930 0.1712 10	0.00331 0.9887 21	0.05283 0.8201 21	-0.18087 0.4327 21
Number per km Age 1	-0.25601 0.2626 21	-0.53903 0.0117 21 *	-0.28913 0.2037 21	0.34868 0.1214 21	0.32711 0.3562 10	-0.22338 0.3304 21	-0.33233 0.1411 21	0.05070 0.8272 21
Number per km Age 2	0.00117 0.9960 21	-0.20733 0.3672 21	0.24321 0.2881 21	0.33277 0.1405 21	0.64173 0.0455 10 *	0.05112 0.8258 21	0.18143 0.4312 21	0.06652 0.7745 21
Number per km Age 3	-0.08895 0.7014 21	0.11514 0.6192 21	0.18145 0.4312 21	0.02146 0.9264 21	0.32083 0.3661 10	0.02200 0.9246 21	0.28447 0.2114 21	0.12366 0.5933 21
Number per km Age 4	0.03704 0.8733 21	0.00843 0.9711 21	-0.15790 0.4942 21	0.05934 0.7983 21	0.14031 0.6991 10	0.27919 0.2203 21	0.14685 0.5253 21	0.15696 0.4968 21

Table B10.-(cont.)

	% Silt Substrate	% Sand Substrate	% Gravel Substrate	% Cobble Substrate	% Small Boulder Substrate	% Large Boulder Substrate	% Bedrock Substrate	Mean Embed. Gravel Substrate
Number per km Age 0	0.22698 0.3224 21	-0.11081 0.6325 21	-0.04914 0.8325 21	0.26284 0.2497 21	-0.17521 0.4475 21	-0.22567 0.3253 21	. 17	-0.07514 0.7744 17
Number per km Age 1	0.27564 0.2265 21	-0.09330 0.6875 21	0.29716 0.1908 21	-0.11971 0.6052 21	-0.36660 0.1021 21	0.15623 0.4989 21	. 17	0.21470 0.4079 17
Number per km Age 2	0.43363 0.0495 21 *	0.14550 0.5292 21	0.49894 0.0213 21 *	-0.34982 0.1201 21	-0.46087 0.0355 21 *	-0.17378 0.4512 21	. 17	0.38755 0.1243 17
Number per km Age 3	0.24557 0.2833 21	-0.15951 0.4898 21	0.13763 0.5519 21	-0.00397 0.9864 21	-0.20021 0.3842 21	-0.00715 0.9755 21	. 17	-0.16080 0.5375 17
Number per km Age 4	0.68648 0.0006 21 ***	0.09431 0.6843 21	0.32849 0.1460 21	-0.31696 0.1615 21	-0.25200 0.2705 21	0.05543 0.8114 21	. 17	-0.25404 0.3251 17

	Mean Embed. Cobble Substrate	Dominant Substrate Type	Mean Width	Mean Depth	Maximum Depth	Maximum Riffle Length	Maximum Pool Length	Pool to Riffle Ratio
Number per km Age 0	-0.03944 0.8652 21	-0.22245 0.3325 21	0.12727 0.5825 21	0.02520 0.9137 21	-0.14260 0.5851 17	-0.01680 0.9424 21	0.04008 0.8631 21	-0.30216 0.1831 21
Number per km Age 1	0.33999 0.1316 21	-0.19770 0.3903 21	0.44402 0.0438 21 *	0.24205 0.2905 21	0.38325 0.1289 17	-0.16906 0.4638 21	0.30392 0.1804 21	-0.00724 0.9752 21
Number per km Age 2	0.39618 0.0754 21	-0.31122 0.1697 21	0.51521 0.0168 21 *	0.62281 0.0026 21 **	0.64032 0.0056 17 **	-0.09747 0.6743 21	0.34519 0.1254 21	0.20087 0.3826 21
Number per km Age 3	-0.16857 0.4651 21	-0.05050 0.8279 21	0.39566 0.0758 21	0.42553 0.0545 21	0.66531 0.0036 17 **	0.16313 0.4799 21	0.09830 0.6716 21	-0.11444 0.6213 21
Number per km Age 4	0.28128 0.2168 21	-0.32559 0.1498 21	0.49146 0.0237 21 *	0.51473 0.0170 21 *	0.36770 0.1465 17	0.27872 0.2212 21	0.37746 0.0916 21	-0.07820 0.7362 21

Table B10.-(cont.)

	Gradient	Elevation	Total Length of Cover	Length as Cover- Deep Water	Area as Cover- Deep Water	Length as Cover- Logs	Area as Cover- Logs	Length as Cover- Undercuts
Number per km Age 0	0.12490 0.5896 21	-0.10623 0.6467 21	-0.13607 0.5565 21	-0.15640 0.4984 21	-0.17686 0.4431 21	0.12150 0.5998 21	0.09253 0.6899 21	-0.24522 0.2840 21
Number per km Age 1	-0.15073 0.5143 21	0.09558 0.6802 21	0.57494 0.0064 21 **	0.56469 0.0077 21 **	0.46933 0.0318 21 *	0.58482 0.0054 21 **	0.42245 0.0564 21	0.23546 0.3042 21
Number per km Age 2	-0.29896 0.1880 21	-0.17749 0.4415 21	0.79830 0.0001 21 ***	0.80715 0.0001 21 ***	0.74295 0.0001 21 ***	0.51380 0.0172 21 *	0.29154 0.1998 21	0.25399 0.2666 21
Number per km Age 3	0.19319 0.4014 21	-0.04598 0.8431 21	0.44499 0.0432 21 *	0.40704 0.0671 21	0.37798 0.0911 21	0.14138 0.5410 21	0.07686 0.7405 21	-0.21542 0.3483 21
Number per km Age 4	-0.39492 0.0764 21	0.00596 0.9795 21	0.30022 0.1861 21	0.39588 0.0757 21	0.42570 0.0543 21	0.35142 0.1183 21	0.31280 0.1674 21	-0.15419 0.5046 21

	Area as Cover- Undercuts	Length as Cover- Rocks	Area as Cover- Rocks	% Sample Area as Cover	% Sample Length as Cover	Percent Overhead Canopy	Subjective Fishing Pressure
Number per km Age 0	-0.17381 0.4511 21	-0.29356 0.1965 21	-0.36472 0.1040 21	-0.25141 0.2716 21	-0.25268 0.2691 21	0.20642 0.3693 21	-0.00437 0.9850 21
Number per km Age 1	0.18351 0.4259 21	-0.07083 0.7603 21	-0.14422 0.5328 21	0.39850 0.0736 21	0.50978 0.0182 21 *	-0.05767 0.8039 21	0.38068 0.0887 21
Number per km Age 2	0.14644 0.5265 21	-0.34291 0.1281 21	-0.16323 0.4796 21	0.78969 0.0001 21 ***	0.64982 0.0014 21 **	-0.39112 0.0796 21	0.04179 0.8573 21
Number per km Age 3	-0.15870 0.4920 21	-0.10270 0.6578 21	-0.17034 0.4604 21	0.40442 0.0690 21	0.35050 0.1193 21	0.14514 0.5302 21	-0.20841 0.3646 21
Number per km Age 4	-0.12000 0.6044 21	-0.15692 0.4970 21	-0.20511 0.3724 21	0.29026 0.2018 21	0.25583 0.2630 21	0.00825 0.9717 21	0.04981 0.8302 21

Table B11.-Results of correlation analysis for class Brook-1 trout populations using length at age vs. selected variables.

