LARVAL SPORT FISH DRIFT IN THE NEW RIVER

WAYNE A. POTTER, Ecological Sciences Division, NUS Corporation, Pittsburgh, PA 15220
KENNETH L. DICKSON, North Texas State University, Institute of Applied Science, Denton, TX 76203
LARRY A. NIELSEN, Department of Fisheries and Wildlife, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061

Abstract: Abundance of larval sport fishes in the New River, at Glen Lyn, VA, was calculated from catch, volume of water sampled through drift nets, and daily river discharge for the period June through August 1976. The estimates of larval sport fish drift included 2,410,000 channel catfish (*Ictalurus punctatus*), 162,000 flathead catfish (*Pylodictis olivaris*), 106,000 rock bass (*Ambloplites rupestris*), 46,900 smallmouth bss (*Micropterus dolomieu*), and 125,000 spotted bass (*M. punctulatus*). The seasonal distribution and occurrence of larvae were comparable to literature reports. Drift sampling may be an effective technique for estimating the absolute abundance of fish at an early developmental stage. These estimates may give fisheries managers the lead time necessary for implementation of effective management strategies in large river systems where it is difficult to sample later life stages quantitatively.

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The ecology of larval fishes in lotic environments becomes increasingly important as larger quantities of waters are diverted for cooling purposes. Qualitative aspects, such as spatial and temporal distribution are well documented (Armundrud et al. 1974; Dovel 1967, 1971; Faber 1976; Nelson and Cole 1975; Wells 1973, 1974). Taxonomic descriptions and keys are available (Fish 1932; Mansueti and Hardy 1967; Nelson and Cole 1975; Taber 1969), but quantitative estimates of early life history parameters are scarce.

Estimates of the abundance of larval fish are generally reported as densities based on the number of fish eggs or larvae collected per volume of water sampled. Such densities are useful for studying the diel periodicity of drift (Clifford 1972; Eldridge 1977; Larimore 1972) and seasonal variations in abundance (Gale and Mohr 1978; Mancini 1974). The utility of densities for assessing such factors as year-class strength or reproductive success is impaired because inferences must be based on long-term empirical relations between densities and the parameter of interest. Estimates of absolute abundance would permit immediate assessment and management of fish stocks.

Estimates of the abundance of larval sport fish drift in the New River, at Glen Lyn, VA, were calculated from catch, volume of water strained in drift nets, and daily river discharge. Estimates were made for 5 locally important sport fishes, including the channel catfish, flathead catfish, rock bass, smallmouth bass and spotted bass.

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MATERIALS AND METHODS

Description of the Study Area

The New River, mainstem of the Kanawha River, flows north and west from North Carolina through Virginia and West Virginia. The study area was near Glen Lyn, which is located in Giles County, southwest Virginia, near the border of Virginia and West Virginia (Fig. 1). The New River at Glen Lyn is a series of extended riffles and long pools. The river is 0.5 to 2.5 m deep during normal flow and is approximately 150 m wide. The substrate is primarily tilted bedrock covered with gravel and silt. River discharge is affected daily by releases from the Claytor Lake Reservoir, 80 km upstream, for hydroelectric generation.

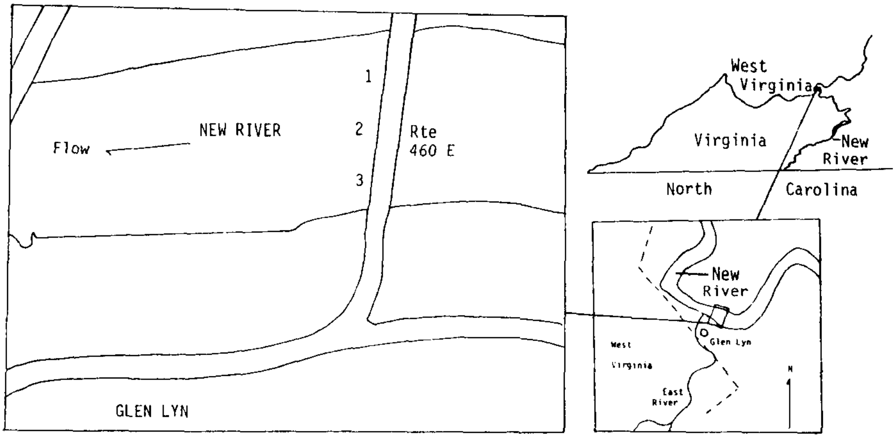

Fig. 1. Location of ichthyoplankton drift sampling stations in the New River, Glen Lyn, Virginia.

