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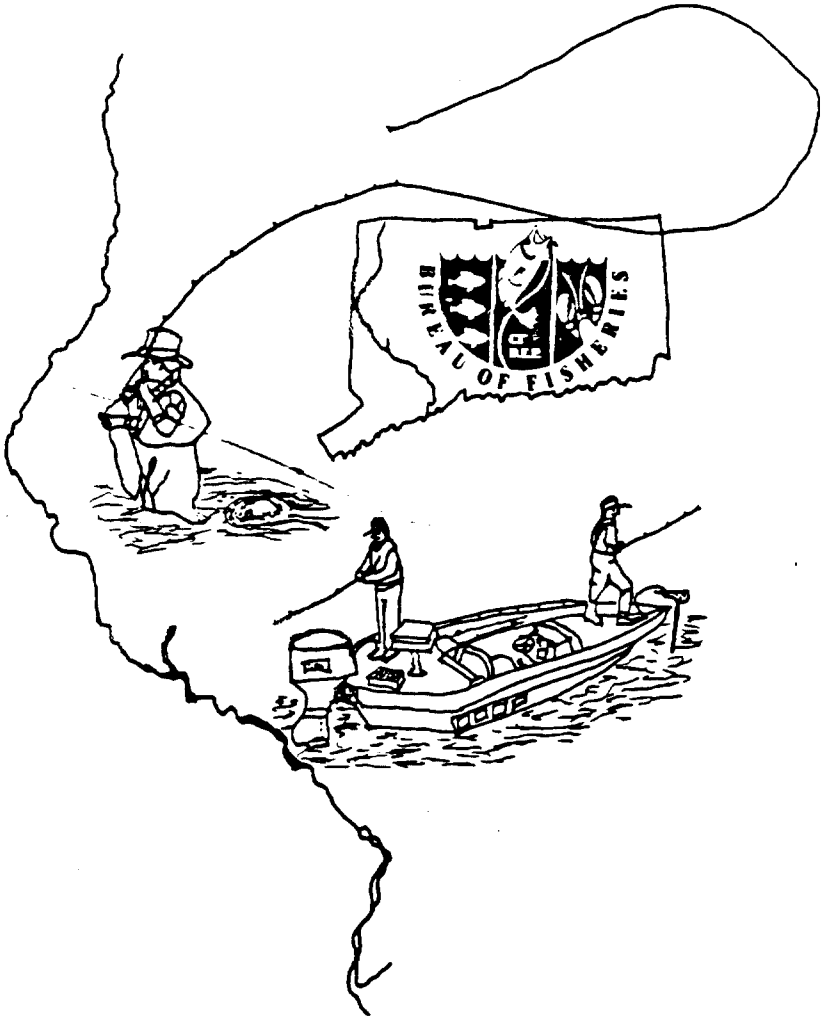
A CREEL AND ECONOMIC SURVEY OF THE HOUSATONIC RIVER



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STATE OF CONNECTICUT

Department of Environmental Protection

Bureau of Fisheries

Final Report

Project Title: **An Angler Survey and Economic Study of the Housatonic River Fishery Resource.**

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Prepared by: Timothy Barry, Project Leader

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Approved by: _____

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ABSTRACT

An estimated 33,022 Angler Days (95% C.I. ±12%) were spent fishing the Housatonic River annually. Trout fishing, predominantly in Section 2 (Trout Management Area), accounted for 12,344 of the total angler days (37%). Bait fishing accounted for 42.3% of the total fishing effort followed by flyfishing and lure fishing which made up 30.7% and 27.1%, respectively. Nonresidents contributed 9% of the total effort with flyfishing, in Section 2, being the most popular method and area for these anglers.

Anglers caught an estimated 244,942 fish (95% C.I. ±24%) from the Housatonic River annually. The catch was dominated by miscellaneous panfish/gamefish which comprised 46.8% of the total catch. Largemouth and smallmouth bass together comprised 36.2% of the overall estimate and trout comprised 17%. The percentage of anglers catching their target species was high, both riverwide and throughout the year.

Estimated gross annual expenditures riverwide were $846,882 (range ±12%) which approximates $25.65 per angler day. Both daily and fixed expenditures showed considerable variation between sections and method of fishing. These expenditures are estimated to have an annual net economic impact of $1,270,323 (range ±21%) on the State of Connecticut. Several different methods were used to derive annual consumer surplus which was estimated at $507,700 (range +61% and -32%). The compensatory value required to compensate anglers for the loss of one year's fishing on the Housatonic River was an estimated $852,185. A capitol investment of $5,802,286 would be necessary to produce a return to the State of Connecticut equal to the primary benefit of fishing on the River.

Riverwide, flyfishermen had the highest average yearly income ($32,868) and baitfishermen the lowest ($23,618). A health advisory against eating fish from the Housatonic River is in effect due to PCB contamination yet, on a riverwide basis 54% of all bait anglers responded that they consumed their catch.

1.0 INTRODUCTION

The Housatonic River (HR) is a picturesque waterway flowing 80 miles through a mixture of rural, and urbanized areas from the Connecticut - Massachusetts border to Long Island Sound (Figure 1). The far upstream areas of the River are located in the foothills of the Berkshire Mountains and the southerly portions flow through heavily urbanized areas of Connecticut. The river supports a variety of agricultural, industrial and recreational activities. Four hydroelectric dams currently are found within the study area. Recreational activities supported by the Housatonic River include fishing, kayaking, canoeing, hunting and hiking, with the Appalachian Trail running along much of the length of the upper river valley. The River is inhabited by a variety of fish species (Table 1), and supports sport fisheries for trout, largemouth bass, smallmouth bass and panfish.

Historically, the Connecticut Department of Environmental Protection (DEP) stocked a seven mile stretch of the River in the Cornwall to West Cornwall area. An average of 17,000 trout were stocked annually. Polychlorinated biphenyls (PCB's) were detected in the River in 1976, and concentrations in fish surpassed the U. S. Food and Drug Administration's health standards (>5 ppm, 1976 standard; changed to >2 ppm in 1984). In 1977 an advisory by the Commissioners of Health Services and Environmental Protection was issued discouraging the consumption of all fish from the HR between the Connecticut - Massachusetts border and the Stevenson Dam. Trout stocking was terminated in 1980 to reduce the potential health hazard from the consumption of fish contaminated by PCB's. In 1981 the DEP Fisheries Bureau began a project evaluating "Catch and Release" fishing within a 15 kilometer area designated as a Trout Management Area (TMA) and some trout stocking was resumed. This area was studied, from 1981 to 1985, and "Catch and Release" fishing was determined to be extremely successful. Catch rates for trout were good (x = 0.77 trout/ hour), fishing pressure was sustained throughout the seasons and total usage increased (Orciari and Phillips 1986). The Housatonic River TMA has recently received much attention in popular, national publications such as Flyfisherman 1986; Sports Afield 1987; Field & Stream 1987.

Information was lacking on other recreational fisheries in the Housatonic River. Much of the river was thought to support a lightly, exploited smallmouth bass population. In addition, two hydroelectric

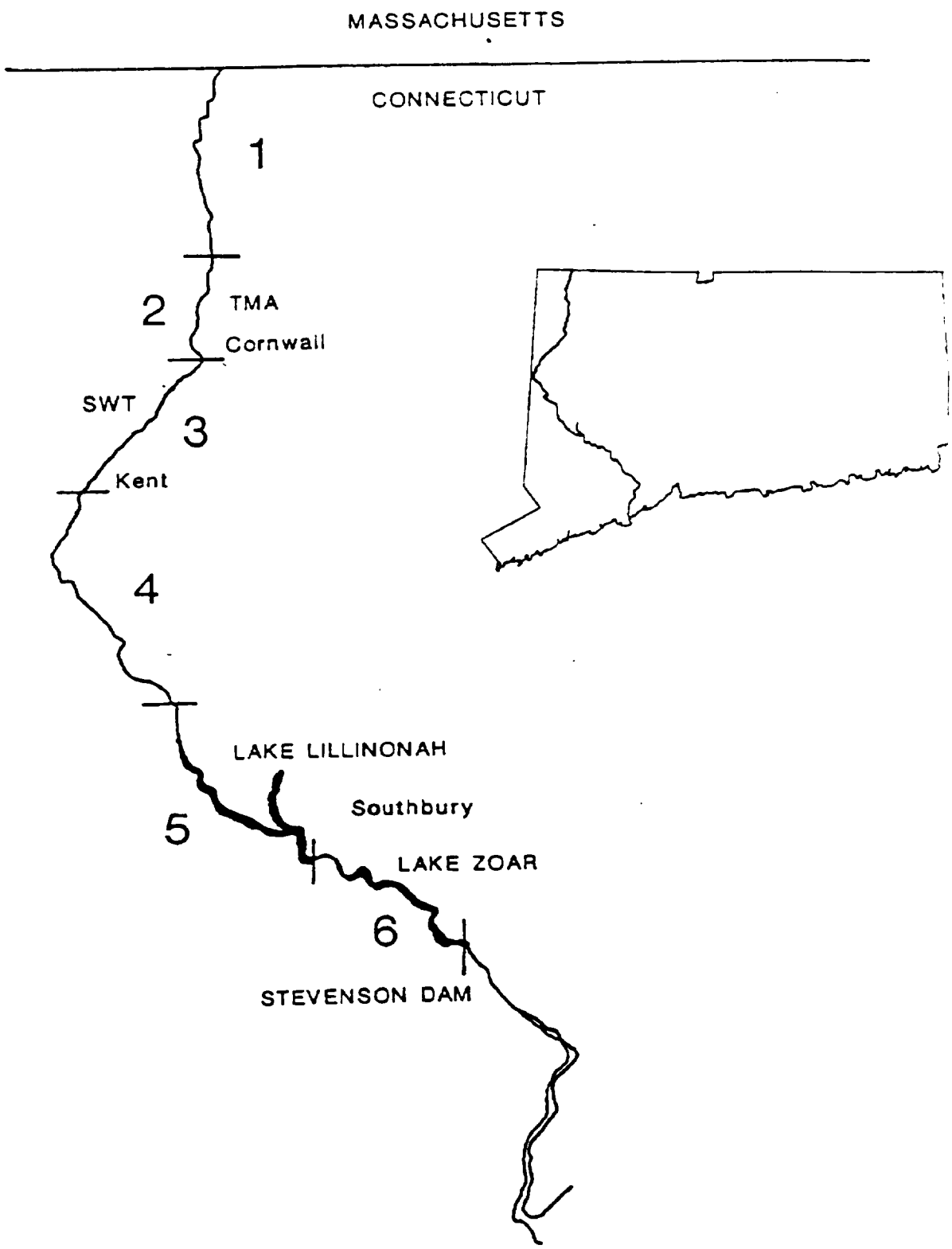

Figure 1. Housatonic River, Connecticut study section location (TMA = Trout Management Area; SWT = Stanley Works Tract).