	Number per ha Age 0	Number per ha Age 1	Number per ha Age 2	Number per ha Age 3	Number per km Age 0	Number per km Age 1	Number per km Age 2	Number per km Age 3
Length at Age 1	-0.17174 0.1016 92	-0.25074 0.0159 92 *	-0.33635 0.0010 92 ***	-0.05448 0.6060 92	-0.05176 0.6241 92	-0.11236 0.2863 92	-0.24183 0.0202 92 *	-0.01589 0.8805 92
Length at Age 2	-0.16367 0.1635 74	-0.12194 0.3007 74	-0.48247 0.0001 74 ***	-0.05363 0.6499 74	-0.06868 0.5609 74	-0.00530 0.9642 74	-0.39296 0.0005 74 ***	-0.00263 0.9823 74
Length at Age 3	0.08286 0.8086 11	0.39666 0.2271 11	-0.00041 0.9990 11	0.03092 0.9281 11	0.19911 0.5572 11	0.56282 0.0715 11	-0.11973 0.7259 11	0.17739 0.6018 11

	Length at Age 1	Length at Age 2	Length at Age 3	Kg per Hectare Age 0	Kg per Hectare Age 1	Kg per Hectare Age 2	Kg per Hectare Age 3
Length at Age 1	1.00000 0.0000 92	0.83312 0.0001 74 ***	0.90783 0.0001 11 ***	0.04427 0.6752 92	0.20601 0.0488 92 *	-0.09347 0.3755 92	0.03260 0.7577 92
Length at Age 2	0.83312 0.0001 74 ***	1.00000 0.0000 74	0.90063 0.0002 11 ***	0.09750 0.4086 74	0.31784 0.0058 74 **	-0.15761 0.1799 74	0.07297 0.5367 74
Length at Age 3	0.90783 0.0001 11 ***	0.90063 0.0002 11 ***	1.00000 0.0000 11	0.38135 0.2472 11	0.75742 0.0069 11 **	0.43066 0.1861 11	0.30584 0.3604 11

	Conductivity at 25°C	Dissolved Oxygen	pH	Water Temp.	Maximum Water Temp.	Alkalinity	Velocity	Stream Discharge Velocity
Length at Age 1	0.35295 0.0006 91 ***	-0.10018 0.3447 91	0.18944 0.0721 91	0.20034 0.0555 92	0.23490 0.2584 25	0.23126 0.0302 88 *	0.35512 0.0006 90 ***	0.18541 0.0802 90
Length at Age 2	0.31278 0.0071 73 **	-0.11121 0.3489 73	0.21601 0.0664 73	0.17980 0.1253 74	0.18402 0.4246 21	0.27126 0.0221 71 *	0.29610 0.0110 73 *	0.03083 0.7957 73
Length at Age 3	0.00099 0.9977 11	0.11751 0.7308 11	0.14598 0.6684 11	-0.03393 0.9211 11	0.85923 0.3419 3	-0.02585 0.9399 11	0.04008 0.9069 11	-0.29536 0.3779 11

	% Silt Substrate	% Sand Substrate	% Gravel Substrate	% Cobble Substrate	% Small Boulder Substrate	% Large Boulder Substrate	% Bedrock Substrate	Mean Embed. Gravel Substrate
Length at Age 1	0.06612 0.5312 92	0.27867 0.0071 92 **	0.06499 0.5383 92	-0.07025 0.5058 92	-0.21187 0.0426 92 *	-0.14474 0.1686 92	-0.02389 0.8345 79	-0.08018 0.4971 74
Length at Age 2	-0.05125 0.6645 74	0.11044 0.3489 74	0.20505 0.0797 74	0.06057 0.6082 74	-0.25832 0.0263 74 *	-0.23515 0.0437 74 *	0.11718 0.3684 61	-0.11367 0.3872 60
Length at Age 3	0.17945 0.5975 11	0.42125 0.1969 11	0.30132 0.3679 11	-0.31172 0.3507 11	-0.37919 0.2501 11	0.11941 0.7266 11	. 9	-0.07597 0.8348 10

Table B11.-(cont.)

	Mean Embed. Cobble Substrate	Dominant Substrate Type	Mean Width	Mean Depth	Maximum Depth	Maximum Riffle Length	Maximum Pool Length	Pool to Riffle Ratio
Length at Age 1	0.26181 0.0137 88 *	-0.09665 0.3594 92	0.26608 0.0104 92 *	0.30748 0.0029 92 **	0.09070 0.4266 79	0.13852 0.1879 92	0.20892 0.0457 92 *	0.09716 0.3568 92
Length at Age 2	0.11227 0.3478 72	-0.06696 0.5708 74	0.23995 0.0395 74 *	0.19835 0.0902 74	0.09490 0.4669 61	0.10575 0.3699 74	0.12993 0.2699 74	0.10993 0.3511 74
Length at Age 3	-0.09701 0.7766 11	-0.03930 0.9087 11	0.00065 0.9985 11	0.03025 0.9296 11	0.02191 0.9554 9	-0.33907 0.3077 11	-0.10019 0.7694 11	0.43306 0.1834 11

	Gradient	Elevation	Total Length of Cover	Length as Cover-Deep Water	Area as Cover-Deep Water	Length as Cover-Logs	Area as Cover-Logs	Length as Cover-Undercuts
Length at Age 1	-0.23882 0.0226 91 *	-0.58572 0.0001 91 ***	0.23072 0.0269 92 *	0.21381 0.0407 92 *	0.22462 0.0313 92 *	0.11380 0.2801 92	0.11512 0.2745 92	0.19874 0.0575 92
Length at Age 2	-0.24495 0.0367 73 *	-0.46623 0.0001 73 ***	0.14954 0.2035 74	0.13041 0.2681 74	0.13561 0.2493 74	-0.03317 0.7791 74	-0.00579 0.9610 74	0.14632 0.2135 74
Length at Age 3	-0.33257 0.3177 11	-0.32746 0.3256 11	-0.02714 0.9369 11	-0.01292 0.9699 11	-0.12851 0.7065 11	-0.12373 0.7170 11	-0.09653 0.7777 11	-0.23636 0.4841 11

	Area as Cover-Undercuts	Length as Cover-Rocks	Area as Cover-Rocks	% Sample Area as Cover	% Sample Length as Cover	Percent Overhead Canopy	Subjective Fishing Pressure
Length at Age 1	0.14122 0.1794 92	-0.11027 0.2954 92	-0.06237 0.5548 92	0.20377 0.0514 92	0.20555 0.0493 92 *	-0.22691 0.0296 92	0.06213 0.5563 92
Length at Age 2	0.05825 0.6220 74	-0.15466 0.1883 74	-0.04587 0.6979 74	0.10633 0.3672 74	0.10265 0.3841 74	-0.17334 0.1397 74	0.06676 0.5720 74
Length at Age 3	-0.40114 0.2214 11	0.04831 0.8878 11	0.02531 0.9411 11	0.29660 0.3758 11	0.25577 0.4478 11	-0.30985 0.3538 11	-0.22513 0.5057 11

Table B12.-Results of correlation analysis for class Brown-1 trout populations using length at age class vs. selected variables.