Three stations were estabilished on a transect across the New River at the Route 460 E bridge near Glen Lyn (Fig. 1). Station 1 was approximately 30 m from the east shore; station 2 was at midstream; and station 3 was approximately 30 m from the west shore. Each station represented a 50 m cross section of river. The average depth was 2.34 m at station 1, 1.88 m at station 2, and 1.34 m at station 3. The relative river flow rates based on unity at station 1 were 1.00 at station 1, 1.93 at station 2, and 2.70 at station 3.

Sample Design

Sampling to determine the species composition and abundance of ichthyoplankton was conducted June through August 1976. Twenty-four hour periods were sampled twice weekly when river conditions permitted. Additional sampling was done in September, November, and December 1976, and April and May 1977 to investigate the possibility of spawning at other times.

Larval fish were collected in drift nets with 0.63 m x 0.94 m rectangular openings and 0.5-mm nylon mesh (Fig. 2). The nets were 3 m long which allowed sufficient sieving area without net clogging during sampling. It was assumed that avoidance of the net by larvae was minimized through the use of large nets and net openings. Samples were taken by lowering the nets down 5 mm plastic coated cables which were heavily weighted and clamped to the bridge railing on the downstream side (Fig. 2). Each net was positioned so that the top of the net was just below the water surface. Vertical stratification of ichthyoplankton was not considered an important factor in sampling, due to the shallow, relatively well mixed nature of the New River at the study area.

Each 24 hour sampling period was divided into three 8 hour periods defined as (1) day; (2) sunset; and (3) dawn. These time periods were selected to sample the rnage of drift abundance assuming the pattern of diel larval fish abundance reported by Larimore (1972).

Three replicates were taken successively at each station during each time period, with a minimum of elapsed time between replicates. The duration of sampling was usually 10 minutes although shorter times were used when river flow and quantity of debris were

