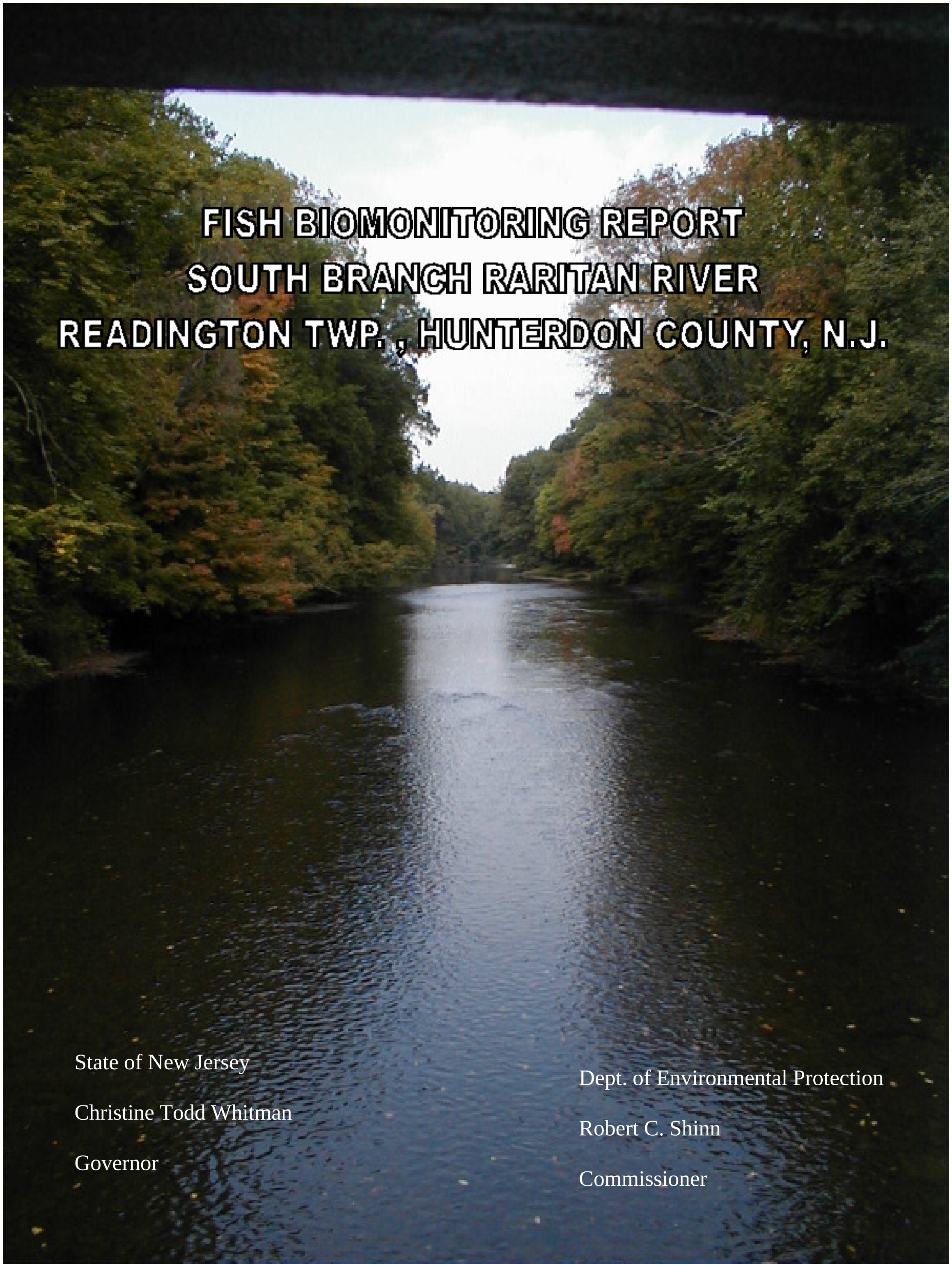

FISH BIOMONITORING REPORT
SOUTH BRANCH RARITAN RIVER
READINGTON TWP. , HUNTERDON COUNTY, N.J.

State of New Jersey

Christine Todd Whitman

Governor

Dept. of Environmental Protection

Robert C. Shinn

Commissioner

NJ Department of Environmental Protection
Division of Watershed Management
P.O. Box 427, Trenton, NJ 08625-0427

WATER MONITORING MANAGEMENT
James E. Mumman, Administrator

Bureau of Freshwater & Biological Monitoring
Alfred L. Korndoerfer, Jr., Chief

December, 2000

FISH BIOMONITORING REPORT SOUTH BRANCH RARITAN RIVER READINGTON TOWNSHIP, N.J.