	Number per ha Age 0	Number per ha Age 1	Number per ha Age 2	Number per ha Age 3	Number per km Age 0	Number per km Age 1	Number per km Age 2	Number per km Age 3
Length at Age 1	0.27804 0.2223 21	-0.07554 0.7448 21	0.37316 0.0957 21	0.04239 0.8552 21	0.23042 0.3150 21	-0.08277 0.7213 21	0.26009 0.2549 21	0.01467 0.9497 21
Length at Age 2	0.12504 0.5994 20	-0.29384 0.2086 20	0.20665 0.3820 20	0.06553 0.7837 20	0.18694 0.4300 20	-0.16824 0.4783 20	0.21590 0.3606 20	0.07723 0.7462 20
Length at Age 3	0.16785 0.5499 15	-0.11131 0.6929 15	0.23474 0.3997 15	0.10563 0.7079 15	0.23243 0.4045 15	0.05493 0.8458 15	0.29851 0.2798 15	0.12355 0.6609 15

	Length at Age 1	Length at Age 2	Length at Age 3	Kg per Hectare Age 0	Kg per Hectare Age 1	Kg per Hectare Age 2	Kg per Hectare Age 3	Conductivity at 25 °C
Length at Age 1	1.00000 0.0000 21	0.63261 0.0028 20 **	0.58380 0.0223 15 *	0.44796 0.0417 21 *	0.36636 0.1024 21	0.40577 0.0680 21	0.20227 0.3792 21	0.49839 0.0215 21 *
Length at Age 2	0.63261 0.0028 20 **	1.00000 0.0000 20	0.92270 0.0001 15 ***	0.28228 0.2279 20	0.19249 0.4162 20	0.41082 0.0720 20	0.35253 0.1274 20	0.56536 0.0094 21 **
Length at Age 3	0.58380 0.0223 15 *	0.92270 0.0001 15 ***	1.00000 0.0000 15	0.24379 0.3813 15	0.39246 0.1479 15	0.46149 0.0833 15	0.48436 0.0673 15	0.45028 0.0921 15

	Dissolved Oxygen	pH	Water Temp.	Maximum Water Temp.	Alkalinity	Velocity	Stream Discharge Velocity	% Silt Substrate
Length at Age 1	-0.28326 0.2134 21	0.55380 0.0092 21 **	0.32453 0.1512 21	-0.21864 0.5439 10	0.34904 0.1210 21	0.24067 0.2933 21	-0.03678 0.8742 21	0.22702 0.3224 21
Legnth at Age 2	-0.18191 0.4427 20	0.47458 0.0345 20 *	0.21051 0.3730 20	0.26506 0.4592 10	0.51540 0.0200 20 *	0.22463 0.3410 20	0.21305 0.3671 20	0.64138 0.0023 20 **
Length at Age 3	-0.34417 0.2091 15	0.44214 0.0989 15	0.42795 0.1115 15	0.60314 0.0855 9	0.46911 0.0777 15	0.18387 0.5118 15	0.12534 0.6563 15	0.63159 0.0116 15 *

	% Sand Substrate	% Gravel Substrate	% Cobble Substrate	% Small Boulder Substrate	% Large Boulder Substrate	% Bedrock Substrate	Mean Embed. Gravel Substrate	Mean Embed. Cobble Substrate
Length at Age 1	0.51036 0.0181 21 *	0.25437 0.2658 21	-0.19615 0.3941 21	-0.22990 0.3161 21	-0.55786 0.0086 21 **	. 17	0.14172 0.5874 17	0.51889 0.0159 21 *
Length at Age 2	0.37767 0.1006 20	0.28037 0.2312 20	-0.23497 0.3187 20	-0.13197 0.5791 20	-0.74613 0.0002 20 ***	. 16	0.17204 0.5241 16	0.19171 0.4181 20
Length at Age 3	0.34927 0.2019 15	0.39621 0.1437 15	-0.19809 0.4791 15	-0.36472 0.1813 15	-0.77262 0.0007 15 ***	. 12	0.17975 0.5386 14	0.28375 0.3054 15

Table B12.-(cont.)

	Dominant Substrate Type	Mean Width	Mean Depth	Maximum Depth	Maximum Riffle Length	Maximum Pool Length	Pool to Riffle Ratio	Gradient
Length at Age 1	-0.20508 0.3725 21	-0.05941 0.7981 21	0.10378 0.6544 21	-0.17380 0.5047 17	-0.00590 0.9797 21	-0.08779 0.7051 21	-0.02036 0.9302 21	-0.19771 0.3903 21
Length at Age 2	-0.47064 0.0362 20 *	0.25399 0.2799 20	0.25360 0.2807 20	0.05984 0.8258 16	0.09643 0.6859 20	0.25327 0.2813 20	0.03198 0.8935 20	-0.50365 0.0236 20 *
Length at Age 3	-0.62725 0.0123 15 *	0.34915 0.2021 15	0.28627 0.3010 15	0.37643 0.2278 12	0.11876 0.6734 15	0.21602 0.4394 15	-0.02265 0.9361 15	-0.61639 0.0144 15 *

	Elevation	Total Length of Cover	Length as Cover-Deep Water	Area as Cover-Deep Water	Length as Cover-Logs	Area as Cover-Logs	Length as Cover-Undercuts	Area as Cover-Undercuts
Length at Age 1	-0.39263 0.0783 21	-0.12887 0.5777 21	0.02810 0.9038 21	0.07407 0.7497 21	-0.26423 0.2471 21	-0.29325 0.1970 21	0.04453 0.8480 21	0.05620 0.8088 21
Length at Age 2	-0.60201 0.0050 20 ***	0.10519 0.6590 20	0.22351 0.3435 20	0.28162 0.2290 20	-0.11700 0.6232 20	-0.13451 0.5718 20	0.03843 0.8722 20	0.03592 0.8805 20
Length at Age 3	-0.48939 0.0641 15	0.21758 0.4360 15	0.41288 0.1261 15	0.46044 0.0841 15	0.01449 0.9591 15	0.03606 0.8985 15	0.06416 0.8203 15	0.04216 0.8814 15

	Length as Cover-Rocks	Area as Cover-Rocks	% Sample Area as Cover	% Sample Length as Cover	Percent Overhead Canopy	Subjective Fishing Pressure
Length at Age 1	-0.37661 0.0924 21	-0.30089 0.1850 21	0.08034 0.7292 21	-0.34999 0.1199 21	-0.52527 0.0145 21	0.04090 0.8603 21
Length at Age 2	-0.37755 0.1008 20	-0.13850 0.5604 20	0.20781 0.3793 20	-0.15713 0.5082 20	-0.37855 0.0998 20	-0.13115 0.5815 20
Length at Age 3	-0.48263 0.0684 15	-0.50005 0.0577 15	0.37145 0.1728 15	-0.05878 0.8352 15	-0.28211 0.3083 15	-0.11407 0.6856 15

Appendix C: Angler survey statistics for individual streams

Table C1.-Angler Survey statistics for angler effort and catch from individual Connecticut streams surveyed 1988-1994.