generating impoundments (Lakes Lillinonah and Zoar) are the sites for a number of bass fishing tournaments each year. Data collected during a stock assessment study of the bass populations in nine Connecticut lakes revealed that largemouth bass were abundant and extremely fast growing (reaching 305 mm before age 3) in Lake Lillinonah (Jacobs et al. 1986). Information on the angler use and economic values associated with these fisheries and the attitudes of HR anglers towards PCB pollution was insufficient.

In the winter of 1984 a survey of anglers in the PCB impacted portion of the river was undertaken to acquire this information. The objectives of the Housatonic River Angler and Economic Survey were to:

1) Estimate the individual and cumulative economic value of the Housatonic River fisheries;

2) Establish a detailed data base for each of the presently existing fisheries;

3) Determine angler attitudes towards PCB contamination.

The methods employed on the Housatonic River Economic and Creel Survey and for the economic analysis were similar to those used on the Farmington River (Hyatt 1986). The economic value for the combined fisheries of the HR is represented by 1) associated total expenditures (daily+fixed expenditures); 2) net economic impact; 3) consumer surplus (as contingent value (CV), alternative recreational option value (AROV) and travel cost method (TCM)); 4) compensatory value; and 5) capitol value of annual consumer surplus. All five components are needed to present a "complete picture" of the total value of angling.

The second objective was to establish a data base for each of the existing fisheries on the HR (Table 2). Effort (angler hours/day), method of fishing (bait, lure, and fly), and number of resident and nonresident anglers were derived. Total catch, catch per hour (CPUE) and angler success (at catching target species) were estimated for a species, or group of species (i.e. bass = largemouth and smallmouth bass; panfish and misc. gamefish = bullhead, catfish, pickerel, pike, etc.) that received significant fishing pressure from HR anglers.

To fulfill the last objective, socioeconomic data (age, income, sex, etc.) were compared to the percentage of anglers eating their catch from the PCB portion of the River, for each section and method of fishing within the section.

2.0 MATERIALS AND METHODS

2.1 ANGLER SURVEY

2.1.1 General Sampling Design

The sampling design and all methods are similar to that described by Hyatt (I986). The survey of the HR anglers began during the winter of 1984 and consisted of a roving census (Malvestuto et al. 1978, Fraidenburg and Bergman 1982) combined with a stratified design (Cochran 1977, Robson 1960).

The River was divided into six sections between the Connecticut - Massachusetts border (Canaan, CT) and the Stevenson Dam (Lake Zoar, Monroe, CT) (Table 2; Figure 1). These divisions represented homogeneous sampling units based upon perceived differences in the type of fishery supported by each section. The sampling period was divided into early spring, spring, summer, fall, late fall, and winter to account for seasonal variations in fishing pressure. A procedure developed by Malvestuto et al. (1978) which incorporated non-uniform probability sampling was used for the winter survey segments in 1984, and early spring, spring, and summer 1985 sample seasons. Probabilities were subsequently assigned to each section within each season (Table 3), the data from the first seasons were used to calculate optimum sample size and allocation for the fall 1985 and all samples thereafter (Appendices 1-5). Within each stratum, subprobabilities were assigned to sampling locations (Table 4). Samples were taken randomly within and among days to further adjust for varying fishing pressure. The sum of the probabilities within each component (day of week, location, time of day) was equal to one.

Depending on the section being sampled, anglers were contacted by a census agent on foot or by two agents working from a canoe or motorboat. Each sample consisted of a total angler count from a stretch of river or the impoundments. Each stretch was between 6.4-8.1 km (4-5 mi.) in length, and was determined to require approximately one hour to complete by canoe or outboard motorboat (on the lakes).

A total count of anglers utilizing Lake Zoar was possible, however, because Lake Lillinonah is much larger, it was impossible to complete the sample within one hour. Therefore, Lake Lillinonah was divided into two subsections so that the data were analyzed as per sections 1-4. Anglers were interviewed (Appendix 6) regarding their

catch, expenses (daily and fixed), economic value of fishing on the HR and decision whether to consume PCB contaminated fish. For additional information, a pre-addressed, postage-paid postcard was given to each angler after the interview (Appendix 7).

Data for individual interviews were transcribed by season onto a Burroughs B25 computer using Microrim Inc., R:base Series 4000 version software program for data storage and retrieval. Data analysis followed the methods of Malvestuto et al. (1980) and Hyatt (1986). To obtain annual effort, catch, expenditures, economic value and percentage of anglers eating fish from the HR, seasonal data were analyzed separately and then summed.

2.1.2 Late Fall, Winter and Early Spring Sampling Design

Much of the methods was modified to accommodate the November to April (late fall, winter, early spring) survey segment. This was necessary because of the overwhelming importance of weather conditions which influenced fishing pressure during these months. The fisheries sampled during these months were: 1) the open water stream fishery during the late fall and early spring (section 2, TMA, Figure 1); and 2) the ice fisheries on Lakes Zoar and Lillinonah. A "fishing day" for the open water fishery was when the maximum air temperature reached 45°F, while an "ice fishing" day was recorded when the ice cover exceeded 3".

2.2 ECONOMIC ANALYSIS

2.2.1 Estimates of Expenditures

Separate estimates of variable and fixed expenditures for resident and nonresident anglers were from the angler information via onstream interviews. Each angler contacted was asked about angling success and variable and fixed costs. All repeat interviews were noted to insure that an individual's fixed expenditures were counted only once per fishing season.

Mean daily expenditures per angler day include round-trip travel costs ($.20 per mile) plus daily expenditures (bait, food, etc.). A fisherman's fixed costs were applied as a proportion to total fishing time allocated to the HR. A survey of local tackle shops and catalogs was conducted and mean costs were determined for each item (reels,

rods, etc.). Costs were then allocated annually to each angler prorated by the percentage of all fishermen purchasing that item each year (U. S. Fish and Wildlife Service-Bureau of Census 1982). The cost of a fishing license was included only when it was established that an angler would not purchase a license if prohibited from fishing the HR. Mean individual fixed costs per fishing season were estimated separately by stream section and method of fishing (bait, lure, fly). Total resident and nonresident expenditures per fishery were estimated separately.

Fixed expenditures for motorboats used by anglers on either lake were determined separately from their expenditures of durable goods. The following methodology was developed to derive those costs. At the time of the interview, individual boat owners were asked to estimate the present dollar value of their craft and the percentage of time that it was used (from their overall fishing time) on the HR. The angler's estimated worth of the craft was multiplied by the percentage use on the HR. Totals, attributable to the HR, were determined for each section, mode of fishing (bait or lure), and season. The seasonal data (spring, summer, and fall) were then summed and an annual total of all anglers' estimated worth of boats, attributable to the HR, calculated.

To accurately determine annual fixed expenditures for motorboats it was necessary to calculate the mean value per motorboat per year. Mean value per motorboat was derived by dividing the annual totals by the number of boats interviewed for each section and fishing mode.

Since no data were available on the life expectancy of a motorboat used for fishing, the average boat value was prorated over an arbitrary 10 year period by dividing the mean value/boat by 10. The actual, average years of ownership produced from the data was 7.58 years at the time of the interview. The average life expectancy of a typical boat used for fishing on the HR would be 17.58 years (10 years prorated value from the time of interview +7.58 years average, actual ownership). This estimate of boat life would prorate the dollar value of the boat over a longer period of time and tend to reduce fixed cost per year. I believe the values produced by this method to be conservative. Due to the lack of information in other economic studies of recreational fisheries, I felt it would be better to underestimate the fixed cost boating values than to overestimate them.

Next, the fixed costs of boats/angler day were estimated by the method of (Hyatt 1986):

$$\text{FC of boats/angler day} = \frac{\text{FC/boat/year}}{\text{20 days (\%)}}, \qquad (1)$$

where: FC of boats/angler day = The mean fixed costs of a boating angler day for each method and river section;
FC/boat/year = As above: 20 days = annual average fishing days/fisherperson (U. S. Fish and Wildlife Service-Bureau of the Census 1982);
% = The average percentage of boat fishing time on each section of the HR.

The total number of boating angler days for each fishing mode in each lake were estimated by multiplying the effort (Angler Days) by the percentage of boat anglers. Annual estimates of the number of fishing boats on each lake for each mode of fishing were determined by dividing annual boating Angler Days by 2, to represent anglers/boat. The actual data indicated an average of 1.62 to 1.95 anglers/boat.

Fixed costs for boat anglers were expanded by multiplying the FC of boats/angler day by the estimated number of boats per section and fishing mode.