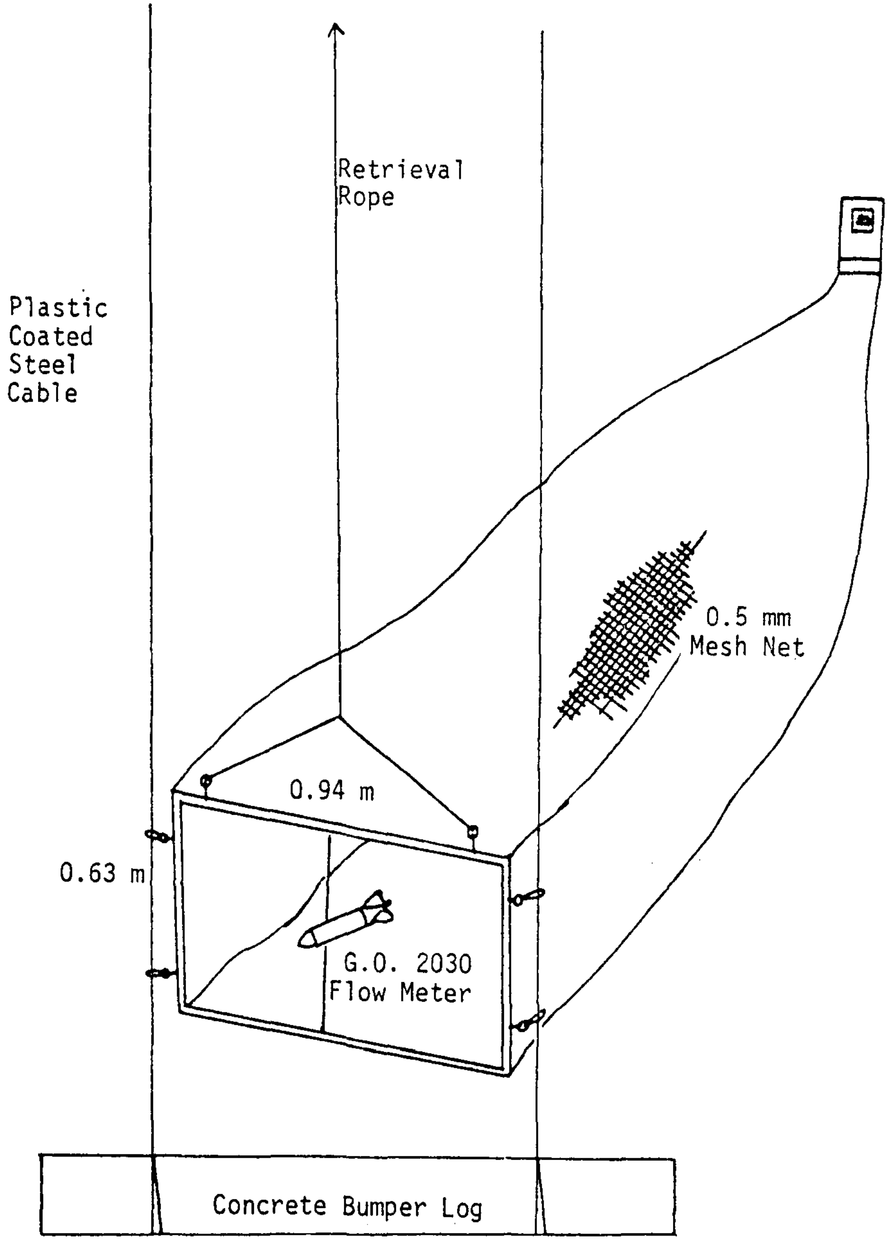

Fig. 2. Larval fish drift sampling gear.

high. A calibrated flow meter (General Oceanics, Inc. Model 2030) was suspended in the mouth of each net to determine the volume of water strained during each sample. The volume of water strained varied among stations and with river flow but the average at each station was greater than 100 m^3. Noticeable variation in catch per 100 m^3 between replicates occurred so all estimates were computed using the average of the 3 replicates at each station.

Identification of the larvae was aided with Fish (1932), Hogue, Wallus, and Kay (1976), Lippson and Moran (1974), Mansueti and Hardy (1967), May and Gasaway (1967), Meyer (1970), and Taber (1969). Terminology for stages of larval fish development was taken from Snyder (1976).

Computational procedures

The numbers of drifting larval fish per 24 hour period (I_{24}) were estimated as:

$$I_{24} = \sum_{p=1}^{3} \sum_{s=1}^{3} (D/3)\,(w_s)\,(T_{s+p}/100)$$

where
- p — the 3 time periods
- s — the 3 river sections
- D — average daily river discharge (m^3) from data gathered by the U.S.G.S. at the Glen Lyn gage station
- w_3 — relative discharge for each section of the river
- T_{s+p} — the average catch per 100 m^3 of each species during each time period

The proportion of the total river discharge (w_s) in each of the 3 sections of the river was estimated from the relative flow rates and average depths of each section. Relative flow rates were calculated using linear regression analyses (Steel and Torrie 1960) on the flow meter readings from the samples. These analyses incorporated different flow rates during all months, since subsets of the data yielded only slightly different results. It was assumed that river dischage was the same during all 3 time periods. Relative river discharge was 0.244 for river section 1 (represented by station 1), 0.378 for section 2 (station 2), and 0.377 for section 3 (station 3).