Name	Angler Effort/km	Trout Catch/km	CPUE	Percent Return to the Angler
Adult Streams:				
WHITING RIVER	100.	63.	0.519	18.
STRATTON BROOK	127.	38.	0.300	4.
MASHAMOQUET BROOK	156.	9.	0.606	46.
MERRICK BROOK IN WMA	173.	56.	0.730	--
BLACKBERRY RIVER	199.	154.	0.740	56.
NORWALK RIVER	238.	144.	0.606	45.
PEQUONNOCK RIVER	245.	607.	1.251	49.
EAST ASPETUCK RIVER	248.	158.	0.662	55.
EAST BRANCH NAUGATUCK RIVER	340.	636.	1.391	97.
MILL RIVER-FAIRFIELD	366.	758.	1.404	272.
SANDY BROOK	394.	77.	1.434	103.
MACEDONIA BROOK	399.	331.	1.042	123.
WILLIMANTIC RIVER	417.	215.	0.515	105.
EIGHTMILE BROOK	425.	544.	0.920	129.
LITTLE RIVER	469.	227.	0.720	69.
SCANTIC RIVER	508.	82.	0.441	29.
FARM RIVER	532.	259.	0.484	64.
FURNACE BROOK	626.	1066.	1.451	81.
LATIMER BROOK	633.	271.	0.782	126.
MOOSUP RIVER NON-TMA	656.	195.	0.539	102.
SAUGATUCK RIVER-OPEN	706.	582.	0.606	43.
COGINCHAUG RIVER	738.	909.	0.476	175.
ROARING BROOK	768.	702.	0.9140	131.
MOOSUP RIVER (PRE-TMA) OPEN	769.	393.	0.930	112.
NEPAUG RIVER	837.	213.	1.274	220.
NATCHAUG RIVER	850.	629.	0.740	64.
YANTIC RIVER	1,171.	704.	0.629	78.
FENTON RIVER	1,281.	834.	0.651	135.
HAMMONASSET RIVER	1,402.	377.	0.269	50.
JEREMY RIVER	1,809.	119.	0.255	392.
EAST BRANCH SALMON BROOK	2,821.	1,016.	0.730	187.
MILL RIVER-HAMDEN	4,136.	1,778.	0.429	133.
CHATFIELD HOLLOW BROOK	4,371.	1,768.	0.405	136.
SALMON RIVER-UPPER BAIT	5,066.	7,486.	0.708	--
SALMON RIVER-LOWER BAIT	6,522.	3,559.	0.947	--
Impoundment on stocked stream (Data is total catch and effort)				
EIGHTMILE BK (Southford Falls)	6,065.	3,729.	0.520	126.
Fly-Fishing-Only Areas:				
BANTAM RIVER	378.	227.	0.578	33.
MOOSUP RIVER (PRE-TMA) FLY	512.	636.	1.230	112.
YANTIC RIVER-FLY	1,200.	831.	0.556	88.
SAUGATUCK RIVER-FLY	3,397.	1,455.	0.429	90.
SALMON RIVER-FLY ONLY	7,576.	5,235.	0.705	131.

Table C1.-Contintued

Name	Angler Effort/km	Trout Catch/km	CPUE	Percent Return to the Angler
<u>Nonstocked Streams:</u>				
BELDEN BROOK	0.	0.	0.	
GREAT BROOK	0.	0.	0.	
HOCKANUM RIVER	0.	0.	0.	
CENTER BROOK	0.	0.	0.	
HURRICANE BROOK	0.	0.	0.	
COLEBROOK BROOK	8.	0.	2.951	
HOUSATONIC RIVER-BULLS BRIDGE	270.	78.	0.326	
<u>TMA-ALT:</u>				
SALMON R TMA-OPEN (PRESEASON)1993	181.	0.	0.000	--
SALMON R TMA-OPEN (PRESEASON)1994	32.	13.	1.200	11.
MOOSUP RIVER TMA-OPEN	470.	405.	0.862	130.
HAMMONASSET RIVER TMA	2,225.	2,596.	1.167	352.
MIANUS RIVER TMA	4,852.	5,957.	1.228	400.
<u>TMA-FFO:</u>				
SALMON R TMA-FLY (PRESEASON) 1993	350.	5.	0.033	--
SALMON R TMA-FLY (PRESEASON) 1994	292.	27.	0.235	11.
MOOSUP RIVER TMA-FLY (1993&1994)	748.	1,389.	1.857	422.
WILLIMANTIC RIVER TMA	1,313.	1,316.	1.002	456.
<u>Yearling Streams:</u>				
TAYLOR BROOK	0.	0.	0.000	
PARMALEE BROOK	24.	0.	0.000	
SAFSTROM BROOK	35.	17.	0.500	14.
LAKE WARAMAUG BROOK	42.	103.	2.475	66.
LONG MEADOW POND BROOK	56.	34.	1.400	58.
BEACON HILL BROOK	162.	222.	1.940	92.
KENT FALLS BROOK	226.	221.	0.862	37.
KETTLETOWN BROOK	232.	523.	2.250	46.
STONY BROOK	239.	58.	0.548	42.
UNIONVILLE BROOK	277.	42.	0.142	15.
BRANCH BROOK	455.	683.	1.430	101.
<u>Summer and Fall Creels:</u>				
MOOSUP RIVER (PRE-TMA) Open-Summer	203.	0.	0.000	0.
MOOSUP RIVER (PRE-TMA) Open-Fall	41.	26.	0.652	0.
MOOSUP RIVER (PRE-TMA) Fly-Summer	0.	0.	0.000	0.
MOOSUP RIVER (PRE-TMA) FLY-Fall	23.	42.	1.838	0.
HAMMONASSET RIVER TMA FALL	310.	821.	0.945	0.
SALMON RIVER TMA-OPEN Fall	513.	0.	0.	151.
SALMON RIVER TMA-FLY Fall	913.	224.	0.614	151.
SALMON RIVER NON TMA Fall	1671.	135.	0.405	87.

Table C2.-Miscellaneous creel data from Connecticut streams surveyed 1988-1994.