Monitoring Report Design By:
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FIELD SUPERVISOR
Bud Cann, Supervising Environmental Specialist

DATA REDUCTION AND GRAPHICS
William Honachefsky
Brian Margolis
Charles Lawless

FISH IDENTIFICATIONS
Brian Margolis and William Honachefsky
Confirmation by: Philadelphia Academy of Natural Sciences

FIELD COLLECTION STAFF
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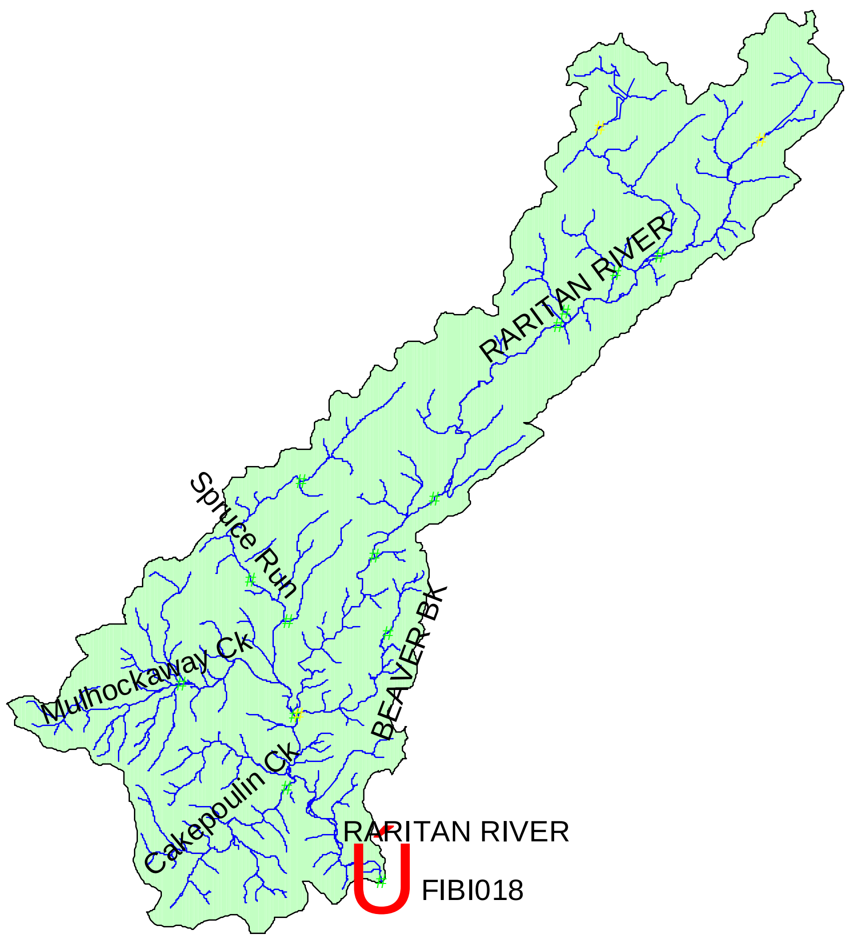
SPECIAL ACKNOWLEDGEMENT FOR ASSISTANCE
James Kurtenbach, U.S. EPA Region 2

South Branch Raritan River - FIBI018

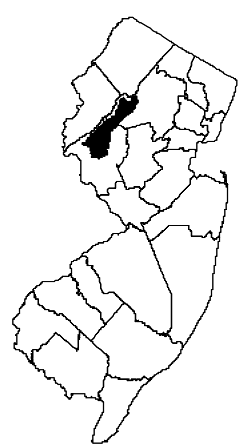
Drainage area of sampled reach= 150.2 square miles