Numbers of ichthyoplankton that drifted by Glen Lyn each month (I_{mo}) were estimated as follows:

$$I_{mo} = \sum_{e=1}^{m} d_e\,(I_{24})$$

e = the number of 24 hour estimates per month
d = the number of days represented by a 24 hour estimate

It was assumed that the densities and composition of ichthyoplankton per 24 hour estimate and average daily river discharge were the same for all days represented by a single 24 hour estimate. The number of days represented by each 24 hour estimate was determined by taking an equal number of days before and after each estimate, so that all days were represented, unless the 24 hour estimate was the first or last in a month. Then the number of days before and after an estimate might not be equal.

The total number of larval fish drift for each taxon was estimated by summing the month estimates. These estimates were interpreted as representing only the production of the entire New River in the reach immediately upstream of Glen Lyn.

RESULTS AND DISCUSSION

A total of 22 24-hour drift surveys was performed during June through August 1976. Flooding during mid-June and subsequent loss of the gear attached to the bridge prevented sampling during the latter part of June.

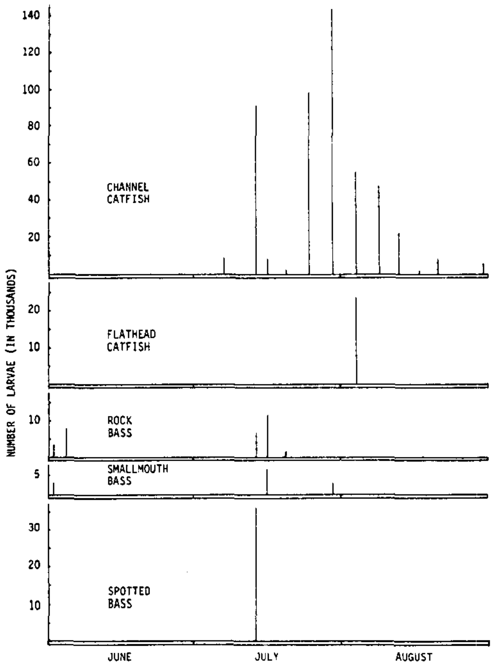

Fig. 3. Estimates of larval sport fish abundance per 24-h in the New River near Glen Lyn, Virginia, during June through August 1976.

Seasonal Distribution

Larvae of channel catfish were collected during July and August. Peak abundances were observed during mid- to late July (Fig. 3). Larvae ranged in size from 14 mm (with yolk sac) to 27 mm. Larval flathead catfish were collected only in early August (Fig. 3) and ranged in size from 18 mm to 21 mm. Larvae of rock bass were collected in early June and mid-July (Fig. 3) and were in proto- to metalarval stages ranging in length from 7 mm to 11 mm. Smallmouth bass larvae were taken in early June and mid- and late July; meso- and metalarval stages were represented (7 mm to 18 mm). Part of the 1976 spawn of smallmouth bass was presumably missed since the period prior to June was not sampled. Subsequent sampling during April and May 1977 yielded smallmouth bass larvae. Larval spotted bass were collected during mid-July (Fig. 3). Meso- and metalarval stages were represented (6 mm to 15 mm). Again, sampling in May 1977 yielded larvae of spotted bass. No larvae of any species were collected after August.

The order in which larvae of the fishes appeared in the drift followed the presumed order of spawning in the New River. Larval spotted bass and smallmouth bass appeared in the drift during May (1977) and remained in the drift through July or August (1976). Larval rock bass were captured only in June and July. This corresponds to the time described by Pflieger (1975), in which spotted bass and smallmouth bass spawn concurrently over an extended period and rock bass spawn during a later and more constricted interval. Larvae of channel catfish and flathead catfish appeared in the drift during July and early August, respectively, corresponding to the reported spawning times of early June and July for channel catfish and late June or July for flathead catfish (Pflieger 1975). Drift of larval rock bass and channel catfish occurred somewhat earlier in New River than in the Susquehanna River (Gale and Mohr 1978), probably in response to latitudinal differences in temperature regimes.

Estimates of Drift

An estimated 1,710,000 channel catfish larvae drifted by Glen Lyn during July (Table 1). An additional 703,000 drifted by Glen Lyn during August. An estimated 162,000 flathead catfish larvae during early August constituted the total drift (Table 1).