Stream Name/ Creel Period	River Type	Percentage of anglers releasing trout	Percent Angler Type:			Hours per Trout
			Fly	Bait	Lure	
Bantam River 04/18/92-06/15/92	Fly-Fishing-Only	18.5	98.5	0.75	0.75	0.524
Beacon Hill Brook 04/20/91-06/15/91	Yearling	30.0	0.0	92.0	8.0	0.936
Belden Brook 04/18/88-06/13/88	Nonstocked	.	.	.	.	.
Blackberry River 04/18/92-06/15/92	Adult	26.1	1.8	82.7	15.4	1.014
Branch Brook 04/20/91-06/15/91	Yearling	31.0	0.0	91.0	9.0	1.337
Center Brook 04/16/88-06/12/88	Nonstocked	.	.	.	.	.
Chatfield Hollow Brook 04/21/90-06/11/90	Adult	24.0	1.0	82.0	7.0	3.249
Coginchaug River 04/15/89-06/03/89	Adult	11.0	2.0	89.0	8.0	1.386
Colebrook Brook 04/16/88-05/27/88	Nonstocked	100.0	0.0	100.0	0.0	.
East Aspetuck River 04/18/92-06/15/92	Nonstocked	10.5	2.0	89.2	8.8	0.829
East Branch Naugatuck River 04/18/92-06/15/92	Adult	33.0	3.2	85.5	11.3	0.591
East Branch Salmon Brook 04/21/88-06/12/88	Adult	25.0	3.0	77.0	20.0	5.404
Eightmile Brook (Southford Falls) 04/20/91-06/15/91	Adult	0.0	2.0	90.0	8.0	.
Eightmile Brook 04/20/91-06/15/91	Adult	23.0	3.0	93.0	5.0	5.462
Farm River 04/21/90-06/11/90	Adult	10.0	1.0	89.0	10.0	1.228

Table C2.-Miscellaneous creel data. (cont.)

Stream Name/ Creel Period	River Type	Percentage of anglers releasing trout	Percent Angler Type: Fly	Bait	Lure	Hours per Trout
Fenton River 04/16/94-06/15/94	Adult	16.6	6.0	84.0	10.0	2.018
Furnace Brook 04/18/92-06/15/92	Adult	29.0	1.7	95.5	2.8	0.520
Great Brook 04/18/92-06/15/92	Nonstocked	.	.	.	.	.
Hammonasset River 04/21/90-06/12/90	Adult	17.0	6.0	71.0	23.0	1.755
Hammonasset River TMA (Preseason) 03/01/93-04/16/93	Preseason TMA	100.0	45.4	15.2	39.4	2.118
Hammonasset River TMA 04/17/93-06/15/93	TMA	66.0	14.1	60.1	25.8	1.920
Hammonasset River TMA (Fall) 09/01/93-11/15/93	Fall TMA	.	19.2	73.1	7.7	0.421
Hockanum River 04/15/89-05/21/89	Nonstocked	.	.	.	.	.
Housatonic River-Bulls Bridge 04/18/92-06/15/92	Nonstocked	54.5	1.5	52.9	45.5	.
Hurricane Brook 04/17/88-06/11/88	Nonstocked	.	.	.	.	.
Jeremy River 04/15/89-06/10/89	Adult	56.0	8.3	79.2	12.5	5.446
Kent Falls Brook 04/18/92-06/15/92	Yearling	18.8	6.9	89.2	3.9	0.377
Kettletown Brook 04/20/91-06/15/91	Yearling	25.0	7.0	86.0	7.0	0.400
Lake Waramaug Brook 04/18/92-06/15/92	Yearling	42.8	0.0	100.0	0.0	0.080
Latimer Brook 04/17/93-06/15/93	Adult	8.0	8.4	77.8	13.8	1.609

Table C2.-Miscellaneous creel data. (cont.)

Stream Name/ Creel Period	River Type	Percentage of anglers releasing trout	Percent Angler Type:			Hours per Trout
			Fly	Bait	Lure	
Little River 04/20/91-06/15/91	Adult	25.0	0.0	94.0	6.0	2.450
Long Meadow Pond Brook 04/20/91-06/15/91	Yearling	42.0	71.0	0.0	29.0	0.381
Macedonia Brook 04/18/92-06/15/92	Adult	39.6	4.2	93.7	2.1	1.181
Mashamoquet Brook 04/16/94-06/15/94	Adult	8.6	8.0	69.0	23.0	0.717
Merrick Brook in WMA 04/16/94-06/15/94	Adult	43.0	26.0	60.0	14.0	2.092
Mianus River TMA (Preseason) 03/01/90-04/20/90	Preseason TMA	100.0	61.8	0.0	38.2	2.931
Mianus River TMA 04/21/90-06/15/90	Adult	71.0	25.0	70.0	5.0	1.389
Mill River-Fairfield 04/21/90-06/10/90	Adult	22.0	2.0	76.0	22.0	1.947
Mill River-Hamden 04/21/90-06/11/90	Adult	13.0	10.0	66.0	24.0	3.011
Moosup River TMA-Fly (Preseason) 03/01/93-04/16/93	Preseason TMA-FFO	100.0	100.0	0.0	0.0	0.773
Moosup River TMA-Fly 03/01/94-04/15/94	Preseason TMA-FFO	.	.	.	.	0.000
Moosup River TMA-Open (Preseason) 03/01/93-04/16/93	Preseason TMA	100.0	100.0	0.0	0.0	1.583
Moosup River TMA-Open (Preseason) 03/01/94-04/15/94	Preseason TMA	100.0	100.0	0.0	0.0	0.113
Moosup River (Pre-TMA)-Fly 04/18/92-06/15/92	Fly-Fishing-Only	76.7	92.1	0.0	7.9	0.898
Moosup River (Pre-TMA)-Fly 06/16/92-09/01/92	Fly-Fishing-Only	.	.	.	.	0.000

Table C2.-Miscellaneous creel data. (cont.)

Stream Name/ Creel Period	River Type	Percentage of anglers releasing trout	Percent Angler Type: Fly	Bait	Lure	Hours per Trout
Moosup River (Pre-TMA) Fly-Fall 09/01/92-11/15/92	Fly-Fishing-Only-Fall	100.0	100.0	0.0	0.0	0.028
Moosup River (Pre-TMA)-Open 04/18/92-06/15/92	Adult	41.0	15.5	47.6	36.9	1.349
Moosup River (Pre-TMA) Open-Fall 09/01/92-11/15/92	Adult-Fall	100.0	100.0	0.0	0.0	0.071
Moosup River (Pre-TMA) Open-Summer 06/16/92-09/01/92	Adult	.	1.0	33.0	66.0	0.356
Moosup River Non TMA 04/17/93-06/15/93	Adult	31.0	4.8	69.7	25.5	1.821
Moosup River TMA-Fly 04/16/94-06/15/94	TMA-FFO	100.0	94.0	0.0	6.0	0.575
Moosup River TMA-Fly 04/17/93-06/15/93	TMA-FFO	100.0	92.0	8.0	0.0	0.581
Moosup River TMA-Open 04/16/94-06/15/94	TMA	100.0	26.0	37.0	37.0	0.193
Moosup River TMA-Open 04/17/93-06/15/93	TMA	100.0	32.3	38.7	29.0	0.848
Natchaug River 04/16/94-06/15/94	Adult	26.3	23.0	64.0	13.0	0.874
Nepaug River 04/16/88-06/13/88	Adult	24.0	0.0	95.0	5.0	1.618
Norwalk River 04/21/90-06/09/90	Adult	10.0	15.0	78.0	7.0	0.693
Parmalee Brook 04/15/89-06/03/89	Yearling	.	0.0	100.0	0.0	0.275
Pequonnock River 04/12/90-06/10/90	Adult	50.0	5.0	66.0	29.0	0.520

Table C2.-Miscellaneous creel data. (cont.)