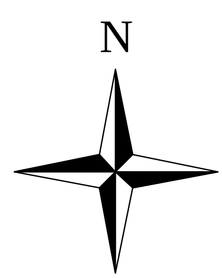
Water quality classification = FW2-TM



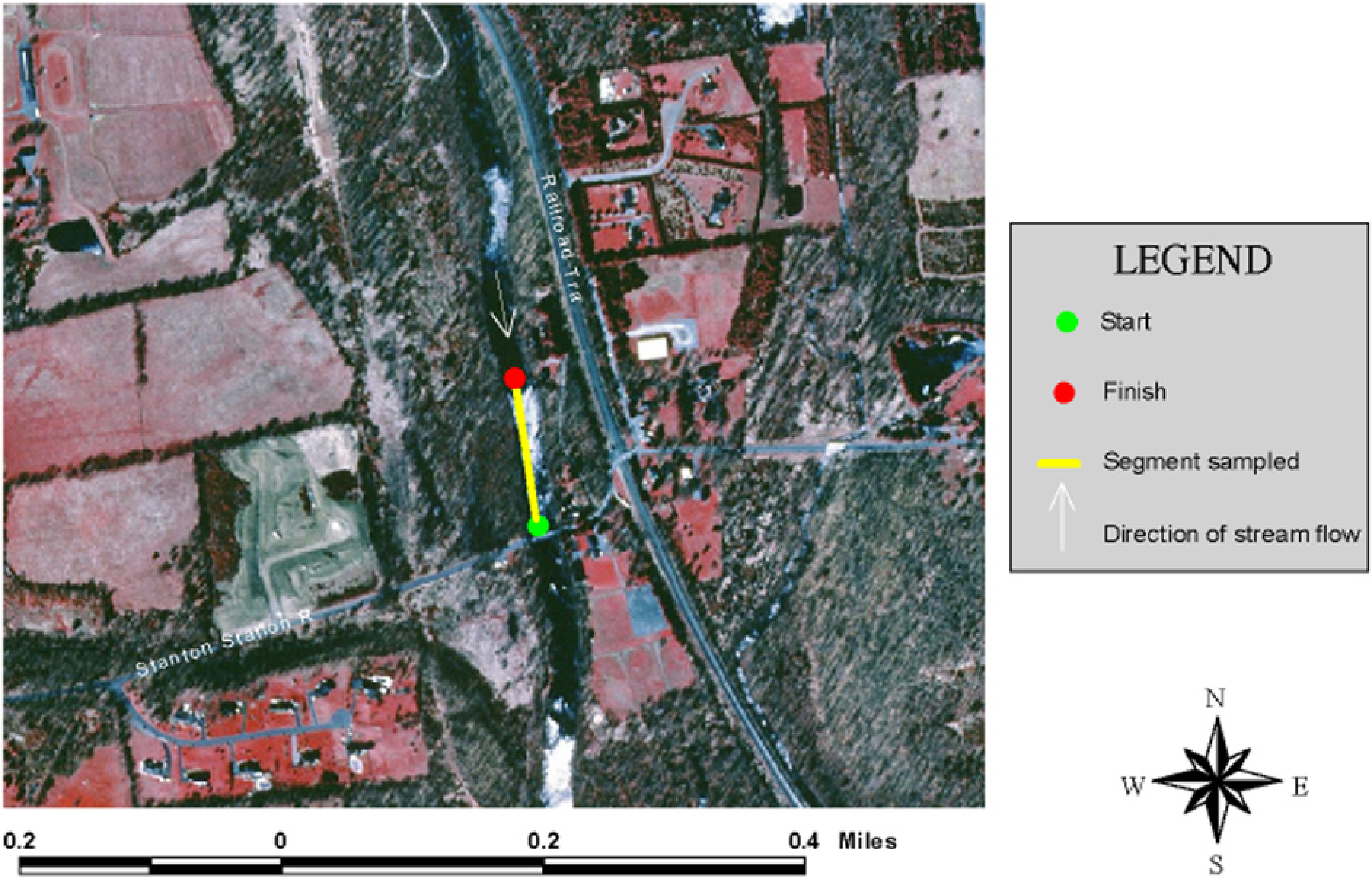
AMNET Station Impairment

- # **MODERATE**
- # **NONE**
- Ú **FIBI Sampling Station**





FIBI018
South Branch RARITAN RIVER
Stanton Station Rd.
Raritan Twp., Hunterdon Co.



INTRODUCTION

The monitoring of stream fish assemblages is an integral component of many water quality management programs for a variety of reasons (See Table 1.1), and its importance is reflected in the aquatic life use support designations adopted by many states. Narrative expressions such as "maintaining coldwater fisheries", "fishable", or "fish propagation" are prevalent in many state standards. Here in New Jersey, surface water quality criteria are closely aligned with descriptors such as *trout production, trout maintenance and non-trout* waterways. Assessments of fish assemblages can measure the overall structure and function of the icthyofaunal community to adequately evaluate biological integrity and protect surface water quality. Fish bioassessment data quality and comparability are assured through the utilization of qualified fisheries professionals and consistent methods (Plafkin et al., 1989).

TABLE 1.1

ADVANTAGES OF USING FISH AS INDICATORS

1. Fish are good indicators of long-term (several years) effects and broad habitat conditions because they are relatively long-lived and mobile (Karr et al. 1986).

2. Fish communities generally include a range of species that represent a variety of trophic levels (omnivores, herbivores, insectivores, planktivores, piscivores). They tend to integrate effects of lower trophic levels; thus, fish community structure is reflective of integrated environmental health.

3. Fish are at the top of the aquatic food chain and are consumed by humans, making them important subjects in assessing contamination.

4. Fish are relatively easy to collect and identify to the species level. Most specimens can be sorted and identified in the field and released unharmed.

   - Environmental requirements of common fish are comparatively well known.
   - Life history information is extensive for most species.
   - Information on fish distributions is commonly available.

5. Aquatic life uses (water quality standards) are typically characterized in terms of fisheries (coldwater, coolwater, warmwater, sport, forage).

   - Monitoring fish communities provides direct evaluation of "fishability", which emphasized the importance of fish to anglers and commercial fisherman.

6. Fish account for nearly half of the endangered vertebrate species and subspecies in the United States (Warren and Burr 1994).

The general methodology currently employed in the compilation of these studies and reports is the *Rapid Bioassessment Protocol V (RBP V)* described in Plafkin et al. (1989) with some modifications for regional conditions. The principal evaluation mechanism utilizes the technical framework of the *Index of Biotic Integrity (IBI),* a fish assemblage approach developed by Karr (1981). The IBI incorporates the zoogeographic, ecosystem, community and population aspects of the fish assemblage into a single ecologically based index. Calculation and interpretation of the IBI involves a sequence of activities including: fish sample collection; data tabulation; and regional modification[1] and calibration of metrics and expectation values. This concept has provided the overall multimetric index framework for rapid bioassessment in this document.

Data provided by the fish IBI can serve to assess use attainment, develop biological criteria, prioritize sites for further evaluation, provide a reproducible impact assessment, and assess status and trends of the fish assemblage.

