

# Effects of Excavation and Snagging on the Fish Populations of a Coastal Stream in North Carolina

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*Abstract:* Island Creek, a tributary of the Northeast Cape Fear River in Duplin County, North Carolina, was modified through excavation and snagging during 1977 and 1978. To evaluate the effects on resident fish populations, rotenone samples were taken before alteration in 1977 and after the project in 1981 and 1982. Mean standing crop of fish increased from 27.5 to 38.3 kg/ha after the project and total number of fish captured increased from 424 to 1,058. Significantly greater ( $P < 0.05$ ) centrarchid and total game fish biomass were found after the project. No statistically significant differences could be detected between biomass and numbers of nongame fish or numbers of game fish before and after the project.

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The adverse environmental impacts of conventional channelization on lotic resources have resulted in development of alternative drainage and flood control techniques designed to be less damaging to streams and wetlands. Among the proposed alternatives are snagging, clearing, and limited excavation. Excavation usually involves limited sediment removal from the existing stream course with no widening or straightening of the channel. Increases in channel capacity and flood protection are usually less than with channelization projects. Nunnally and Keller (1979) utilized a channel design to reduce flooding of urban streams that involved creating a meandering channel, debris removal, and bank stabilization with riprap and revegetation. Limited excavation of major sediment blockages coupled with debris removal and limited bank disturbance were part of the design guidelines of the Wolf River project by the Soil Conservation Service in Tennessee (McConnell et al. 1980).

A number of researchers have described the effects of channelization on aquatic ecosystems (Tarplee et al. 1971, Zimmer and Bachman 1976, Huish

and Pardue 1978, and Groen and Schmulbach 1978). Comparatively little is known about the effects of alternative drainage projects on fish populations. This study was initiated to evaluate the effects of snagging and excavation on the fish assemblage in Island Creek, a coastal plains stream in Duplin County, North Carolina.

## Methods

Island Creek is a permanent, second order stream with a length of 14.5 km and a drainage area of 80 km<sup>2</sup>. Stream gradient averages 0.75 m/km. The stream is typical of non-tidal, coastal plain, swamp forest streams with wide floodplains in the lower reaches and semi-permanent swampy areas in low-lying sections. The upper 12.5 km of the stream were excavated by the North Carolina Department of Human Resources, Division of Health Services for mosquito control. A hydraulic backhoe excavator was used to deepen the stream without widening or straightening the channel. Mean depth of excavation was about 1 m. A temporary right-of-way was cleared along one side of the stream for the operation of equipment and the spoil was placed along this corridor in discontinuous piles. Logs and other woody material were snagged from the lower 2 km of Island Creek.

Pre-alteration fish population samples were taken by the North Carolina Wildlife Resources Commission in July 1977 (Borawa and Little 1979). Five 60-m sections were sampled with 5% emulsifiable rotenone at a concentration of 2 ppm for 5 minutes. Block nets were employed at both the upstream and downstream limits of the sample areas. Four of the 5 sample sections were re-sampled in August of 1981 and 1982. A localized fish kill at the fifth section necessitated its omission. Two sample areas (NC 41 confluence and bridge) were located in the snagged portion of Island Creek and 2 areas (NC 11 and SR 1102) were within the excavated section. The sample area sizes were 579.5 m<sup>2</sup> (NC 41 confluence), 451.4 m<sup>2</sup> (NC 41 bridge), 496.0 m<sup>2</sup> (NC 11), and 236.5 m<sup>2</sup> (SR 1102). Fish collected were either weighed and measured (total length) in the field or preserved in 10% formalin and identified, weighed, and measured in the laboratory. A paired student's *t*-test ( $P < 0.05$ ) was used to evaluate differences between standing crop and numbers of fish before and after the project (Snedecor and Cochran 1967).

## Results and Discussion

The results of the study indicate snagging and excavation of Island Creek had little measurable impact on the fish assemblage 4 to 5 years post-project. A total of 1,058 fish representing 25 species were collected post-project (Table 1). In comparison, the 1977 samples contained 424 fish and 21 species. Mean standing crop increased from 27.5 to 38.3 kg/ha (Table 2). Game fish increased from 8.2 to 21.7 kg/ha while nongame fish decreased from 19.3 to

**Table 1.** Number and weight of fishes collected from Island Creek before and after excavation and snagging. Pre-alteration data are from Borawa and Little (1979).