Stream Name/ Creel Period	River Type	Percentage of anglers releasing trout	Percent Angler Type:			Hours per Trout
			Fly	Bait	Lure	
Roaring Brook 04/16/94-06/15/94	Adult	20.8	3.0	83.0	14.0	1.297
Safstrom Brook 04/15/89-06/10/89	Yearling	100.0	17.0	83.0	0.0	0.274
Salmon River TMA-Fly (Preseason) 03/01/94-04/15/94	Preseason TMA-FFO	100.0	100.0	0.0	0.0	0.681
Salmon River TMA-Fly (Preseason) 03/01/93-04/16/93	Preseason TMA-FFO	100.0	88.5	7.6	3.9	0.817
Salmon River TMA-Open (Preseason) 03/01/93-04/16/93	Preseason TMA	.	66.0	33.0	0.0	0.664
Salmon River TMA-Open (Preseason) 03/01/94-04/15/94	Preseason TMA	100.0	40.0	40.0	20.0	0.117
Salmon River Non TMA 09/01/93-11/15/93	Adult-Fall	.	17.8	60.2	21.9	1.737
Salmon River TMA-Fly 09/01/93-11/15/93	TMA-FFO-Fall	.	100.0	0.0	0.0	0.819
Salmon River TMA-Open 09/01/93-11/15/93	TMA-Fall	.	25.0	27.5	47.5	0.723
Salmon River-Fly Only 04/15/89-06/10/89	TMA-FFO	100.0	100.0	0.0	0.0	1.499
Salmon River-Lower Bait 04/15/89-06/10/89	Adult	36.0	2.2	20.0	77.8	.
Salmon River-Upper Bait 04/15/89-06/10/89	Adult	57.0	1.9	24.1	74.0	.
Sandy Brook 04/16/88-06/05/88	Adult	33.0	0.0	100.0	0.0	0.780
Saugatuck River-Fly 04/21/90-06/12/90	Fly-Fishing-Only	65.0	100.0	0.0	0.0	2.231

Table C2.-Miscellaneous creel data. (cont.)

Stream Name/ Creel Period	River Type	Percentage of anglers releasing trout	Percent Angler Type:			Hours per Trout
			Fly	Bait	Lure	
Saugatuck River-Open 04/21/90-06/10/90	Adult	42.0	5.0	25.0	70.0	0.733
Scantic River 04/15/89-05/21/89	Adult	28.0	1.9	73.6	24.5	2.020
Stony Brook 04/17/93-06/15/93	Yearling	40.0	8.3	58.3	33.3	0.766
Stratton Brook 04/16/88-06/06/88	Adult	25.0	0.0	100.0	0.0	0.135
Taylor Brook 04/20/88-06/11/88	Yearling	.	.	.	.	0.000
Unionville Brook 04/16/88-05/20/88	Yearling	0.0	8.0	77.0	15.0	1.039
Whiting River 04/18/92-06/15/92	Adult	71.4	1.0	75.5	23.5	0.283
Willimantic River TMA (Preseason) 03/01/94-04/15/94	Preseason TMA-FFO	100.0	99.0	0.0	1.0	1.612
Willimantic River 04/16/94-06/15/94	Adult	23.0	10.0	60.0	3.0	1.677
Willimantic River TMA 04/16/94-06/15/94	TMA-FFO	98.0	100.0	0.0	0.0	3.521
Yantic River 04/17/93-06/15/93	Adult	35.0	9.4	64.3	26.2	1.234
Yantic River-Fly 04/17/93-06/15/93	Fly-Fishing-Only	75.4	94.0	2.0	4.0	1.264

Table C3.-Economic value for individual streams by kilometer from Connecticut streams creeled 1988-1994.

Stream Name	Variable Cost	Fixed Cost	Economic Impact	Consumer Surplus	Compensatory Fishing	Value of: This Stream	Expenditure per Trout Stocked
BANTAM RIVER	$ 803.66	$ 1,659.10	$ 3,694.14	$ 1,786.50	$ 9,000.00	$ 4,479.75	$ 3.42
BEACON HILL BROOK	$ 318.34	$ 360.88	$ 1,018.82	$ 1,454.69	$ 3,636.73	$ 1,515.31	$ 2.00
BELDEN BROOK	$.	$.	$.	$.	$.	$.	$.
BLACKBERRY RIVER	$ 382.90	$ 195.21	$ 867.16	$ 946.67	$ 1,865.39	$ 946.67	$ 2.95
BRANCH BROOK	$ 706.80	$ 462.37	$ 1,753.76	$ 2,069.17	$ 5,172.92	$ 2,166.68	$ 1.82
CENTER BROOK	$.	$.	$.	$.	$.	$.	$.
CHATFIELD HOLLOW BROOK	$11,606.15	$ 3,268.85	$22,312.50	$18,732.86	$37,205.54	$18,732.86	$ 11.06
COGINCHAUG RIVER	$ 1,833.10	$ 1,332.99	$ 4,749.13	$5,871.13	$11,682.96	$ 5,871.13	$ 3.53
COLEBROOK BROOK	$.	$.	$.	$.	$.	$.	$.
EAST ASPETUCK RIVER	$ 476.97	$ 269.65	$ 1,119.92	$ 1,180.95	$ 2,347.73	$ 1,180.95	$ 2.49
EAST BRANCH NAUGATUCK RIVER	$ 419.83	$ 377.10	$ 1,195.40	$ 1,619.05	$ 3,218.26	$ 1,619.05	$ 1.38
EAST BRANCH SALMON BROOK	$ 633.38	$ 455.85	$ 1,633.85	$ 1,760.59	$ 3,459.56	$ 1,760.59	$ 2.09
EIGHTMILE BROOK (SOUTHFORD FALLS)	$.	$.	$.	$.	$.	$.	$ 8.00
EIGHTMILE BROOK	$ 5,554.86	$ 1,517.19	$10,608.08	$ 8,502.36	$17,025.77	$ 8,502.36	$ 21.85
FARM RIVER	$ 1,167.16	$ 467.40	$ 2,451.83	$ 2,533.33	$ 5,016.00	$ 2,533.33	$ 3.77
FENTON RIVER	$ 2,004.89	$ 1,943.96	$ 5,923.27	$ 6,100.00	$12,230.50	$ 6,100.00	$ 6.22
FURNACE BROOK	$ 2,578.54	$ 754.64	$ 4,999.77	$ 2,980.95	$ 5,966.38	$ 2,980.95	$ 2.77
GREAT BROOK	$.	$.	$.	$.	$.	$.	$.
HAMMONASSET RIVER TMA (PRESEASON)	$ 1,201.39	$ 2,310.68	$ 5,268.10	$ 3,980.95	$ 8,865.58	$ 4,888.61	$ 8.90
HAMMONASSET RIVER TMA	$ 4,110.27	$ 2,494.22	$ 9,906.74	$ 6,975.61	$18,351.20	$13,050.01	$ 8.96
HAMMONASSET RIVER TMA (FALL)	$ 875.77	$ 519.38	$ 2,092.72	$.	$ 4,683.21	$ 3,094.83	$ 1.89
HAMMONASSET RIVER	$ 3,387.13	$ 1,538.98	$ 7,389.17	$ 6,676.19	$13,168.79	$ 6,676.19	$ 6.17

Table C3.-CONTINUED. Economic value for individual streams by kilometer from Connecticut streams creeled 1988-1994.