FIELD COLLECTION PROCEDURES

Primary objectives of the fish collections are to obtain samples with representative species and abundances, at a reasonable level of effort. Sampling effort is standardized by using similar stream lengths, collection methods, sampling times and habitat types.

Stream segments selected for sampling must have a minimum, one riffle, run, and pool sequence to be considered representative. Channelized streams may be an obvious exception, as are streams located in central and southern New Jersey, where low gradient precludes typical riffle habitat. In low gradient streams, the sampling requires that stream lengths encompass major habitat types such as pools, runs, bends, and log jams. Determination of the stream length necessary for adequate sampling is based on stream size (Table 1.2).

TABLE 1.2

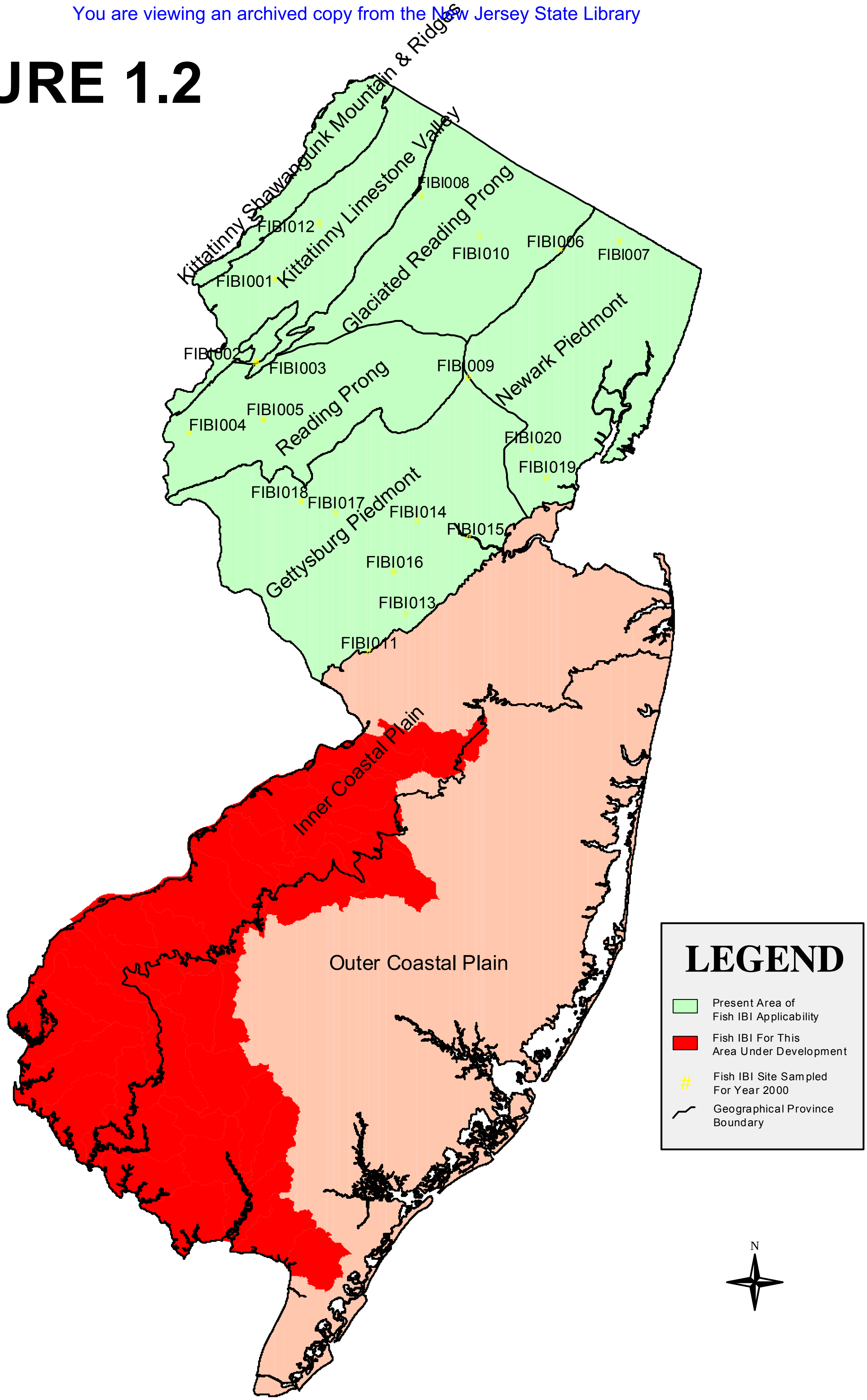
REQUIREMENTS FOR FISH SAMPLING BASED ON STREAM SIZE

	A	B	C
Stream Size	Moderate to large streams and rivers (5th order or greater)	Wadeable streams (3rd and 4th order)	Headwater streams (1st and 2nd order)
Sampling Distance (meters)	500 m	200 - 150 m	150 m
Electrofishing Gear	12' boat	Barge with generator pulsator unit	Backpack shocker or Barge unit
Power Source	5000 watt generator	2500 watt generator	24 volt battery

Streams with drainage areas less than 5 square miles are excluded from IBI scoring because of naturally occurring low species richness. Often streams classified as trout production waters fall into this category. More appropriate assessment methods for these streams include the measurement of trout abundance and/or young of the year production. Benthic macroinvertebrate assessments are also a viable alternative. In addition, atypical habitats such as bridge crossings, dams and mouths of tributaries are avoided, unless the intent of the study is to determine the influence these habitats have on the fish community. Most often, sampling atypical habitats results in the collection of fish species not represented in typical stream reaches. Sampling intermittent streams should also be avoided. These streams require the development of a separate set of IBI scoring criteria.