The estimates of fixed expenditures for boating anglers on the HR are probably minimum estimates for two reasons. First, due to the 10 year prorated value of a boat as explained above and secondly, the possible underestimation of the actual number of fishing boats. This would be due to the expanding of the number of anglers/boat to 2, when the data produced values of 1.62 to 1.95.

2.2.2 Net Economic Impact

The individual and cumulative value of each fishery was estimated by the income multiplier method of Weithman and Hass (1982):

$$GE \cdot IM = NEI \qquad (2)$$

where: GE = Gross expenditures;
IM = Income multiplier;
NEI = Net economic impact.

Net benefits so derived are the total direct and indirect income from fishing, minus the expenses incurred to import the necessary goods. The income multiplier used in this report was changed from 1.9 (Hyatt, 1984) to 1.5. This change is based on further discussions with economist Joe LeForte (DEP Planning and Development) and William Hyatt (DEP Bureau of Fisheries) and based on their belief that the earlier value was too high. A value of 1.5 was used because income multipliers derived for Connecticut businesses are between 1.5 and 1.7 range (Joe LeForte, personal communication).

2.2.3 Consumer Surplus

The median was used to represent the average response to all consumer surplus and compensatory value questions in the study. "No sale" and "zero" responses were recorded as such, and were incorporated into the study as high ("no sale") and low ("zero") dollar values.

Three different economic indices were used to estimate the consumer surplus associated with fishing the HR. The three indices of consumer surplus were used because of shortfalls or bias associated with each individual approach. The first was a contingent value question in which anglers were asked "How much greater do you think your total expenses for todays trip would have to become before you would have decided not to have gone fishing today?" (Question 19, Appendix 6). Attempts were then made to bid anglers up and down. When adequate numbers of responses allowed the contingent value results were grouped by river section and method of fishing. Seasons were grouped to produce annual median values; only 1986 data were used due to the high number of non-responses in 1985.

The second means of evaluating consumer surplus was an alternative recreational option value (AROV) analysis. Anglers were asked to provide an alternative activity if they could not fish the HR. Expenditures for alternative activities were derived from a previous creel and economic study (Hyatt 1986) and, where necessary, adjusted to present day values. AROV was expressed as:

$$IFE - AE = AROV \quad (\$'s/trip) \qquad (3)$$

where: IFE = Individual Fishing Expenditures;
AE = Alternative Expenditures.

The absolute value of AROV is an estimate of the minimum dollar value of an individual fishing trip. This method was applied only to variable expenditures. An angler's work wages were incorporated into the AROV value only if the respondent specifically stated that he/she had passed up a day of work in order to fish the Housatonic River. Estimates for wage rates were derived by method of fishing from socio-economic data collected during the study (Question 26, Appendix 1). These estimates were based on a 40 hour, 52 week working year (minus federal income and withholding taxes) and the overall average trip length of 4.82 hours. Responses for AROV analysis were then grouped by river section, season and method of fishing to examine attitude differences. The percentage distribution was expanded to include all estimated trips and summed to derive a total. For a more complete description of AROV and contingent value procedures see Hyatt (1986).

The third estimator of consumer surplus was the travel cost method (TCM). The previous two methods involved direct questioning of anglers on their dollar values of fishing and other recreational activities. The TCM is a more indirect method in which information obtained from the survey (i.e., the town from which the anglers traveled and number of people in vehicle) is used. This method can be done in two ways. One of these is to use the number of trips taken annually to a specific recreational site by individuals, traveling from different locations. The other procedure involves using a zonal approach. In this method the number of trips to a site by groups of individuals, traveling from predetermined zones of varying, incremental distances are used. Advantages and disadvantages exist for both methods. A more

complete explanation and overview of the TCM is given by Walsh (1986).

The zonal approach was used in this study because of the concerns expressed by Brown (1983). It is recommended that some value for the "cost of travel time" be incorporated in the TCM. Acceptable values range between 1/2 and 1/3 of an individuals hourly wage rate (Walsh 1986). In this study a value of 1/3 of the hourly wage rate (after taxes) was used. Only river Sections 2, 5 and 6 were analyzed by the TCM since these sections accounted for 85% to 90% of angler effort, and expenditures (variable and fixed). Sections 1, 3 and 4 were not included in this analysis. The TCM data for Sections 1, 3 and 4 were estimated by deriving their average percentage of the totals of AROV and CV estimates and expanding the TCM values.

2.2.4 Compensatory Value

Compensatory value analysis was designed to determine the dollar value required to compensate anglers for any reduction in public fishing recreation on the Housatonic River after 1984. Compensatory values can be legitimately applied only where future losses in fishing opportunities are considered. This value represents the aggregate of the minimum dollar amount anglers would be willing to voluntarily receive to accept a loss, rather than the sum they would be willing to pay (contingent value) (Meyer 1980a and 1980b). Similar to the Farmington River Creel and Economic Survey (Hyatt 1986), two hypothetical questions were asked Housatonic River anglers to determine the compensatory value of fishing both anywhere and, more specifically, the HR (Questions 20 and 21, Appendix 6). Preliminary results from 1985 were believed to be excessively high. In addition, a large number of respondents chose not to answer the questions (20%-45%). The observations of the creel agents and project leader indicated anglers were not fully comprehending the question in its original form. During the 1986 season the questions were reworded. Subsequently, the values appeared more reasonable and the number of non-responses decreased significantly. For this reason data derived from the 1986 compensatory value questions were used and expanded to both years of the study.

2.2.5 Capitalized Value

Capitalized value is equivalent to the money that the State of Connecticut has to invest at the current prime interest rate to obtain

a return equal to the consumer surplus of the fishery (Gordon et al. 1973, Stroud 1981). It is estimated by:

$$C = N/i \qquad (4)$$

where: C = capitalized value;
N = consumer surplus;
i = prime interest rate (8.75% used).

Due to the fluctuation of the prime interest rate, over the last six months, the current rate for the day (12/28/87) was used which can be adjusted up or down.

2.3 ANGLER ATTITUDES TOWARDS PCB CONTAMINATION

2.3.1 Socioeconomic Information

Several questions pertaining to the social and economic status of the Housatonic River anglers were asked (Questions 23, 24, 25 and 26, Appendix 6). The responses were then pooled by river section, fishing method, and season and finally summed by method of fishing on a riverwide basis.

2.3.2 Anglers Consumption of PCB Contaminated Fish

A public health advisory against eating all species of fish from the HR is in effect in the study area because levels of PCB's in fish tissue may exceed FDA maximum allowable limits. Anglers in all river sections were asked to respond to a question whether or not they usually consumed the fish that they caught from the river (Question 22, Appendix 6). Responses were grouped by river section, and method of fishing. Comparisons and possible relationships were tested between the socioeconomic data and responses of whether fish from the HR were consumed.

3.0 RESULTS AND DISCUSSION

3.1 ANGLER SURVEY

3.1.1 Angler Effort

An estimated 33,022 Angler Days (95% C.I. ±12%) were spent fishing the Housatonic River annually. Seventeen percent of all anglers seen and counted during samples were interviewed with long interview forms (Appendix 6). Survey agents conducted approximately 1700 of these interviews. An additional 750 (8%) "repeat anglers" were encountered (anglers who were previously interviewed) and survey agents conducted "short interviews" (catch and effort data) with these fishermen. Seasonal angling pressure was greatest during the spring and decreased thereafter. The degree of precision about the effort estimates varied from ±10% in the spring to a high of ±32% in late fall (Table 5).

Total fishing effort was greatest in Lake Lillinonah (section 5) where 12,097 angler days were spent annually. Section 6 had 6,456 annual angler days. Based on surface area, angler effort was greatest in section 2 with 197 angler days/hectare/year or 10,286 annual angler days (Table 6). Effort estimates in other riverine sections (1, 3, and 4) were low with 8, 16, and 16 angler days/hectare/year, respectively. Fishing effort on the lakes was relatively low, because the surface areas of the lakes were much greater than the riverine surface areas. Sections 5 and 6 had 16 angler days/hectare/year.

The heaviest seasonal fishing pressure occurred in the spring in section 5 with 5,897 angler days (8 angler days/hectare). Heavy fishing pressure was sustained throughout the spring and summer seasons in section 2 (TMA). On a surface area basis (hectares), this section had 74 angler days/hectare for the spring and 68 angler days/hectare for the summer sampling seasons.

Bait fishermen accounted for 41.2% (13,593 angler days) of the total fishing effort and made up the largest overall component. Bait fishing was the predominant method in sections 3, 4, 5, and 6 (Table 7). Flyfishing dominated in sections 1 and 2, accounting for 31% of the total fishing effort (10,121 angler days). In addition, large numbers of lure fishermen were interviewed on Lakes Zoar (31%) and Lillinonah (41%), largely due to their popularity for bass fishing. Nonresidents contributed 9% (2,797 angler days) of the total effort,

and flyfishing contributed 1,939 (65%) of the nonresident angler days.

Trout fishing comprised 12,344 of the total angler days (37%), predominately in the TMA (Table 8). Bass fishing (both smallmouth and largemouth) accounted for 8,845 angler days and fishing for panfish/gamefish (anything, yellow and white perch, sunfish, catfish, etc.) constituted 12,255 angler days. The majority of angling for bass and panfish/gamefish occurred in sections 5 and 6.

During the study design and the scheduling of data collection, highest priority was given to estimation of angling effort, because they were the basis for all subsequent economic analysis. Catch data were given a lower priority since no other analysis depended on catch and a creel survey can not be conducted concurrently in all areas. These priorities are justified by the observed difference in 95% C.I. for angler effort (±12%) and total catch (±24%). A more detailed description of possible sampling biases and steps taken to minimize their effects can be found in Hyatt (1986).