Table 1. Estimates of larval sport fish drift per month in New River, near Glen Lyn, Virginia during 1976.

	June	*July*	*August*	*Total*
Channel catfish	0	1710000	703000	2410000[a]
Flathead catfish	0	0	162000	162000
Rock bass	33400	73500	0	106000[a]
Smallmouth bass	6520	40400	0	46900[a]
Spotted bass	0	125000	0	125000

[a]Accuracy to 3 significant figures.

Estimates of 33,400 (June) and 73,500 (July) represented the drift of rock bass. Some 6,520 and 40,400 larval smallmouth bass drifted by Glen Lyn during June and July, respectively. An estimated 125,000 larvae during July constituted the total drift of spotted bass. As was noted earlier, some of the drift for rock bass, smallmouth bass, and spotted bass in 1976 probably was missed prior to June. Estimates of drift during May 1977 included 33,000 smallmouth bass and 55,000 spotted bass.

Relative Abundance of Larvae

Estimates of larval abundance suggested that during 1976 lavae of the channel catfish were at least 10 times more abundant than larvae of other sport fishes. Estimates of abundance of flathead catfish and rock bass were intermediate and of similar magnitude. The relative abundance of smallmouth bass and spotted bass was difficult to assess because a portion of the annual drift may have occurred in May before sampling began. It appeared, however, that smallmouth bass produced the least abundant cohort of the 5 species examined.

Estimates of the spawning populations in the vicinity of Glen Lyn were not available. Rotenone and block net sampling during previous years (Hocutt 1974; Stauffer 1975) revealed that the relative abundance of the resident populations of these 5 sport fishes in the New River near Glen Lyn varied among the 3 years sampled, prhobiting generalization about the relations between abundance of spawning fishes and larval fish abundance.

Interpretation of Estimates of Larval Abundance

The utility of larval abundance estimates based on drift catches is dependent on precision of the sampling design and definitiveness with which the data can be interpreted. As with all fisheries data, these considerations are complicated by variability and complexity of aquatic ecosystems.

Because larval fish drift may vary substantially in composition and abundance over periods shorter than a day, accurate characterization of the larval community requires frequent sampling (Potter 1978). Larval fish drift may be stratified horizontally or vertically and patterns of stratification may change in relation to environmental factors (e.g. change in light during a diel period). A sampling program adequate to account for the changes in all these factors would require nearly continuous monitoring of the drift at several locations. Sampling aimed at specific species, however, probably can be concentrated with regard to depths, locations, and times of year using information found in the existing literature.

Variations in the vulnerability of larvae to sampling would affect the efficiency of drift nets. Vulnerability of fish larvae to towed nets is a function of larval size (Noble 1971), and a similar relation between larval fish size and escape from drift nets is probable. Vulnerability to capture may also vary under different environmental conditions if such factors as light intensity, water clarity, or flow rate affect the distance at which larvae perceive the net. Problems related to vulnerability can be mitigated by restricting estimates to larvae smaller than the size at which avoidance begins or is significant. Establishing a size interval for the fishes included in the estimate also assures that the larvae represent the same stage of development rather than mixed stages drifting from varied locations.

Given that an accurate sampling method can be developed, interpretation of abundance estimates is complicated by the one-way-flow of riverine systems. Larvae drifting past a location represent upstream spawning. The distance which the larvae traveled must be determined before the spawning stock can be identified. The stock of fish to which the drifting larvae eventually are recruited must also be determined before year-class strength, mortality, or other population phenomena may be predicted.

Despite these problems, drift estimates may represent an effective technique for estimating the absolute abundance of fish at an early developmental stage. Drift sampling can readily be standardized and described which permits collection and replication of large samples with relative ease. Estimates of larvae seem particularly valuable for game species which are difficult to sample at later stages because of clumped distributions, inaccessible habitats, or low abundance. Provided that mortality relations from larval to adult stages can be modeled, larval estimates may give managers the lead time necessary for implementation of truly effective management strategies.

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