[1] The IBI methodology presently being used in these studies was modified from Plafkin et al. (1989) to meet the regional conditions of New Jersey (not all of the state, however, is covered, **see Fig. 1.2)** based on work by Kurtenbach (1994). It should be noted, however, that an enumeration of fish assemblages, regardless of whether an IBI is calculated or not, is still a useful *environmental indicator* capable of providing stand alone information useful to determine whether the affected stream(s) are capable of meeting the narrative criteria of "fishable".

FIGURE 1.2


Kittatinny Shawangunk Mountain & Ridges
Kittatinny Limestone Valley
Glaciated Reading Prong
Newark Piedmont
Reading Prong
Gettysburg Piedmont
Inner Coastal Plain
Outer Coastal Plain
FIBI001
FIBI002
FIBI003
FIBI004
FIBI005
FIBI006
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FIBI020
LEGEND
Present Area of Fish IBI Applicability
Fish IBI For This Area Under Development
Fish IBI Site Sampled For Year 2000
Geographical Province Boundary
N

Fish are sampled primarily with electrofishing gear using pulsed direct current (DC) output. This method of collection has proved to be the most comprehensive and effective single method for collecting stream fishes. Direct current is safer, more effective especially in turbid water, and less harmful to the fish. In waters with low conductivity (less than 75 µmhos/cm) it may be necessary to use an AC unit (Lyons 1992). If the use of pulsed DC is preferred in low conductivity waters, it should be set at a minimum of 120 pulses/sec. Selection of the appropriate electrofishing gear is dependent on stream size (Table 1.2). A typical sampling crew consists of four to five people (Fig. 1.3), depending on the gear being utilized. A minimum of two people are required for netting the stunned fish. Electrofishing is conducted by working slowly upstream and placing the electrodes in all available fish habitat. Stunned fish are netted at and below the electrodes as they drift downstream. Netters attempt to capture fish representing all size classes. All fish captured are immediately placed in water filled containers strategically located along the stream bank in order to reduce fish mortality.

FIGURE 1.3

TYPICAL ELECTROSHOCKING OPERATION

Sampling time generally requires 1.5 to 2 hours per station. This includes the measurement of chemical and physical parameters. Sampling is conducted during daylight hours, June through early October, under normal or low flows, and never under atypical conditions such as high flows or excessive turbidity caused by heavy precipitation. Fish collections made in the summer and early fall are easier, safer and less likely to disturb spawning fish.

SAMPLE PROCESSING

Fish are identified to the species level, counted, examined for disease and anomalies, measured (game fish), released and recorded on fish data sheets in the field. Only fish greater than 20 mm in length are counted. Reference specimens and difficult to identify individuals are placed in jars containing 10 percent formaldehyde, and later confirmed at the laboratory using taxonomic keys; (Werner 1980; Eddy and Underhill 1983; Smith 1985; Page and Burr 1991; Jenkins and Burkhead 1993). Species particularly difficult to identify are forwarded to fisheries experts outside the BFWBM (At present the Philadelphia Academy of Natural Sciences) for confirmation.

MEASUREMENT OF PHYSICAL AND CHEMICAL PARAMETERS

Physical and chemical measurements (e.g. pH, conductivity, temperature, depth) of existing stream conditions are recorded on physical characterization/water quality field data sheets and later summarized.

HABITAT ASSESSMENT

Habitat assessments are conducted at every sampling site and all information is recorded on field sheets (Plafkin et al. 1989). Habitat assessments provide useful information on probable causes of impairment to instream biota, when water quality parameters may not indicate any problem. The habitat assessment consists of an evaluation of the following physical features: substrate, channel morphology and stream side cover. Individual parameters within each of these groups are scored and summed to produce a total score, which is assigned a habitat quality category (**Appendix 3**).

DESCRIPTION AND DISCUSSION OF THE IBI[2]

Once the fish from each sample collection have been identified, counted, examined for disease and anomalies, and recorded, several biometrics are used to evaluate biological integrity. Fish community analysis is accomplished using a regional modification of the original IBI (Karr et al. 1986), developed by Kurtenbach. Consistent with Karr et al. (1986), a theoretical framework is constructed of several biological metrics that are used to assess a fish community's richness, trophic composition, abundance and condition, and compared to fish communities found in regional reference streams[3, 4]. The modified IBI (New Jersey version) uses the following ten biometrics: 1) total number of fish species, 2) number and identity of benthic insectivorous species, 3) number and identity of trout and sunfish species, 4) number and identity of intolerant species, 5) proportion of individuals as white suckers, 6) proportion of individuals as generalists (carp, creek chub, goldfish, fathead minnow, green sunfish and banded killifish), 7) proportion of individuals as insectivorous cyprinids, 8) proportion of individuals as trout or proportion of individuals as piscivores (top carnivores) - excluding American eels, 9) number of individuals in the sample and 10) proportion individuals with disease or anomalies (excluding blackspot disease). **See Appendices 1 and 2.**

[2] Narrative for this section taken largely from Kurtenbach (1994).