3.1.2 Angler Catch

Anglers caught an estimated 244,942 fish annually (95% C.I. ±24%) fishing the Housatonic River (Table 9). Both total catch (Table 9) and target species (Table 10) varied by stream section and season. Approximately 97,000 fish were caught during the spring and summer seasons. However, the summer catch shifted slightly from trout to bass (Table 11). Overall, the catch was dominated by miscellaneous panfish and gamefish which comprised 48% of the total (95% C.I. ±39%) (Table 11). Largemouth and smallmouth bass together comprised 36% of the overall estimate and trout comprised 17%.

Approximately 41,000 trout are caught annually, mostly from the TMA (section 2) (Tables 10 and 11). Each spring, 9,000 brown trout were stocked in this area. No trout may be creeled in this area due to special "Catch and Release" regulations. These regulations ensure that a substantial number of trout "holdover" from year to year, resulting in an estimated summer population of between 13,000 and 15,000 fish (Orciari and Phillips 1986). The catch data indicate that each trout is caught between 2 and 3 times per year. The trout catch was highest in the spring (Table 11), declining considerably in the summer even though angler effort remained high.

The catch of panfish/gamefish was highest in the summer (Table 11) with the heaviest angling pressure occurring in Sections 5 and 6 (Table 10). Approximately 22,000 panfish/gamefish were caught in sections 5 and 6 during a short-duration icefishing season. Bass (mostly smallmouth) were caught riverwide, making them the most popular of the sportfish (Table 10). The greatest number (43,535) were caught during the summer sampling season (Table 11).

Precision (±34% to ±41%) of the catch estimates remained relatively stable for trout throughout the year (Table 12). The bass catch estimates had the greatest seasonal variability in precision (±10% to ±49%). The data also indicate that many trout fishermen in Section 2 (TMA) catch smallmouth bass as a by-catch throughout the year but more so in the summer when effort is still high and trout catch rates drop (Tables 10, 13 and 14). Panfish/gamefish had precision of catch estimates between ±8 and ±36% (Table 12) and were consistent during spring and summer when their catches were highest (Table 11).

Catch rates for bass were highest in the riverine sections (1-4) except during fall (Table 13). Trout catch rates were highest in stream section 2 (TMA) throughout the year. The large number of trout caught during the spring (19,397) reflects the high catch rate (0.76 fish/hr.) for that season (Table 13). Interestingly, the lowest catches of trout occurred in the summer (0.44 fish/hr.) when effort for this species remained high. Catch rates for target species were good and could support even greater levels of angling pressure, especially for smallmouth bass in the riverine sections and panfish/gamefish in the two lakes.

Trout were the major gamefish caught in section 2, while miscellaneous game and panfish dominated in sections 5 and 6 (Table 14). Because smallmouth bass were abundant riverwide (Table 14), bass were well represented in the total catch data from all sections and seasons. The percentage of anglers catching their target species was high throughout the entire year (Table 15). This appears to be due to the high productivity of the Housatonic River.

3.2 ECONOMIC ANALYSIS

3.2.1 Expenditures and Net Economic Impact

Housatonic River anglers spent $538,574 (±12%) annually, $16.31 per Angler Day, for out-of-pocket (i.e. variable) expenditures (Table 16). Average variable expenditures differed considerably among study sections and ranged from a high of $22.69 in Section 2 to $12.21 in section 6.

The amount of variable expenditures by stream section differed from that of angler effort. Section 2 accounted for 31% of all angling effort, but 43.3% of the variable expenditures. Conversely, section 5 provided 36% of the total angling effort and 27.9% of the variable expenses, whereas section 6 comprised 20% of total effort and 14.7% of variable expenditures. One notable difference was that flyfishermen constituted only 31% of the total effort but 43.8% of the total variable expenditures, while bait and lure fishermen made up a greater percentage of the total angler effort but attributed lower total variable expenditures (Table 17). This would indicate that flyfishermen are more willing to incur high daily expenditures to pursue the "Catch and Release" experience, provided by the HR TMA, than anglers employing other methods and fishing other areas of the River. Therefore, the method of fishing is of considerable importance for an accurate description of expenditures, but angler effort by section is not a good indicator of these same expenditures.

Nonresident anglers produced 9.4% of the total effort and 21.9% of all variable expenses. This is primarily due to the dollars spent by nonresident flyfishermen in the HR TMA. The results indicate that these anglers think that this area provides a "quality" experience and are willing to spend the money to travel to fish there. These results also indicate that though these anglers are not a major component of the angling effort on the HR, they are contributing to the State economy in pursuit of recreational activities.

Annual fixed expenditures for the HR were $308,308 (±12%) and averaged $9.34 per Angler Day (Table 18). The distribution of fixed expenditures by stream section also differed from that of angler effort but not as markedly as with variable expenditures (Table 18). The distributions differed most notably in section 2.

The most dramatic difference between the distribution of fixed

expenditures and effort is evident when the two are compared by method of fishing (Table 19). Lure fishermen, especially those in sections 5 and 6, accounted for a much greater share of the total fixed expenses (52.1%) than of the total angler effort (27.1%). Flyfishermen, to a lesser degree, demonstrated this same trend. This is due to the greater equipment costs for lure fishermen on the lakes i.e., boats, and flyfishermen in the TMA i.e., waders, vests, etc.

The gross annual expenditures on the Housatonic were $846,882 (range ±12%) which equals approximately $25.65 per angler day. These expenditures represent a net economic impact of $1,270,323 (range ±12%) on the State of Connecticut (Table 26).

3.2.2 Consumer Surplus

Consumer surplus, an estimate or measure of net benefits in excess of expenditures (Langeford and Cocheba 1978), was estimated at $507,700/year (Table 20). The range ($819,000 +61%)-($344,000 -32%), is a general index of how willing anglers are to pay for recreational fishing on the HR. The consumer surplus was estimated by employing 3 different methods, contingent value (CV), alternative recreational option value (AROV), and travel cost method (TCM). The estimates of all three methods were summed and averaged for an overall estimate of consumer surplus (Table 20). The contingent value estimate (Table 21) produced a higher value of consumer surplus and its high range was used as the upper bounds. The Travel Cost Method gave a lower estimate (Table 22), so its lower range represented the lower bounds of the consumer surplus estimate. Using the CV upper bounds and the TCM lower bounds for the consumer surplus estimate accounts for the imbalance in the range (upper +61% and lower -32%). Although the consumer surplus estimate by the AROV method (Table 23) was contained within the upper/lower range, the values produced by this method closely approximated the TCM estimates (Table 20).

The second most popular alternative recreational activity among HR anglers was fishing elsewhere (Appendix 9). The TCM estimate was based on the three river sections that dominated the total effort and expenditures. It was then expanded to include the three remaining river sections.

3.2.3 Compensatory Value

The compensatory value of fishing the Housatonic River was estimated to be $852,185 ±12% (Table 24). This would be the dollar value necessary to compensate anglers for not being allowed to fish the HR for one year. The dollar amount necessary to compensate HR anglers for the loss of all fishing opportunities for one year is higher. It is estimated to be $2,516,675 (Table 25). Because the first value represents 34% of the total value of fishing, it indicates that anglers put a high value on this fishery. The compensatory value of fishing the Housatonic River is greater than the estimate of consumer surplus ($852,185 vs $507,700). These estimates appear to be reasonable based on values from other studies (Hyatt 1986, Langeford and Cocheba 1978). These results also indicate that anglers perceived the difference between what they would be willing to pay for a days fishing provided they could do so whenever they wished (CV question for consumer surplus estimate), and the loss of the option to go fishing, in either a particular site (in this case the HR) or anywhere (compensatory value questions).

3.2.4 Capitalized Value

Capitalized value is the dollar amount the State of Connecticut would have to invest to obtain an annual yield equal to the consumer surplus generated by Housatonic River fisheries. That amount equals $5,802,286 +61% and -32% (Table 26). The upper and lower bounds of the consumer surplus estimates were used to set the range for capitalized value.

3.2.5 Economic Summary

A complete economic summary of the fishery resource of the Housatonic River is presented in Table 26. To present a more complete and accurate economic analysis, a variety of economic valuation techniques were used. This was particularly true with consumer surplus due to the shortfalls or bias associated with each approach. The net economic impact of all expenditures for the HR, plus consumer surplus, is equal to the economic value of fishing which was $1,856,323 in 1986. If these fisheries were to be terminated, then $846,882 of the annual expenditures would be redistributed and $852,185 of recreational value (compensatory value) would be lost annually.

3.2.6 Benefit Cost Analysis of the TMA

A benefit/cost analysis is possible for the TMA since it is the only area of the Housatonic River where Connecticut DEP stocks trout. "Catch & Release" fishing in the TMA allows many trout to be caught repeatedly and to survive beyond one year (Orciari and Phillips 1986). The Bureau of Fisheries stocks approximately 3,000 adult trout (9"-12" length, 2.2-2.4 fish to the pound) and 6,000 fingerling trout (6"-8" length, 4.0-5.0 fish to the pound) annually in the HR. The cost to the State is approximately $5,400 annually at a cost of $2.15 per pound of trout produced in 1986. The annual consumer surplus from this section of the river is between $252,030 (CV approach, Table 21) and $173,558 (AROV approach, Table 22). Therefore, the trout fishery in the Housatonic River TMA has a benefit/cost ratio of between $32 and $47 to $1. The fishery in this section also generates approximately 41% ($346,000) of the total annual expenditures and 42% ($534,000) of the net economic impact for the entire HR. The results indicate that Trout Management Areas where "Catch and Release" fishing is regulated can be both cost effective and publicly attractive.