Stream Name	Variable Cost	Fixed Cost	Economic Impact	Consumer Surplus	Compensatory Value of: Fishing	Compensatory Value of: This Stream	Expenditure per Trout Stocked
HOCKANUM RIVER	$.	$.	$.	$.	$.	$.	$.
HOUSATONIC RIVER-BULLS BRIDGE	$.	$ 316.81	$.	$ 642.21	$ 3,211.07	$ 1,289.25	$.
HURRICANE BROOK	$.	$.	$.	$.	$.	$.	$.
JEREMY RIVER	$ 3,504.60	$ 1,958.74	$ 8,195.00	$ 7,044.22	$14,160.64	$ 7,044.22	$ 16.45
KENT FALLS BROOK	$ 477.29	$ 326.14	$ 1,205.14	$ 1,055.20	$ 2,545.19	$ 1,076.19	$ 1.34
KETTLETOWN BROOK	$ 305.14	$ 314.04	$ 928.76	$ 1,066.10	$ 2,568.57	$ 1,104.76	$ 1.07
LAKE WARAMAUG BROOK	$ 90.31	$ 40.06	$ 195.56	$ 197.62	$ 494.05	$ 197.62	$ 0.25
LATIMER BROOK	$ 1,545.67	$ 839.77	$ 3,578.16	$ 3,014.29	$ 6,051.18	$ 3,014.29	$ 6.06
LITTLE RIVER	$ 1,411.00	$ 1,081.74	$ 3,739.11	$ 4,598.04	$ 9,127.11	$ 4,598.04	$ 6.32
LONG MEADOW POND BROOK	$ 89.68	$ 201.26	$ 436.42	$ 228.00	$ 333.33	$ 266.67	$ 1.98
MACEDONIA BROOK	$ 907.94	$ 463.23	$ 2,056.76	$ 1,900.00	$ 3,829.92	$ 1,900.00	$ 4.06
MASHAMOQUET BROOK	$ 451.93	$ 222.98	$ 1,012.36	$ 742.86	$ 1,472.71	$ 742.86	$ 3.10
MERRICK BROOK	$ 343.47	$ 336.84	$ 1,020.47	$ 823.81	$ 1,725.88	$ 823.81	$ 8.23
MIANUS RIVER TMA (PRESEASON)	$ 4,844.87	$ 9,579.35	$21,636.32	$13,800.00	$31,864.20	$13,800.00	$ 14.59
MIANUS RIVER TMA	$ 4,152.71	$ 3,603.09	$11,633.71	$ 9,886.31	$28,844.76	$19,656.31	$ 5.51
MILL RIVER-FAIRFIELD	$ 664.77	$ 757.52	$ 2,133.43	$ 3,112.25	$ 6,084.44	$ 3,112.25	$ 4.24
MILL RIVER-HAMDEN	$11,138.13	$ 8,074.62	$28,819.14	$26,697.99	$53,129.00	$26,697.99	$ 10.32
MOOSUP RIVER (PRE-TMA) FLY	$ 743.54	$ 2,154.16	$ 4,346.55	$ 2,438.10	$ 5,950.78	$ 2,438.10	$ 1.86
MOOSUP RIVER (PRE-TMA) FLY (SUMMER)	$ 31.97	$ 101.16	$ 199.71	$.	$ 542.86	$ 271.43	$ 0.06
MOOSUP RIVER (PRE-TMA) FLY (FALL)	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00
MOOSUP RIVER (PRE-TMA) OPEN	$ 418.18	$ 278.67	$ 1,045.29	$ 966.67	$ 1,778.67	$ 966.67	$ 0.69

Table C3.-CONTINUED. Economic value for individual streams by kilometer from Connecticut streams creeled 1988-1994.

Stream Name	Variable Cost	Fixed Cost	Economic Impact	Consumer Surplus	Compensatory Value of: Fishing	This Stream	Expenditure per Trout Stocked
MOOSUP RIVER (PRE-TMA) OPEN (SUMMER)	$ 125.47	$ 180.14	$ 458.42	$ 193.33	$ 483.33	$ 193.33	$ 0.30
MOOSUP RIVER (PRE-TMA) OPEN (FALL)	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00
MOOSUP RIVER NONTMA	$ 1,222.36	$ 887.22	$ 3,164.38	$ 3,123.81	$ 6,123.45	$ 3,123.81	$ 5.86
MOOSUP R TMA-FLY (PRESEASON)	$ 1,246.04	$ 915.63	$ 3,242.52	$ 982.68	$ 4,913.42	$ 982.68	$ 2.97
MOOSUP R TMA-OPEN (PRESEASON)	$ 141.08	$ 235.16	$ 564.36	$ 252.38	$ 1,261.91	$ 252.38	$ 1.28
MOOSUP RIVER TMA-FLY93	$ 2,848.77	$ 3,225.99	$ 9,112.14	$ 4,145.48	$17,302.86	$ 3,604.76	$ 1.86
MOOSUP RIVER TMA-FLY94	$ 2,859.86	$ 3,150.05	$ 9,014.86	$ 4,346.02	$16,961.81	$ 3,519.05	$ 1.69
MOOSUP RIVER TMA-OPEN93	$ 725.98	$ 508.60	$ 1,851.87	$ 1,163.09	$ 3,403.45	$ 1,787.82	$ 2.62
MOOSUP RIVER TMA-OPEN94	$ 767.90	$ 498.46	$ 1,899.55	$ 1,217.14	$ 3,388.57	$ 1,851.43	$ 2.53
NATCHAUG RIVER	$ 2,227.93	$ 1,675.45	$ 5,855.08	$ 4,047.62	$ 8,429.17	$ 4,047.62	$ 4.01
NEPAUG RIVER	$ 397.88	$ 166.39	$ 846.40	$ 797.40	$ 1,584.84	$ 797.40	$ 1.09
NORWALK RIVER	$ 825.61	$ 742.10	$ 2,351.56	$ 2,250.70	$ 4,630.82	$ 2,250.70	$ 2.30
PARMALEE BROOK	$ 52.82	$ 41.67	$ 141.73	$ 205.52	$ 513.81	$ 205.52	$ 1.08
PEQUONNOCK RIVER	$ 270.54	$ 272.96	$ 815.26	$ 1,166.67	$ 2,277.92	$ 1,166.67	$ 1.15
ROARING BROOK	$ 1,211.03	$ 950.76	$ 3,242.68	$ 3,657.14	$ 7,241.14	$ 3,657.14	$ 3.65
SAFSTROM BROOK	$ 46.04	$ 54.99	$ 151.53	$ 168.33	$ 385.05	$ 168.33	$ 0.79
SALMON RIVER TMA-FLY93 (PRESEASON)	$ 3,092.29	$ 4,521.12	$11,420.12	$ 5,199.62	$24,887.12	$ 5,303.03	$ 5.58
SALMON RIVER TMA-FLY94 (PRESEASON)	$ 4,599.58	$12,889.47	$26,233.59	$.	$69,166.66	$17,291.67	$ 4.93
SALMON RIVER TMA-OPEN (PRESEASON)	$ 852.76	$ 1,292.95	$ 3,218.57	$ 1,877.23	$ 7,821.79	$ 1,877.23	$ 3.58
SALMON RIVER TMA-OPEN93(PRESEASON)	$ 148.21	$ 173.67	$ 482.82	$ 335.24	$ 737.52	$ 536.38	$ 0.54

Table C3.-CONTINUED. Economic value for individual streams by kilometer from Connecticut streams creeled 1988-1994.