[3] For regional reference conditions Kurtenbach (1994) used historical fisheries data collected by the New Jersey Division of Fish, Game and Wildlife (unpublished) at 126 stream sites located in the Delaware, Passaic, and Raritan River watersheds. The fish collection methods and the stream lengths sampled in these historical studies were compatible with Kurtenbach's work.

[4] Trophic guilds, pollution tolerances and origins (native or introduced) of each fish species utilized by Kurtenbach to calculate the IBI were assigned using several fisheries publications (Stiles, 1978; Smith, 1985; Hocutt et al. 1986; Karr et al. 1986; Ohio EPA, 1987; Miller et al. 1988).

Quantitative scoring criteria were developed for each biometric based upon the degree of deviation; 5 (none to slight), 3 (moderately), and 1 (significantly) from appropriate ecoregional reference conditions. Scores for the individual biometrics at each sampling location are summed to produce a total score which is then assigned a condition category. The maximum possible IBI score is 50, representing excellent biological integrity. A score of less than 29 indicates a stream has poor biological integrity. 10 is the lowest score a site can receive. Further descriptions of all of the metrics used in the IBI calculations are presented below:

SPECIES RICHNESS AND COMPOSITION

Four biometrics require the use of Maximum Species Richness (MSR) lines. MSR lines relate species richness to stream size and environmental quality. For any given stream, species richness is expected to increase with higher environmental quality. Additionally, in a stream with a given level of environmental quality, species richness should increase with stream size. Thus, large sized streams with good water quality should have significantly more species than a small, poor quality stream. MSR lines (See Appendix 3) were developed to show the relationship between species richness and waterbody size in New Jersey. Using the procedure described in Karr et al. (1986), MSR lines for each richness metric were drawn by Kurtenbach (1994) with slopes fit by eye to include 95% of the data points. The area under the MSR line is trisected by two diagonal lines.

Points located near the MSR line represent species richness approaching that expected for an unimpacted stream. Points falling within the lowest trisected area, furthest from the MSR line, represent the greatest deviation from an ecoregional reference condition. For example, using the "total number of fish species" graph in Appendix 3, a sample collection resulting in the capture of five total fish species in a stream with a drainage area of 10 square miles, would receive a score of three and have an intermediate deviation from the expected condition.

1. Total number of fish species:

    This metric is simply a measure of the total number of fish species identified from a sample collection. A reduction of taxonomic richness may indicate a pollution problem (e.g., organic enrichment, toxicity) and/or physical habitat loss. Fish species with the least tolerance to environmental change, typically are the first to become absent when water degradation occurs. Although freshwater fish species richness in New Jersey is less than half that of the Midwest region where the IBI was first developed (Karr et al. 1986; Ohio EPA 1987; Lyons 1992), effectiveness of this metric is comparable to regions with richer fish faunas.

2. Number and identity of benthic insectivorous species:

    This metric is a modification of several metrics used in the original IBI (Karr et al. 1986). Darter and sucker species make up a relatively small component of the New Jersey fish fauna. However, several other benthic species require clean gravel or cobble substrate for reproduction and/or living space. Degradation of this habitat from siltation is often reflected by a loss of benthic species richness (Karr et al. 1986) and abundance (Berkman and Rabeni 1987). Several benthic fish require quiet pool bottoms and may decline when benthic oxygen depletion occurs (Ohio EPA 1987). Further, reductions of some benthic insectivorous fish may indirectly indicate a toxics problem. Benthic macroinvertebrates are an important food source for benthic insectivorous fish and their sessile mode of life make them particularly susceptible to toxicant effects.

3. Number and identity of trout and sunfish species:

    This metric was adopted as a hybrid for warmwater and coldwater streams. The metric is similar to that used in a combined coldwater-warmwater version of an IBI developed in Ontario (Steedman 1988), but designed for high-gradient rather than low gradient streams. In New Jersey, sunfish are a depauperate group in small streams with high gradient and are often replaced by trout. Both sunfish and trout are water-column species sensitive to habitat degradation and loss of instream cover (Gammon et al. 1981; Angermeier 1983). In coldwater streams where sunfish are typically absent, trout fill a similar ecological niche and may be used to replace sunfish. Trout are equally, if not more sensitive to habitat degradation.

The relationship between trout populations and habitat are well documented (Peters 1967; Hunt 1969; Meehan 1991).

4. Number and identity of intolerant species:

This metric provides a measure of fish species most sensitive to environmental degradation. The absence of some fish species occurs with subtle environmental changes caused by anthropogenic disturbances. Fish species assigned as intolerant should have historical distributions significantly greater than presently occurring populations and be restricted to streams that have exceptional water quality (Karr et al. 1986).