3.2.7 Comparison to Farmington River Creel and Economic Survey

Similar methods were used to conduct both the Farmington River (FR) and Housatonic River Creel and Economic Surveys. The results of each study show clearly that the two river systems support very different fisheries (i.e. "Put and Take" trout fishery on the FR vs "Catch and Release" Trout Management Area on the HR; important bass fishery on the HR not found on the FR; seasonal American shad fishery on the FR not found on the HR). In addition, the rivers flow through areas of the State having different demographic characteristics. The entire Farmington River is located close to the greater Hartford metropolitan area, while approximately half of the Housatonic River is located in northwestern Connecticut (sections 1, 2 and 3) which is somewhat removed from the more heavily urbanized areas of the State. The downstream portion of the Housatonic however, (sections 4, 5 and 6) flows near many of the heavily populated and affluent areas located in the southwestern portion of Connecticut. Thus, it is reasonable to assume that sociological and economic factors differ between the two fisheries.

The FR received more Angler Days annually than the HR with 45,726

and 33,022 Angler Days, respectively (Table 26 and 27). The higher effort in the FR may be partially attributable to its' close proximity to heavily populated areas and to the large number of trout (40,000) stocked annually (Hyatt 1986). In addition, the FR has a longer area of river which is managed for trout fishing than the Housatonic River TMA. Nevertheless, the fisheries of the HR appear to be more economically valuable compared with those of the FR (Tables 26 and 27). The 15 km of Housatonic River TMA alone, (Section 2, Table 6) accounted for 31% of the total angler effort. The majority of anglers fishing the TMA and upper portions of the Housatonic River came from New Haven and Fairfield counties (Figure 2) and have to travel farther to reach the river, which equates to greater variable expenditures. Expenditures allocated to travel on the Housatonic River TMA averaged $13.61 per Angler Day (Table 16) whereas the same expenditures on the FR only averaged $3.77. This explains much of the difference in average variable expenditures between the Housatonic (average variable expenditures = $16.31/day) and the Farmington Rivers (average variable expenditures = $6.73/day).

Differences between the economic values of the two rivers are also related to varying fixed expenditures. Lakes Zoar and Lillinonah support a much greater number of total Angler Days (18,553 annually) compared to Rainbow Reservoir, the single impoundment studied on the FR (3,370 Hyatt 1986). The lake fisheries generated 58.5% of the total fixed expenditures on the HR (Table 18), but only 8% on the FR. Average fixed expenditures equaled $9.34/angler day on the Housatonic and $2.45/angler day on the Farmington River.

Net economic impact will automatically be higher on the Housatonic ($1,270,323) as compared to the Farmington River ($629,758) because the value is based upon total expenditures (Tables 26 and 27). All other economic values between the two rivers appear to be reasonable, based on individually associated expenditures and the subsequent dollar values that anglers attribute to the fishing opportunities in these rivers.

The remaining significant socioeconomic differences between the two rivers pertain to the value the anglers attribute to the fisheries above and beyond expenses (i.e. consumer surplus and compensatory value). Both of these values are much greater for the HR fisheries, which is obvious when one looks at the two rivers' trout fisheries (median

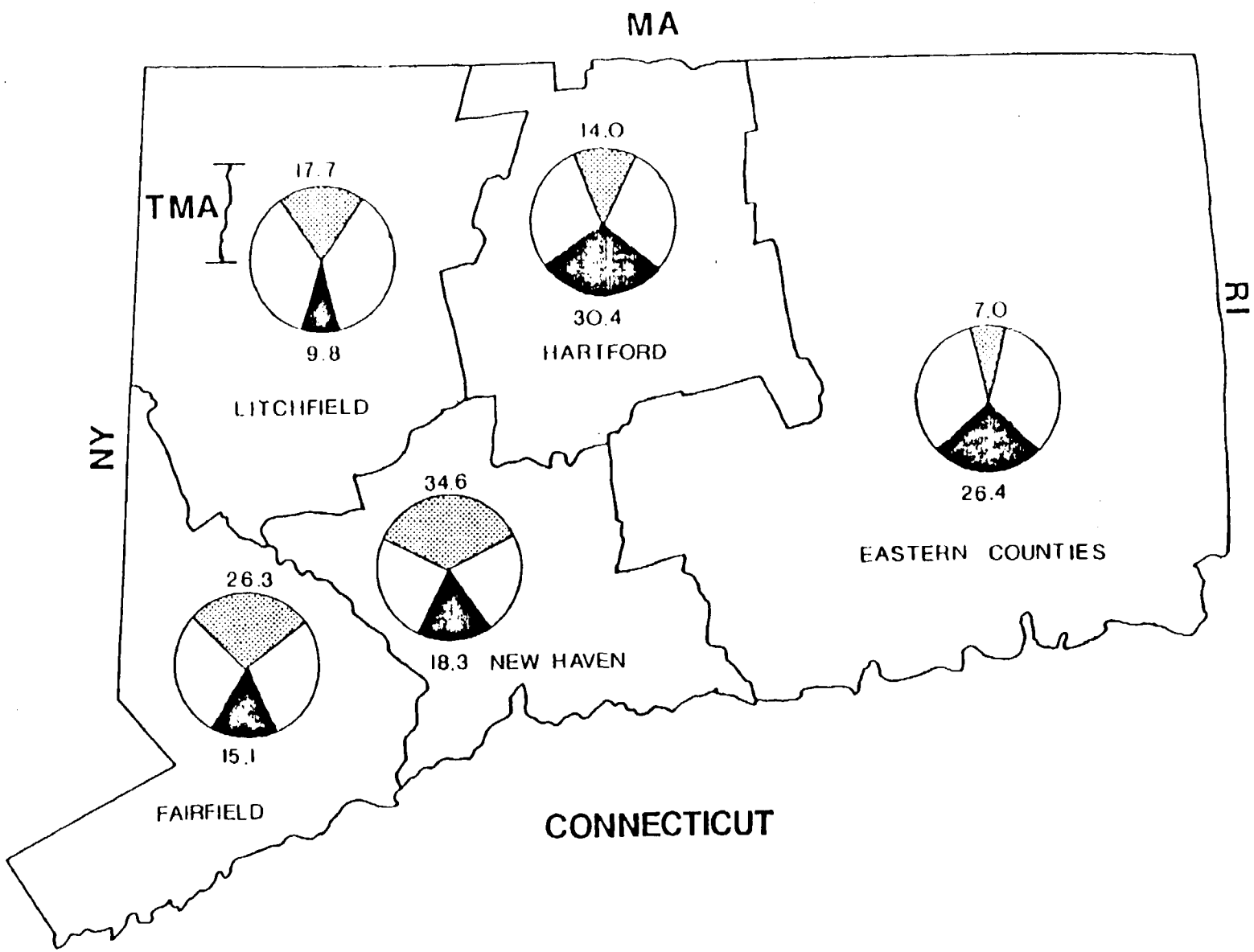

Figure 2. Percentage origin of individual anglers on the Housatonic River TMA (stippled) and percentages of license holders (solid) from Connecticut counties. (License percentages taken from Moulton 1975 and Orciari and Phillips 1986).

CV for HR approximately $22.00/Angler Day; median CV for FR approximately $7.00/Angler Day).

There are two likely explanations for these observed differences. First, the HR offers a "Catch and Release" trout fishing experience that is unique in Connecticut. The river provides anglers with an opportunity to fish for an abundance of large, "holdover" trout. It is logical that anglers would value fishing on the Housatonic River TMA more than they would on one of the State's many "Put and Take" streams. Secondly, since the majority of the HR is not close to any densely populated (by Connecticut standards) areas, many of the anglers who make the effort to fish the river have already made a substantial commitment of both time and money. By contrast, a significant portion of the FR users are local, "spur of the moment" anglers (Hyatt 1986). Anglers who make such a commitment are more likely to place a higher value on the experience. Additionally, a greater percentage of these committed anglers are likely to be able and willing to "pay more" for a fishing trip (Table 28).

3.3 ANGLER ATTITUDES TOWARDS PCB CONTAMINATION

There was an increasing percentage of bait fishermen eating their catch from section 2 through section 6 (Table 29). The largest percentage and numbers of anglers eating fish from the Housatonic River were bait fishermen on Lakes Zoar and Lillinonah. Only 19% of lure fishermen and 4% of fly anglers consumed fish from the HR. On a river-wide basis, bait fishermen earn the lowest average annual income ($23,618, Table 28), but consume a higher percentage of their catch from the Housatonic River (54%, Table 29).

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Table 1. Fish species inhabiting the freshwater areas of the Housatonic River, CT (Whitworth et al. 1968).

Family	Common Name	Scientific. Name	Origin[a]
Amiidae	bowfin	*Amia calva*	I
Anguillidae	American eel	*Anguilla rostrata*	N
Clupeidae	alewife	*Alosa pseudoharengus*	N
Salmonidae	brown trout	*Salmo trutta*	I
	rainbow trout	*Salmo gairdneri*	I
	brook trout	*Salvelinus fontinalis*	N
Esocidae	northern pike	*Esox lucius*	N
	chain pickerel	*Esox niger*	N
Cyprinidae	goldfish	*Carassius auratus*	I
	carp	*Cyprinus carpio*	I
	cutlips minnow	*Exoglossum maxillingua*	I
	golden shiner	*Notemigonus crysoleucas*	I
	bridled shiner	*Notropis bifrenatus*	N
	common shiner	*Notropis cornutus*	N
	spottail shiner	*Notropis hudsonius*	N
	blacknose dace	*Rhinichthys atratulus*	N
	longnose dace	*Rhinichthys cataractae*	N
	creek chub	*Semotilus atromaculatus*	N
	fallfish	*Semotilus corporalis*	N
Catostomidae	white sucker	*Catostomus commersoni*	N
	creek chubsucker	*Erimyzon oblongus*	N
Ictaluridae	white catfish	*Ictalurus catus*	I
	brown bullhead	*Ictalurus nebulosus*	N
	black bullhead	*Ictalurus melas*	I
Cyprinodontidae	banded killifish	*Fundulus diaphanus*	N
Percichthyidae	white perch	*Morone americana*	N
	striped bass	*Morone saxatilis*	N
Centrarchidae	rock bass	*Ambloplites rupestris*	I
	redbreast	*Lepomis auritus*	N
	pumkinseed	*Lepomis gibbosus*	N
	bluegill	*Lepomis macrochirus*	I
	smallmouth bass	*Micropterus dolomieui*	I
	largemouth bass	*Micropterus salmoides*	I
	black crappie	*Pomoxis nigromaculatus*	I
Percidae	tessellated darter	*Etheostoma olmstedi*	N
	yellow perch	*Perca flavescens*	N
	walleye	*Stizostedion vitreum*	I

[a] Native or Introduced

Table 2. Housatonic River study section location and primary fisheries found within.