Stream Name	Variable Cost	Fixed Cost	Economic Impact	Consumer Surplus	Compensatory Value of: Fishing	This Stream	Expenditure per Trout Stocked
SALMON RIVER TMA-OPEN94(PRESEASON)	$ 3,569.53	$ 2,371.75	$ 8,911.92	$.	$23,176.61	$ 7,591.18	$ 3.81
SALMON RIVER NONTMA (FALL)	$ 4,337.15	$ 2,850.77	$10,781.88	$.	$16,170.90	$ 7,949.19	$ 7.47
SALMON RIVER-FLY-FISING-ONLY	$20,577.40	$34,702.96	$82,920.53	$46,555.20	$186,220.00	$93,110.39	$ 10.94
SALMON RIVER-LOWER BAIT	$ 4,066.08	$ 2,575.91	$ 9,963.00	$ 7,264.07	$13,195.18	$ 7,264.07	$ 6.91
SALMON RIVER-UPPER BAIT	$10,380.08	$ 5,427.50	$23,711.37	$17,834.29	$32,538.65	$17,834.29	$ 7.06
SANDY BROOK	$ 721.40	$ 380.36	$ 1,652.64	$ 1,876.19	$ 3,752.38	$ 1,876.19	$ 2.18
SAUGATUCK RIVER-FLY-FISHING-ONLY	$ 3,914.64	$15,292.72	$28,811.04	$16,176.19	$80,880.95	$40,440.48	$ 12.62
SAUGATUCK RIVER-OPEN	$ 1,394.06	$ 1,442.18	$ 4,254.36	$ 4,575.93	$ 8,465.46	$ 4,575.93	$ 2.16
SCANTIC RIVER	$ 1,877.45	$ 716.30	$ 3,890.63	$ 3,228.28	$ 6,289.50	$ 3,228.28	$ 5.01
STONY BROOK	$ 358.13	$ 344.30	$ 1,053.65	$ 947.46	$ 2,250.58	$ 1,136.96	$ 2.25
STRATTON BROOK	$ 299.96	$ 122.60	$ 633.85	$ 604.76	$ 1,209.52	$ 604.76	$ 0.45
TAYLOR BROOK	$	$.	$.	$.	$.	$.	$.
UNIONVILLE BROOK	$ 356.35	$ 367.80	$ 1,086.24	$ 1,220.12	$ 2,918.39	$ 1,319.05	$ 2.72
WHITING RIVER	$ 202.04	$ 113.62	$ 473.49	$ 477.62	$ 929.57	$ 477.62	$ 0.89
WILLIMANTIC RIVER TMA (PRESEASON)	$ 1,908.11	$ 1,353.23	$ 4,892.01	$ 1,461.90	$ 7,265.67	$ 1,461.90	$ 17.12
WILLIMANTIC RIVER TMA	$ 4,081.49	$ 4,463.62	$12,817.66	$ 5,988.10	$23,952.38	$ 4,790.48	$ 29.91
WILLIMANTIC RIVER	$ 613.50	$ 481.49	$ 1,642.48	$ 1,449.57	$ 2,983.54	$ 1,449.57	$ 4.40
YANTIC RIVER	$ 993.73	$ 771.20	$ 2,647.41	$ 2,847.20	$ 5,641.68	$ 2,847.20	$ 1.74
YANTIC RIVER-FLY-FISHING-ONLY	$ 3,443.31	$ 5,072.83	$12,774.21	$ 5,714.29	$27,600.00	$13,771.43	$ 11.63

Appendix D: List of Invertebrate Families Collected.

Table D1.-List of invertebrate families found in Connecticut streams during 1988-94 stream survey sampling.

Phylum	Class	Order	Family
Platyhelminthes	Turbellaria		
Nematoda			
Nematomorpha			
Tardigrada			
Annelida	Oligochaeta		
	Hirudinea		
Arthropoda	Crustacea		
		Amphipoda	
		Decapoda	
		Isopoda	
	Insecta	Coleoptera	Circulionidae
			Dryopidae
			Dytiscidae
			Elmidae
			Gyrinidae
			Hydrophilidae
			Ptilodactylidae
			Psephenidae
		Collembola	
		Diptera	Athericidiae
			Blephariceridae
			Ceratopogonidae
			Chironomidae
			Culicidae
			Dixidae
			Dolichopodidae
			Empididae
			Muscidae
			Psychodidae
			Simuliidae
			Stratiomyidae
			Tabanidae
			Tipulidae
		Ephemeroptera	Baetidae
			Caenidae
			Ephemeridae
			Ephemerellidae
			Heptageniidae
			Leptophlebiidae
			Oligoneuriidae
			Potamanthidae
			Siphlonuridae
			Tricorythidae
		Hemiptera	Corixidae
			Gerridae
			Saldidae
			Veliidae
			Belostomatidae
			Notonectidae
		Lepidoptera	Cosmopterigidae
			Napticulidae
			Noctuidae
			Pyralidae
			Tortricidae
		Megaloptera	Corydalidae
			Sialidae

Table D1.-Continued.

Phylum	Class	Order	Family
		Odonata Anisoptera[1]	
			Aeshnidae
			Cordulegastridae
			Gomphidae
			Libellulidae
			Macromiidae
		Zygoptera[1]	
			Agrionidae
			Calopterygidae
			Coenagronidae
			Corduliidae
			Lestidae
			Protoneuridae
		Plecoptera	Capniidae
			Chloroperlidae
			Leuctridae
			Nemouridae
			Perlidae
			Perlodidae
			Peltoperlidae
			Pteronarcyidae
			Taeniopterygidae
		Orthoptera	Tettigoniidae
		Trichoptera	Brachycentridae
			Glossosomatidae
			Helicopsycidae
			Hydropsychidae
			Hydroptilidae
			Lepidostomatidae
			Leptoceridae
			Limnephilidae
			Molannidae
			Odontoceridae
			Philopotamidae
			Phryganeidae
			Polycentropodidae
			Psychomyiidae
			Rhyacophilidae
			Sericostomatidae
		Neuroptera	Sisyridae
Mollusca	Gastropoda	Basomnatophora	"limpets"
			Ancylidae
			Lymnacidae
			Physidae
			Planorbidae
		Mesogastropoda	Viviparidae
	Pelecypoda		Spheridae
Arachnoidea		"Hydracarina"	

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[1] Super family