5. Proportion of individuals as white suckers:

The white sucker has been chosen to replace green sunfish as a more regionally appropriate tolerant species in the northeast (Miller et al. 1988; Langdon 1992). In New Jersey, the white sucker is commonly found in small and large streams representing a wide range of water quality conditions. White suckers adapt well to changing environmental conditions and often become dominant at disturbed sites. This metric is generally useful in distinguishing moderately and severely impaired conditions

TROPHIC COMPOSITION

Trophic composition metrics, unlike the richness metrics, are scored based on a percentage of the total numbers of individual fish captured. The influence of stream size on trophic composition has not been determined for New Jersey streams. In Illinois and Wisconsin streams (Karr 1981; Lyons 1992), trophic composition was not strongly influenced by stream size. Based on these findings, fixed scoring criteria are used on all stream sizes found in New Jersey, with the exception of large rivers.

6. Proportion of individuals as generalists (carp, creek chub, goldfish, fathead minnow, green sunfish and banded killifish):

This metric replaces the omnivore metric used in the original IBI (Karr et al. 1986). Use of the omnivore metric was determined to be inappropriate in New Jersey because omnivores are naturally depauperate. Generalists as defined here, are species with flexible feeding strategies and broad habitat requirements. Often a shift from predominantly specialist groups to generalist groups occurs as water quality becomes degraded (Leonard and Orth 1986; Ohio EPA 1987). Due to broad feeding and habitat requirements, species included for use in this metric are considered tolerant of environmental degradation.

7. Proportion of individuals as insectivorous cyprinids:

Like many streams found in North America, cyprinids are the dominant insectivorous fish in New Jersey (excluding Pineland streams). A shift from specialized invertebrate feeders to generalist with flexible foraging behaviors often indicates poor conditions associated with water quality and/or physical habitat degradation (Karr et al. 1986). Similar to the benthic insectivore metric, insectivorous cyprinids in some instances, may indirectly measure the effects of toxicity.

8. Proportion of individuals as trout or proportion of individual as piscivores (top carnivores) - excluding American eel:

Streams with slight or moderate water quality impairment generally contain several top predator fish species. In cold water streams of New Jersey, predator fish such as bass and pickerel are depauperate and typically replaced by trout. Thus, a metric is required which measures both groups of top carnivores. A metric fulfilling this requirement is currently used on Vermont streams (Langdon 1992) and has been adopted for use in New Jersey. American eels are excluded from use in this metric. The ubiquity of American eels in streams that have a wide range of water quality and habitat conditions, limits their use as an indicator of aquatic health.

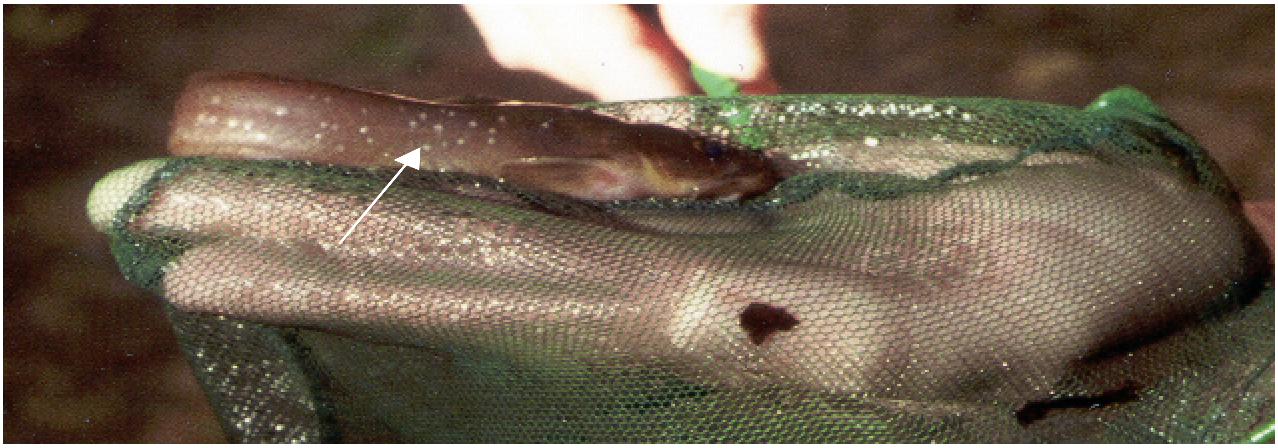
FISH ABUNDANCE AND CONDITION

9. Numbers of individuals in the sample:

This metric measures the relative abundance of fish captured from a specified area or stream reach and is used to distinguish streams with severe water quality impairment. Like the original IBI (Karr et al. 1986), catch per unit effort is used to score this metric. Severe toxicity and oxygen depletion are examples of perturbations often responsible for extremely low fish abundances.

10. Proportion of individuals with disease or anomalies (excluding blackspot disease)

This metric provides a relative measure of the condition of individual fish. Similar to metric nine, this metric is especially useful in distinguishing streams with serious water quality impacts. This metric is intended to detect impacts occurring below subacute chemical discharges or areas highly contaminated by chemicals. A significant relationship between the incidence of blackspot disease and environmental quality has not been established for New Jersey streams. As a result, blackspot disease is excluded from use in this metric.