Section	Location	Length (km)	Fishery
1 (Falls Village Pool)	CT/MA border-Rt. 7 bridge	16.17	trout, smallmouth bass
2 (TMA)[a]	Rt. 7 bridge-Rt. 4 bridge	16.00	trout, smallmouth bass
3 (Stanley Works Tract)	Rt. 4 bridge-Rt. 341 (Kent)	13.33	trout, smallmouth bass
4 (Gaylordsville)	Rt. 341 bridge New Milford	26.17	panfish, smallmouth bass, misc. gamefish
5 (Lake Lillinonah)	New Milford-Shepaug Dam	27.83	largemouth & smallmouth bass, panfish/gamefish
6 (Lake Zoar)	Shepaug Dam Stevenson Dam	17.67	largemouth & smallmouth bass, panfish/gamefish

[a] Trout Management Area

Table 3. Strata (location, time of week, time of day) with assigned probabilities used in sample allocation (Sp. = spring, Su. = summer, Fa. = fall, are survey segments).

Stratum	River Section	Probabilities Sp.	Su.	Fa.	Time of Week	Prob.	Time of Day	Prob.
N1	1	.05	.05	.05	W[a]	.60	AM-PM[c]	.50
N2					W		PM[d]	.50
N3					WH[b]	.40	AM+PM[e]	1.00
N4	2	.30	.35	.35	W	.60	AM-PM	.50
N5					W		PM	.50
N6					WH	.40	AM+PM	1.00
N7	3	.05	.05	.05	W	.60	AM-PM	.50
N8					W		PM	.50
N9					WH	.40	AM+PM	1.00
N10	4	.10	.10	.15	W	.60	AM-PM	.50
N11					W		PM	.50
N12					WH	.40	AM+PM	1.00
N13	5	.30	.25	.25	W	.60	AM-PM	.50
N14					W		PM	.50
N15					WH	.40	AM+PM	1.00
N16	6	.20	.20	.15	W	.60	AM-PM	.50
N17					W		PM	.50
N18					WH	.40	AM+PM	1.00

[a] Weekday [b] Weekday/holiday [c] Sunrise till 3:00 PM [d] 3:00 PM till Sunset [e] Sunrise till Sunset

Table 4. Assigned probilities for sampling locations and time which were used in the Housatonic River study 1984-1986.

River Section	Sampling Location	Probabilities	Probability of Selecting Each Hour AM-PM 8hrs[a]	PM 3hrs[b]	AM+PM 11hrs[c]
1	1	.25	.125	.33	.09
	2	.25			
	3	.25			
	4	.25			
2	1	.50	- ALL SAME AS ABOVE -		
	2	.50			
3	1	.50			
	2	.50			
4	1	.25			
	2	.25			
	3	.25			
	4	.25			
5	1	.50			
	2	.50			
6	1	1.00			

[a] Fall hours shown, Spring = 9 hrs., Summer = 9 hrs.
[b] Fall hours shown, Spring = 4 hrs., Summer = 6 hrs.
[c] Fall hours shown, Spring = 13 hrs., Summer = 15 hrs.

Table 5. Estimated annual angling effort and precision for the Housatonic River.

Season	Angler Days	95% C.I.	Percentage of Total	Range Low	Range High
Winter (ice)	1,168	± 12.7%	3.6%	1,016	1,320
Early Spring	840	± 18.6%	2.6%	697	983
Spring	14,315	± 10.0%	43.7%	12,884	15,747
Summer	11,831	± 10.6%	35.2%	10,530	13,132
Fall	4,410	± 15.2%	13.5%	3,749	5,072
Late Fall	458	± 31.8%	1.4%	311	605
TOTAL	33,022	± 11.6%	100.0%	29,185	36,859

Table 6. Distribution of annual fishing effort by section.

Section	Number of Angler Days	Precentage of total	Surface Area(ha.)	Approx. angler days/ha./yr.
1	975	3%	125.9	7.74
2	10,286	31%	52.2	197.05
3	1,318	4%	77.9	16.92
4	1,890	6%	138.3	13.67
5	12,097	36%	768.9	15.73
6	6,456	20%	411.9	15.67
All	33,022	100%	1,572.2	21.00

Table 7. Distribution of angler days by fishing method and section.

Section	RESIDENTS Bait	RESIDENTS Lure	RESIDENTS Fly	NONRESIDENTS Bait	NONRESIDENTS Lure	NONRESIDENTS Fly
1	316 (32.4%)	139 (14.3%)	344 (35.3%)			176 (18.0%)
2	656 (6.4%)	332 (3.2%)	7,582 (73.7%)	4	16 (0.2%)	1,696 (16.5%)
3	564 (42.8%)	357 (27.1%)	232 (17.6%)	122 (9.3%)	43 (3.2%)	
4	1,289 (68.2%)	373 (19.7%)	91 (4.8%)	137 (7.3%)		
5	6,509 (53.8%)	4,904 (40.5%)		80 (0.7%)	604 (5.0%)	
6	4,259 (66.0%)	1,978 (30.6%)		28 (0.4%)	191 (3.0%)	
ALL	13,593 (41.2%)	8,083 (24.5%)	8,249 (25.0%)	71 (1.1%)	854 (2.6%)	1,872 (5.7%)

Table 8. Distribution of fishing effort as angler days by target species, Housatonic River.

Target Species	Angler Days (Annual)	Percentage of Total
Trout	12,344	37%
Bass (Largemouth & Smallmouth)	8,845	27%
Panfish/Gamefish	12,255	36%
TOTALS	33,444	100%

Table 9. Seasonal total catch estimates and precision for the Housatonic River.

Season	Total Catch	95% C.I.	Range Low	Range High
Winter (ice)	21,756	±26.8%	15,925	27,586
Early Spring	2,287	±36.7%	1,448	3,127
Spring	97,256	±22.0%	75,860	118,653
Summer	97,234	±24.6%	73,314	121,153
Fall	25,971	±25.3%	19,400	32,543
Late Fall	438	±31.3%	301	575
TOTAL	244,942	±24.0%	186,248	303,637

Table 10. Percentage of anglers fishing for specific target species by section on the Housatonic River.

Section	Target Species Trout	Bass	Misc. Panfish/Gamefish
1	46.3%	35.7%	
2	94.5%	5.1%	0.4%
3	38.3%	57.4%	4.3%
4	5.6%	46.3%	48.2%
5		50.5%	49.5%
6		47.6%	52.4%
TOTAL	33%	35%	32%

Table 11. Annual total catch by species and season, % of total catch and precision (95% C.I.) for the Housatonic River.

Season	Trout	Bass	Panfish/Gamefish
Winter (ice)			21,756
Early Spring	2,287		
Spring	19,397	35,470	42,389
Summer	10,509	43,535	43,190
Fall	8,261	8,760	8,950
Late Fall	438		
TOTAL	40,892	87,765	116,285
% of Total Catch	17%	36%	48%
95% C.I.	±36%	±27%	±39%

Table 12. Precision in seasonal catch estimates for Housatonic River species.

Season	Statistic	Species: Trout	Bass	Panfish/Gamefish
Winter	C.I.			±18%
Early Spring	C.I.	±37%		
Spring	C.I.	±34%	±40%	±36%
Summer	C.I.	±37%	±49%	±36%
Fall	C.I.	±41%	±10%	± 8%
Late Fall	C.I.	±36%		
Winter	RSE			±14%
Early Spring	RSE	±18%		
Spring	RSE	±17%	±12%	±21%
Summer	RSE	±19%	±14%	±21%
Fall	RSE	±20%	±18%	±20%
Late Fall	RSE	±17%		

C.I. = 95% confidence interval RSE = relative standard error

Table 13. Catch rates for Housatonic River fish species.

Season	Section	Catch per Hour: Target	Trout	Bass	All Species Combined
Winter	5	4.41			4.41
	6	3.66			3.66
Early Spring	2	0.79	0.79		0.79
Spring	1	0.14	0.14		0.14
	2	0.80	0.76	0.97	1.02
	3	1.26	0.38	2.18	1.70
	4	1.21		1.79	1.28
	5	0.73		0.60	1.33
	6	0.39		0.48	0.47
Summer	1	3.45	1.08	7.53	4.04
	2	0.51	0.44	2.48	0.99
	3	2.82		2.90	2.87
	4	0.86		0.86	1.04
	5	1.21		1.14	1.75
	6	0.81		0.50	1.02
Fall	1	0.20		0.40	0.59
	2	0.91	0.89	1.37	1.21
	3	0.31	0.22	0.40	0.36
	4	0.92		0.20	0.95
	5	1.06		1.18	1.62
	6	0.68		0.67	0.87
Late Fall	2	0.85	0.85		0.85

Table 14. Percentage of total catch by section and season for the Housatonic River.