	Pre-project (1977)		Post-project (1981-1982)	
	N	Wt. (g)	N	Wt. (g)
Longnose gar ( <i>Lepisosteus osseus</i> )			2	17
American eel ( <i>Anguilla rostrata</i> )	3	143	21	510
Redfin pickerel ( <i>Esox americanus</i> ) <sup>a</sup>	4	326	7	199
Chain pickerel ( <i>Esox niger</i> ) <sup>a</sup>	1	112	2	59
Golden shiner ( <i>Notemigonus crysoleucas</i> )			3	43
Highfin shiner ( <i>Notropis altipinnis</i> )	4	5		
Ironcolor shiner ( <i>Notropis chalybaeus</i> )	1	1		
Dusky shiner ( <i>Notropis cummingsae</i> )			5	4
Coastal shiner ( <i>Notropis petersoni</i> )	72	200	240	298
Creek chubsucker ( <i>Erimyzon oblongus</i> )	3	56	13	78
Spotted sucker ( <i>Minytrema melanops</i> )	3	2,200	4	229
Snail bullhead ( <i>Ictalurus brunneus</i> )			84	806
White catfish ( <i>Ictalurus catus</i> )			2	5
Flat bullhead ( <i>Ictalurus platycephalus</i> )	17	314	32	253
Margined madtom ( <i>Noturus insignis</i> )			31	186
Pirate perch ( <i>Aphredoderus sayanus</i> )	83	238	121	165
Mosquitofish ( <i>Gambusia affinis</i> )	34	23	13	7
Flier ( <i>Centrarchus macropterus</i> ) <sup>a</sup>			1	18
Bluespotted sunfish ( <i>Enneacanthus gloriosus</i> )	71	97		
Redbreast sunfish ( <i>Lepomis auritus</i> ) <sup>a</sup>	18	804	147	2,635
Pumpkinseed ( <i>Lepomis gibbosus</i> ) <sup>a</sup>	6	67	9	89
Warmouth ( <i>Lepomis gulosus</i> ) <sup>a</sup>			13	202
Bluegill ( <i>Lepomis macrochirus</i> ) <sup>a</sup>	14	136	60	369
Largemouth bass ( <i>Micropterus salmoides</i> ) <sup>a</sup>	2	1	17	264
Tessellated darter ( <i>Etheostoma olmstedii</i> )	76	134	203	209
Sawcheek darter ( <i>Etheostoma serriferum</i> )	2	1	2	2

Table 1. Continued

	Pre-project (1977)		Post-project (1981-1982)	
	N	Wt. (g)	N	Wt. (g)
Piedmont darter ( <i>Percina crassa</i> )	4	2		
Shield darter ( <i>Percina peltata</i> )	3	1	1	2
Hogchoker ( <i>Trinectes maculatus</i> )	3	3	25	123
Total	424	4,864	1,058	6,772

\* Game fish.

16.6 kg/ha. A comparison of sample areas showed an increase of game fish biomass in all 4 sample areas while nongame fish increased in 2 and decreased in 2. Numbers of game fish increased at all 4 stations while nongame fish increased at all but the furthest upstream site, SR 1102 (Table 3). The paired *t*-test suggests centrarchid and total game fish biomass were significantly greater ( $P < 0.05$ ) after the project. No significant differences were detected between numbers and weight of nongame species or numbers of game fish before and after the project. The average weight of game fish, however, declined from 31 to 15 g. Weight of nongame fish was similar before and after snagging and excavation.

No major changes in species composition were apparent after the project. Centrarchids, as a percentage of the total number of fish captured, remained similar before and after the project (26% vs. 23%), as did percids (20% vs. 19%) and esocids (1% vs. 1%). Within the sunfish family, however, were changes in relative abundance. The bluespotted sunfish (*Enneacanthus gloriosus*) were predominant in 1977 while the redbreast sunfish (*Lepomis auritus*), bluegill (*L. macrochirus*), and largemouth bass (*Micropterus salmoides*) were relatively more abundant in 1981 and 1982. Pirate perch (*Aphredoderus sayanus*) declined from 20% to 11% of the total number. Cyprinids increased from 18% to 23% as did the ictalurids (4% to 14%). Eight species collected in the post-project samples were not found in pre-project sampling while 4 previously collected species were not present in the 1981 and 1982 samples (Table 1).