Most of the adult margined madtoms (*Noturus insignis*) collected in the South Branch Raritan River were covered in raised white bumps. Specimens were sent out for pathology work, however the identification of the anomaly has not been confirmed.

Invasive Asian freshwater clams (*Corbicula sp.*) were prevalent along the sampled reach of the South Branch Raritan River.

REFERENCES

1. Angermeier, P.L. 1983. "*The importance of cover and other habitat features to the distribution and abundance of Ilinois stream fishes*" Ph.D. Dissertation, University of Illinois, Urbana.

2. Berkman, H.E., and C.F. Rabeni. 1987. "*Effect of siltation on stream fish communities*" Environmental Biology of Fishes 18:285-294

3. Eddy, S., and J.C. Underhill. 1983. "*How to Know the Freshwater Fishes*" 3rd ed., William C. Brown Company, Dubque, Iowa.

4. Gammon, J.R., A. Spacie, J.L. Hamelink, and R.L. Kaesler. 1981. "*Role of electrofishing in assessing environmental quality of the Walbash River*" in "*Ecological Assessments of Effluent Impacts on Communities of Indigenous Aquatic Organisms*" J.M. Bates and C.I. Weber (eds.). STP 730, pp. 307-324. American Society for Testing and Materials, Philadelphia, PA.

5. Hocutt, C.H., and E.O. Wiley (eds.). 1986. "*The Zoogeography of North American Freshwater Fishes*" 1986, John Wiley and sons, N.Y.

6. Hunt, R.L. 1969. "*Effects of habitat alteration on production, standing crops and yield of brook trout in Lawrence Creek, Wisconsin*" pp. 281-312. *In* Northcoat.

7. Jenkins, R.E. and N.M. Burkhead. 1993. "*Freshwater Fishes of Virginia*" American Fisheries Society, Bethesda, MD.

8. Karr, J.R. 1981. "*Assessment of biotic integrity using fish communities*" Fisheries 6(6):21-27.

9. Karr, J. R., K.D. Fausch, P.L. Angermeier, P. R. Yant, and I.S. Schlosser. 1986. "*Assessing biological integrity in running waters: a method and its rationale*" Illinois Natural History Survey, Champaigne, IL, Special Publication 5.

10. Kurtenbach, J. P. 1994. "*Index of Biotic Integrity Study of Northern New Jersey Drainages*" U.S.EPA, Region 2, Div. Of Environmental Assessment, Edison, N. J. (Last revised April, 2000).

11. Langdon, R.W. 1992 "*Adapting an index of biological integrity to Vermont streams*" Presented at the 16th annual meeting of the New England Assoc. of Environmental Biologists at Laconia, New Hampshire, 4-6 March, 1992.

12. Leonard, P.M., and D.J. Orth. 1986. "*Application and testing of an index of biotic integrity in small, coolwater streams*" Transactions of the American Fisheries Society 115:401-415.

13. Lyons, J. 1992. "*Using the index of biological integrity (IBI) to measure environmental quality in warmwater streams of Wisconsin*" U.S. Dept. of Agriculture, Forest Service, General Technical Report NC 149.

14. Meehan, W.R. (ed.) 1991. "*Influences of forest and rangeland management on salmonid fishes and their habitats*" American Fisheries Society, Special Publication 19.

15. Miller, D.L., P.M. Leonard, R.M. Hughes, J.R. Karr, P.B. Moyle, L.H. Schrader, B.A. Thompson, R.A.Daniels, K.D. Fausch, G.A. Fitzhugh, J.R. Gammon, D.B. Halliwell, P.L. Angermeier, and D.O. Orth. 1988. "*Regional applications of an index of biotic integrity for use in water resource management*" Fisheries 13:3-11.

16. Ohio Environmental Protection Agency. 1987. "*Biological criteria for the protection of aquatic life: Vol. II. Users Manual for biological field assessment of Ohio surface waters*" Ohio EPA, Division of Water Quality Monitoring and Ass't, Surface Water Section, Columbus, OH.

17. Page, L.M., and B.M. Burr. 1991. "*Peterson Field Guides, Freshwater Fishes*" Houghton Mifflin Company, New York.

18. Peters, J.C. 1967. "*Effects on a trout stream of sediment from agricultural practices*" Journal of Wildlife Management. 31:805-812.

19. Plafkin, J. L., M.T. Barbour, K.D. Porter, S.K. Gross and R.M. Hughes. 1989. "*Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish*" U.S. EPA. EPA/444/4-89-001.

20. Smith, C.L. 1985. "*The inland fishes of New York State*" N.Y. State Department of Environmental Conservation, Albany, N.Y.

21. Steedman, R.J. 1988. "*Modification and assessment of an index of biotic integrity to qualify stream quality in southern Ontario*" Canadian Journal of Fisheries and Aquatic Sciences 45:492-501.

22. Stiles, E. W. 1978, "*Vertebrates of New Jersey*" Somerset, New Jersey

23. Warren, M. L., Jr. and B.M. Burr. 1994. "*Status of freshwater fishes of the US: Overview of an imperiled fauna*" Fisheries 19(1):6-18.

24. Werner, R.G. 1980. "*Freshwater Fishes of New York State: A Field Guide*" Syracuse University Press, New York.