Season	Target Species	Sections 1	2	3	4	5	6
Spring	Trout	100%	82%	9%			
	Bass	18%	91%	55%	39%	33%	
	Panfish/Gamefish				45%	61%	67%
Summer	Trout	24%	39%				
	Bass	76%	61%	100%	43%	31%	23%
	Panfish/Gamefish				57%	69%	77%
Fall	Trout	33%	69%	14%			
	Bass	67%	31%	86%	12%	36%	50%
	Panfish/Gamefish				88%	64%	50%

Table 15. Percentage of Housatonic River anglers catching their target species or miscellaneous panfish/gamefish (based on incomplete trip interviews).

Season	Section	Percentage Catching Target Species	Miscellaneous Panfish/Gamefish
Winter	5	67%	
	6	80%	
Early Spring	2	33%	7%
Spring	1	11%	11%
	2	46%	4%
	3	61%	11%
	4	35%	24%
	5	57%	16%
	6	55%	5%
Summer	1	60%	20%
	2	38%	13%
	3	73%	9%
	4	44%	17%
	5	65%	9%
	6	49%	10%
Fall	1	50%	50%
	2	42%	11%
	3	46%	18%
	4	46%	
	5	60%	8%
	6	47%	7%
Late Fall	2	50%	4%

Table 16. Variable expenditures (VE) by anglers fishing six sections of the Housatonic River and % of total angler effort per section in ( ).

Section	Total Annual $	% of Total VE (% of Total Effort)	Mean $ per Angler Day	% Allocated to Travel Res.	NonRes.
1	$ 21,050	3.9% (3.9%)	$21.59	57%	32%
2	233,376	43.3% (31.0%)	22.69	60%	58%
3	26,275	4.9% (4.0%)	19.94	43%	70%
4	28,760	5.3% (6.0%)	15.22	47%	93%
5	150,230	27.9% (36.0%)	12.42	53%	71%
6	78,884	14.7% (20.0%)	12.21	59%	36%
All	$538,574	100.0%	$16.31	56%	58%

Table 17. Distribution of annual and (daily) variable expenditures of Housatonic River anglers and % of total angler effort by method of fishing.

Section	RESIDENTS Bait	Lure	Fly	NON-RESIDENTS Bait	Lure	Fly
1	$ 5,410 (17.12)	$ 1,174 (3.45)	$ 9,233 (26.84)			$ 333 (29.73)
2	$ 11,058 (16.86)	$ 4,844 (14.59)	$141,372 (18.65)	$ 51 (12.70)	$ 174 (10.88)	$75,877 (18.65)
3	$ 11,018 (19.54)	$ 6,242 (17.48)	$ 2,624 (11.31)	$4,920 (40.33)	$ 1,471 (34.20)	
4	$ 19,748 (15.32)	$ 5,490 (14.72)	$ 1,431 (15.73)	$2,091 (15.26)		
5	$ 76,584 (11.77)	$55,352 (11.29)		$ 931 (11.63)	$17,363 (28.75)	
6	$ 46,602 (10.94)	$22,633 (11.44)		$ 761 (27.16)	$ 8.888 (46.54)	
TOTAL (X/day)	$171,420 (12.54)	$95,734 (11.84)	$154,660 (18.75)	$8,754 (23.60)	$27,896 (32.66)	$81,110 (43.33)
% of Total Var. Exp.	31.6%	17.8%	28.7%	1.6%	5.2%	15.1%
% of Angler Effort	41.2%	24.5%	25.0%	1.1%	2.6%	5.7%

Table 18. Fixed expenditures made by anglers fishing sections of the Housatonic River and % of total angler effort per section in ( ).

Section	Total Annual $	% of Total (% of Total Effort)	$/Angler Day
1	$ 5,932	1.9% (3.0%)	$ 6.08
2	112,855	36.6% (31.0%)	10.97
3	5,918	1.9% (4.0%)	4.49
4	3,083	1.0% (6.0%)	1.63
5	45,981	39.0% (36.0%)	9.94
*Boat	74,310		
6	22,636	19.5% (20.0%)	9.33
*Boat	37,593		
All	$308,308	100.0%	$9.34

* Boating expenditures based on 1986 data and derived separately from equipment costs (rods, reels, etc.)

Table 19. Distribution of annual and (daily) fixed expenditures by Housatonic River anglers, and % of total angler effort by method of fishing.

Section	RESIDENTS Bait	RESIDENTS Lure	RESIDENTS Fly	NONRESIDENTS Bait	NONRESIDENTS Lure	NONRESIDENTS Fly
1	$224 (0.71)	$1,779 (12.00)	$1,795 (5.22)			$2,133 (12.12)
2	$892 (1.36)	$1,816 (5.47)	$88,785 (11.71)	$5 (1.21)	$38 (2.40)	$21,318 (12.57)
3	$1,218 (2.16)	$888 (2.49)	$3,250 (14.01)	$154 (1.27)	$405 (9.43)	
4	$1,224 (0.95)	$1,257 (3.37)	$475 (5.22)	$126 (0.92)		
5	$8,461 (1.30)	$30,453 (6.21)		$131 (1.64)	$6,933 (11.48)	
BOAT	$8,688 (12.22)	$65,822 (23.47)				
6	$6,260 (1.47)	$35,903 (23.47)				
BOAT	$2,362 (11.09)	$35,231 (34.71)				
EQUIPMENT TOTAL (X/day)	$18,282 (1.35)	$52,098 (6.44)	$94,306 (11.43)	$431 (1.16)	$7,836 (9.18)	$23,452 (12.53)
BOAT TOTAL (X/day)	$11,050 (6.34)	$100,853 (13.97)				
% of Total Fixed Exp.	9.5%	49.6%	30.6%	0.1%	2.5%	7.6%
% of Angler Effort	41.2%	24.5%	25.0%	1.1%	2.6%	5.7%

Table 20. Consumer surplus for fishing the Housatonic River as determined from contingent value (CV), alternative recreation option value, (AROV) and travel cost method (TCM) estimates.

Estimate	Lower Bounds	Point Estimate	Upper Bounds
CV	$643,232	$730,945	$818,658
AROV	$353,384	$401,573	$449,762
TCM	$343,654	$390,516	$437,378
Consumer Surplus	$344,000	**$507,700**	$819,000

Table 21. Contingent value (CV) of fishing the Housatonic River.

Section	Method of Fishing	Median Bid* (Annual)	Angler Days	Total $
1	All	$20	975	$19,500
2	Bait	$20	656	
	Lure	$20	348	
	Fly	$25	9,278	$252,030
3	All	$20	1,318	$26,360
4	All	$15	1,890	$28,350
5	Bait	$20	6,589	
	Lure	$30	5,508	$297,020
6	Bait	$15	4,287	
	Lure	$20	2,169	$107,685
All				$730,945

* Bids based on 1986 interview data.

Table 22. Travel cost method (TCM) estimate of consumer surplus for fishing the Housatonic River.

Section	Method of Fishing	Angler Days	Total $
1	All	975	$16,011*
2	All	9,278	$200,825
3	All	1,318	$16,792*
4	All	1,890	$17,964*
5	All	5,508	$94,458
6	All	2,169	$44,466
All			$390,516

* Estimated values, based on the average percentage of the total value which Sections 1, 3, and 4 comprised in the CV and AROV methods.

Table 23. Alternative recreation option value (AROV) of fishing the Housatonic River.

Section	Fishing Method	Median Bid ESp.	Sp.	Su.	Fa.	LFa.	Ice	Angler Days	Total $
1	All		$9	$39	$13			975	$22,129
2	Bait	$12	$12	$7	$21			656	
	Lure	$7	$12	$6	$14	$14		348	
	Fly	$13	$20	$12	$23	(All)		9,278	$173,558
3	All		$17	$13	$16			1,318	$19,606
4	All		$11	$8	$19			1,890	$21,113
5	Bait		$15	$5	$9		$9	6,589	
	Lure		$9	$6	$13			5,508	$114,476
6	Bait		$9	$5	$5		$9	4,287	
	Lure		$11	$6	$13			2,169	$50,691
All									$401,573

Table 24. Compensatory value of fishing the Housatonic River.

Section	Method of Fishing	Median Bid* (Annual)	Angler Days	Total $
1	All	$5	975	$4,875
2	Bait	$20	656	
	Lure	$30	348	
	Fly	$50	9,278	$487,460
3	All	$20	1,318	$26,360
4	All	$20	1,890	$37,800
5	Bait	$10	6,589	
	Lure	$30	5,508	$231,130
6	Bait	$10	4,287	
	Lure	$10	2,169	$64,560
All				$852,185

* Bids based on 1981 interview data.

Table 25. Compensatory value of fishing to Housatonic River anglers.

Section	Method of Fishing	Median Bid* (Annual)	Angler Days	Total $
1	All	$10	975	$9,750
2	Bait	$50	656	
	Lure	$50	348	
	Fly	$50	9,278	$514,100
3	All	$25	1,318	$32,950
4	All	$20	1,890	$37,800
5	Bait	$50	6,589	
	Lure	$250	5,508	$1,706,450
6	Bait	$25	4,287	
	Lure	$50	2,169	$215,625
All				$2,516,675

* Bids based on 1986 interview data.

Table 26. Economics summary for existing Housatonic River fisheries (1986 dollars).

Characteristic	Point Estimates	Precision
Annual Angling Effort	33,022*	±12%
Annual Associated Expenditures	$846,882	±12%
Annual Net Economic Impact	$1,270,323	±12%
Annual Consumer Surplus	$507,700	-32% & +61%
Annual Compensatory Value	$852,185	±12%
Capital Value of Annual Consumer Surplus	$5,802,286	-32% & +61%

* Angler Days

Table 27. Economic summary for existing Farmington River fisheries (1984 dollars; Hyatt 1986).