Four of the species not found in 1977, warmouth (*Lepomis gulosus*), flier (*Centrarchus macropterus*), golden shiner (*Notemigonus crysoleucas*), and dusky shiner (*Notropis cummingsae*), had been collected from Island Creek in an earlier survey (Bayless 1963). With the exception of the snail bullhead (*Ictalurus brunneus*) and the margined madtom (*Noturus insignis*), all occurred in low numbers ( $N < 20$ ) and it is not known if their presence or absence is a function of invasion or depletion or a result of the inability of limited sampling to detect all species present. The failure to identify the snail bullhead pre-project which comprised 8% of the total number of fish post-project, was likely the result of a failure to distinguish it from the flat bullhead

**Table 2.** Weight and estimated standing crop of fish per hectare from Island Creek rotenone samples, August 1981 and August 1982. Numbers in parentheses are from the 1977 study (Borawa and Little 1979).

Sample area	Weight (g) game	Weight (g) nongame	Weight (g) total	Kg/ha game	Kg/ha nongame	Kg/ha total
NC 41 confluence	573 (202)	731 (2,334)	1,304 (2,536)	9.9 (3.5)	12.6 (40.3)	22.5 (43.8)
NC 41 bridge	1,062 (614)	1,407 (180)	2,469 (794)	23.6 (13.6)	31.3 (4.0)	54.9 (17.6)
NC 11 bridge	716 (57)	353 (159)	1,069 (216)	14.3 (1.2)	7.1 (3.2)	21.4 (4.4)
SR 1102 bridge	1,484 (573)	446 (745)	1,930 (1,318)	61.8 (21.6)	18.6 (31.5)	80.4 (53.7)
Mean (weighted by sample area)				21.7 (8.2)	16.6 (19.3)	38.3 (27.5)

**Table 3.** Number and estimated number of fish per hectare from Island Creek rotenone samples, August 1981 and August 1982. Numbers in parentheses are from the 1977 study (Borawa and Little 1979).

Sample area	N game	N nongame	N total	N/ha game	N/ha nongame	N/ha total
NC 41 confluence	104 (4)	343 (80)	447 (84)	1,793 (69)	5,914 (1,379)	7,707 (1,448)
NC 41 bridge	28 (16)	130 (81)	158 (97)	622 (356)	2,889 (1,800)	3,511 (2,156)
NC 11 bridge	72 (4)	274 (73)	346 (77)	1,452 (81)	5,524 (1,472)	6,976 (1,553)
SR 1102 bridge	52 (21)	55 (145)	107 (166)	2,167 (875)	2,292 (6,042)	4,459 (6,917)
Mean (weighted by sample area)				1,446 (254)	4,531 (2,141)	5,977 (2,395)

(*Ictalurus platycephalus*). Of the 4 species not observed post-project, only the bluespotted sunfish was abundant ( $N > 20$ ). The loss of the bluespotted sunfish, which comprised 17% of the pre-project numbers, may have resulted from changes in habitat and competition with other species. This sunfish is usually associated with shallow, low velocity streams and requires areas of aquatic vegetation for nest construction and spawning.

No consistent differences were noted between the snagged and excavated sections with regard to standing crops, numbers, or species composition. The excavated channel of Island Creek has generally stabilized over the past 4 years. The following of the natural meanders has resulted in the maintenance of deeper water habitats, usually eliminated by conventional channelization. The increase in water velocity has reduced areas of silt and detritus deposition in favor of sand dominated substrates and has resulted in bank erosion in several locations, primarily on the outside of meanders below straight sections. Based on informal observation, snagging and excavation has decreased in-stream cover for fishes. As the cover (logs, brush, tree tops, and vegetation) is regenerated, further changes in the fish assemblage may occur. While standing crop may not change, it is likely that the proportion of larger, cover-oriented species (bass, sunfish, and pickerel) will increase. The standing crop in Island Creek before the project was low in comparison to similar coastal streams. Apparently, factors limiting abundance were not significantly altered by the project.

More productive streams may suffer negative impacts to snagging and excavation not evidenced in Island Creek. Changes in biotic or abiotic factors, such as instream cover, may result in significant reductions in fish abundances if the impacted factors are, or become, limiting. Additional work should be undertaken on Island Creek to evaluate channel stability, low flow conditions and water quality changes associated with reduced frequency and duration of out-of-bank flow and the filtering capacity of the floodplain.

The growth of human populations in flood prone areas and the demand for agricultural drainage assure the continued presence of stream alteration projects. The utilization of new techniques may offer a compromise which allows some water management yet minimizes the degradation of aquatic systems.

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