Characteristic	Point Estimates	Precision
Annual Angling Effort	45,726*	±13%
Annual Associated Expenditures	$419,839	±13%
Annual Net Economic Impact	$629,758	±13%
Annual Consumer Surplus	$345,000	±19%
Annual Compensatory Value	$666,335	±13%
Capital Value of Annual Consumer Surplus	$3,631,580	±19%

* Angler Days

Table 28. Socioeconomic information of Housatonic River anglers.

Characteristic	Bait	Lure	Fly
Average Age (Years)	39.5	35.2	41.4
Average Yearly Income	$23,618	$30,947	$32,868
% with Yearly Income >$50,000	2.7%	11.6%	18.4%
% Male Anglers	97.1%	98.2%	99.3%
% Female Anglers	2.9%	1.8%	0.7%

Table 29. Number of anglers interviewed and percentage of anglers eating their catch from the Housatonic River by section and method of fishing.

	Bait		Lure		Fly	
Section	Number Interviewed	Eating Catch	Number Interviewed	Eating Catch	Number Interviewed	Eating Catch
1	5	40%	2	50%	4	25%
2	131	14%	54	9%	63	4%
3	19	42%	17	24%	6	33%
4	29	55%	11	30%		
5	244	67%	221	22%		
6	207	65%	100	15%		
All	635	54%	405	19%	646	4%

5.0 APPENDICES

Appendix 1. Total number of samples available during the winter icefishery (based on 1986 season, includes 24 weekdays and 22 weekend-holidays).

Stratum	Section	Nh*	Samples Section Total	Total N
N13 & 14	5	224		
N15		176	400	
N16 & 17	6	224		
N18		176	400	800

* Total number of possible sampling units, as defined in equation 1 of Hyatt (1986).

Appendix 2. Total number of samples available during early spring (based on 1986 season, includes 11 weekdays and 21 weekend-holidays).

Stratum	Section	Nh*	Samples Section Total	Total N
N4 & 5	2	168		
N6		88	256	256

* Total number of possible sampling units, as defined in equation 1 of Hyatt (1986).

Appendix 3. Total number of samples available during spring (based on 1986 season, includes 44 weekdays and 18 weekend-holidays).

Stratum	Section	Nh*	Samples Section Total	Total N
N1		324		
N2	1	144		
N3		221	689	
N4		324		
N5	2	144		
N6		221	689	
N7		324		
N8	3	144		
N9		221	689	
N10		324		
N11	4	144		
N12		221	689	
N13		324		
N14	5	144		
N15		221	689	
N16		234		
N17	6	104		
N18		143	481[1]	3,926

*Total number of possible sampling units as defined in Equation 1 of Hyatt (1986).

[1]Fewer samples were possible on Section 6 (Lake Loar) due to a lake level drawdown for 2 weeks each spring.

Appendix 4. Total sample units available during summer (based on 1986 season, includes 53 weekdays and 24 weekend-holidays).

Stratum	Section	Nh*	Samples Section Total	Total N
N1		477		
N2	1	318		
N3		360	1,155	
N4		477		
N5	2	318		
N6		360	1,155	
N7		477		
N8	3	318		
N9		360	1,155	
N10		477		
N11	4	318		
N12		360	1,155	
N13		477		
N14	5	318		
N15		360	1,155	
N16		477		
N17	6	318		
N18		360	1,155	6,930

* Total number of possible sampling units, as defined in equation 1 of Hyatt (1986).

Appendix 5. Total sample units available during fall (based on 1986 season, includes 41 weekdays and 17 weekend-holidays).

Stratum	Section	Nh*	Samples Section Total	Total N
N1		328		
N2	1	123		
N3		187	638	
N4		328		
N5	2	123		
N6		187	638	
N7		328		
N8	3	123		
N9		187	638	
N10		328		
N11	4	123		
N12		187	638	
N13		328		
N14	5	123		
N15		187	638	
N16		328		
N17	6	123		
N18		187	638	3,828

* Total number of possible sampling units, as defined in equation 1 of Hyatt (1986).

Appendix 6. HOUSATONIC RIVER SURVEY.

1) License Number _____

2) Name _____,
City/town _____, State _____, Zip _____

3) Date _____ Section _____ Subsection _____ Subtime _____
Strata_____

4) Time started _____, time now _____ (Fishtime HRS. _____)

5) What are you fishing for? _____(See Code #)
(Method used: bait worm ____, fish ____, lure ____, fly ____)
Stillfishing Trolling Casting & Retrieving

6)

	trt	smb	lmb	calico	sunf	yp	wp	other
Number caught	___	___	___	___	___	___	___	___
Number released	___	___	___	___	___	___	___	___

Measured size (to nearest cm)

Species	length	Species	length	Species	length
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

Approx. size of released fish (inches)

Species	length	Species	length	Species	length
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

7) Town traveled from _____, how many in car _____.

8) Expenditures on this trip: bait _____, food _____,
lures _____, flies _____, other _____.

9) How would you rate your fishing success today?
terrible poor average good excellent can't tell yet
Why? _____

10) What % of your legal bass, >12" do you keep? _____%

11) Have you been interviewed previously during this fishing season? yes ___, no ___. If "yes" do not continue the survey.

12) Equipment using: fly rod/reel-graf___glass___boron___bamb___
spin rod/reel-g[illegible]___glass___boron___
baitcasting rod/reel-graf___glass___boron___
hipboots____ waders _____ tackle box ____
bait bucket ____ vest ___net___ creel____
wading stick ___ other_____.

13) Description of boat (type,see code _____, yr _____
Description of motor-make _____, hp ____, yr _____
Anglers estimation of worth _____,
What % of boat use is on HR _____%

14) If using flies/lures how many do you buy each yr? _____

15) Do you fish elsewhere yes ___, no ___, if so what % of your time do you spend fishing on the HR? _____%

16) How many times a yr. do you fish this area of the HR? ____

Appendix 6. HOUSATONIC RIVER SURVEY (continued).

17) Would you still buy a fishing license if you could not fish the HR, but could continue to fish in other parts of the state? yes ___, no ___.

18) If not fishing the HR today , you would most probably _____, travel distance _____mi, out of pocket expences _____.

19) How much greater do you think your total expences for todays trip would have to become before you would probably have decided not to have gone fishing today _____$ - Present range $.50, 1.00, 2.00, 5.00, 10.00, 15.00, 20.00 - allow angler to give exact amount.

20) What is the minimum dollar amount you would accept as compensation if you were not allowed to fish the H. R. and had to fish elsewhere today? $_____ Present range $.50, 1.00, 2.00, 5.00, 10.00, 15.00, 20.00, >20.00 - allow angler to give exact amount.

21) What is the minimum dollar amount you would accept as compensation if you were not allowed to fish anywhere today? $_____ Present range $.50, 1.00, 2.00, 5.00, 10.00, 15.00, 20.00, >20.00 - allow angler to give exact amount.

22) Do you usually eat your catch from the HR? yes ___, no ___

Demographic Data:

23) Occupation _____

24) Sex: male _____ female _____

25) Age _____yrs

26) Total personal income

$0 - 9,999	_____
10k - 19,999	_____
20k - 29,999	_____
30k - 39,999	_____
40k - 49,999	_____
over $50,000	_____
over$100,000	_____

Appendix 7. Information requested on Housatonic River angler report card.

1) Time started fishing _____, Time finished fishing _____

2)

(please specify)	trt	lmb	smb	sunf	wp	yp	calico	other
number caught	___	___	___	___	___	___	___	_____
number released	___	___	___	___	___	___	___	_____

3) How would you rate your fishing trip today?

Excellent _____ Good _____ Fair _____ Poor _____

4) Remarks:

Appendix 8. Statistical comparison of catch rates obtained by on site interviews and catch rates obtained from interviewed anglers electing to return pre-addressed postcards requesting completed trip catch data (1985-1986).

Season	Section	Postcard Returns	Catch per Hour Interviews	PostCards	Di
Winter	5	44.3%	4.41	4.16	-0.25
	6	48.5%	3.66	3.43	-0.23
Early Spring	2	56.1%	0.79	0.86	+0.23
Spring	1	28.6%	0.14	0.00	-0.14
	2	53.6%	1.02	1.22	+0.20
	3	52.9%	1.70	3.49	+1.79
	4	21.7%	1.28	2.54	+1.26
	5	39.5%	1.33	2.10	+0.77
	6	45.6%	0.47	3.31	+2.84
Summer	1	33.3%	4.04	2.50	-1.54
	2	45.0%	0.99	1.26	+0.27
	3	44.4%	2.87	3.61	+0.74
	4	66.7%	1.04	1.86	+0.82
	5	26.7%	1.75	2.93	+1.18
	6	29.3%	1.02	1.58	+0.56
Fall	1	100.0%	0.59	2.00	+1.41
	2	43.5%	1.21	1.83	+0.62
	3	33.3%	0.36	1.29	+0.93
	4	50.0%	0.95	3.64	+2.69
	5	40.9%	1.62	2.48	+0.86
	6	40.0%	0.87	1.87	+1.00
Late Fall	2	28.0%	1.03	1.59	+0.56

Appendix 9. Alternative recreational activities of anglers contacted while fishing the Housatonic River (51 different activities cited, those not listed comprised less than 0.5% of the total sample).

Alternative Activity	Percentage of Total
Home (yard work, watching T.V., etc.)	40.6%
Fishing Elsewhere	38.3%
Working on Job	12.0%
Other Recreation (golfing, hunting, bar, etc.)	9.1%