ATTRACTION OF NATIVE FISH TO CATFISH CULTURE CAGES IN RESERVOIRS[1]

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ABSTRACT

Experimental gill nets were fished at sites with and without cages in which catfish were fed pelleted feed in lakes Hartwell and Keowee, South Carolina, during 1972, 1973, and 1974. Native fishes were indentified, counted, and weighed. Of 34 species captured in the two lakes the most numerous were threadfin and gizzard shad, carp, bullhead species, white bass, bluegill, and largemouth bass. Total numbers of fish caught in each lake were greater at cage sites than at control sites after stocking cages, and total weight of fish caught in Lake Keowee was greater at cage sites than at control sites after stocking the cages and for the overall experiment, but not before stocking.

INTRODUCTION

With the increasing interest in aquaculture, and, in particular, culture of fish in cages there is a need for information on the influence that cage culture has on the aquatic environment. Fishes have been cultured in cages in Asia at least since the early 20th Century (Hickling 1962) and more recently in North America. Collins (1971), Holmes et al. (1974), Lewis (1969), and Schmittou (1970) investigated aspects of culturing caged catfish species and Pagan (1969) cultured caged tilapia. Burch (1975) and Murrell (1973) studied the effects of caged catfish culture on the surrounding water quality and Aldridge and Loyacano (1974) examined the incidence of parasites on native fishes captured near catfish cages. Although Collins (1971) noted that there was "dense population of bluegill and redear sunfishes" around his cages and native catfish were also observed feeding upon pellets splashed from his cages, there has been no previous attempt to quantify the attraction of native fish to catfish culture cages. In addition to the attraction of pelleted feed lost from them, the cages may also serve as shelter for native fish species and as attachment surface for invertebrates that fish feed upon. Culture of fish in cages may have the added advantage of concentrating native fishes, thus making them more accessible to the sport fisherman and increasing the harvest.

The objective of this study was to investigate the degree to which native fish were attracted to catfish culture cages in reservoirs. The work was supported in part by the Office of Water Resources Technology and by the Southeast Reservoir Investigations, both of the U. S. Department of the Interior.

MATERIALS AND METHODS

Study Area

The experiment was conducted at sites in lakes Hartwell and Keowee, South Carolina (Fig. 1). Lake Hartwell is a 24,300-ha impoundment on Savannah River and Lake Keowee is a 7,300-ha impoundment immediately above Lake Hartwell on Keowee River, a tributary to Savannah River. Some principal differences in the lakes are that Keowee serves as the cooling water source for a nuclear power plant, is associated with a pump storage reservoir above it, and contains no white bass or gizzard shad; whereas Hartwell supports only hydroelectric facilities and contains large populations of white bass and gizzard shad.

Cages

Six 1-m^3 floating fish cages of 1.27- × 2.54-cm-mesh welded wire were united with a wooden frame and placed at each of three sites in Lake Hartwell on 15 May 1972 (Fig. 2) and two sites in Lake Keowee on 9 May 1973 (Fig. 3). Surface area encompassed by the six cages was 8.9 m^2. Each cage was equipped with a feeding ring to minimize feed loss. The batteries of cages were secured by cables to steel stakes on shore and concrete anchors in deeper water.

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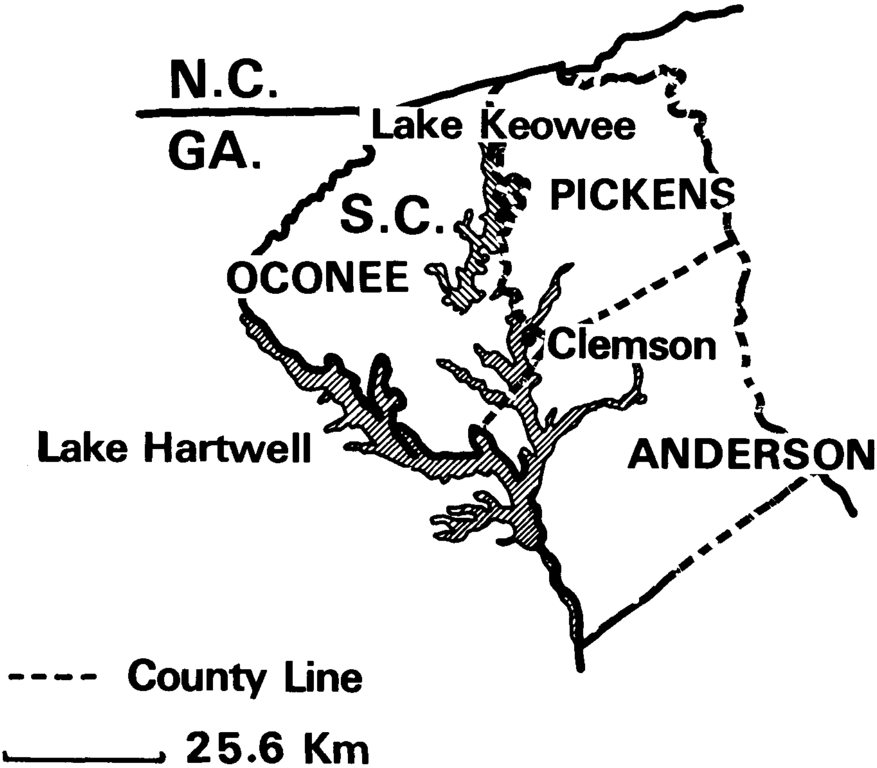

Figure 1. Lakes Hartwell and Keowee, South Carolina.

Culture of Fish

All cages were stocked with channel catfish, all of which were fed Purina Catfish Cage Chow 6 days/wk. Each cage in Lake Hartwell was stocked with 200 fingerlings on 19 May 1972 and 200 more on 26 May 1972. Total mean weight of the 400 fish/cage was 8.5 kg (51.0 kg/cage site). From 29 May through 9 October the fish at each of the three sites received a total of 1616.4 kg of feed, and they were harvested on 27 October 1972.

Each cage in Lake Keowee was stocked with 18.7 kg (approx. 259 fish) of ungraded fingerlings on 1 August 1973. Because of the high air temperature (31°C) prevailing at that time, the fish were stocked by weight to avoid the additional handling stress necessitated by counting individual fish. Total weight of the fish at each site was 112.2 kg. They were harvested on 26 February 1974 after receiving a total of 1,355.0 kg feed/cage site. All cages were restocked on 1 March 1974 with 400 fingerlings that had a mean weight of 17.3 kg/cage (103.8 kg/cage site). They were harvested on 21 August 1974 after receiving 494.7 kg of feed/cage site.

Capture of Native Fish

Fish were collected in sinking experimental gill nets, 1.8-m deep and 37.5-m long, which were divided into five equal-length panels. Mesh size of the panels progressed from 1.27 to 6.25 cm. One net was fished overnight at each of the cage sites and at a corresponding control site without cages for each cage site (Fig. 2 and 3) at 4-wk intervals during the sampling periods.

In Lake Hartwell native fish were collected from March 1972 through February 1973. The nets were set parallel to shore with the small-mesh end adjacent to the battery of cages at cage sites.

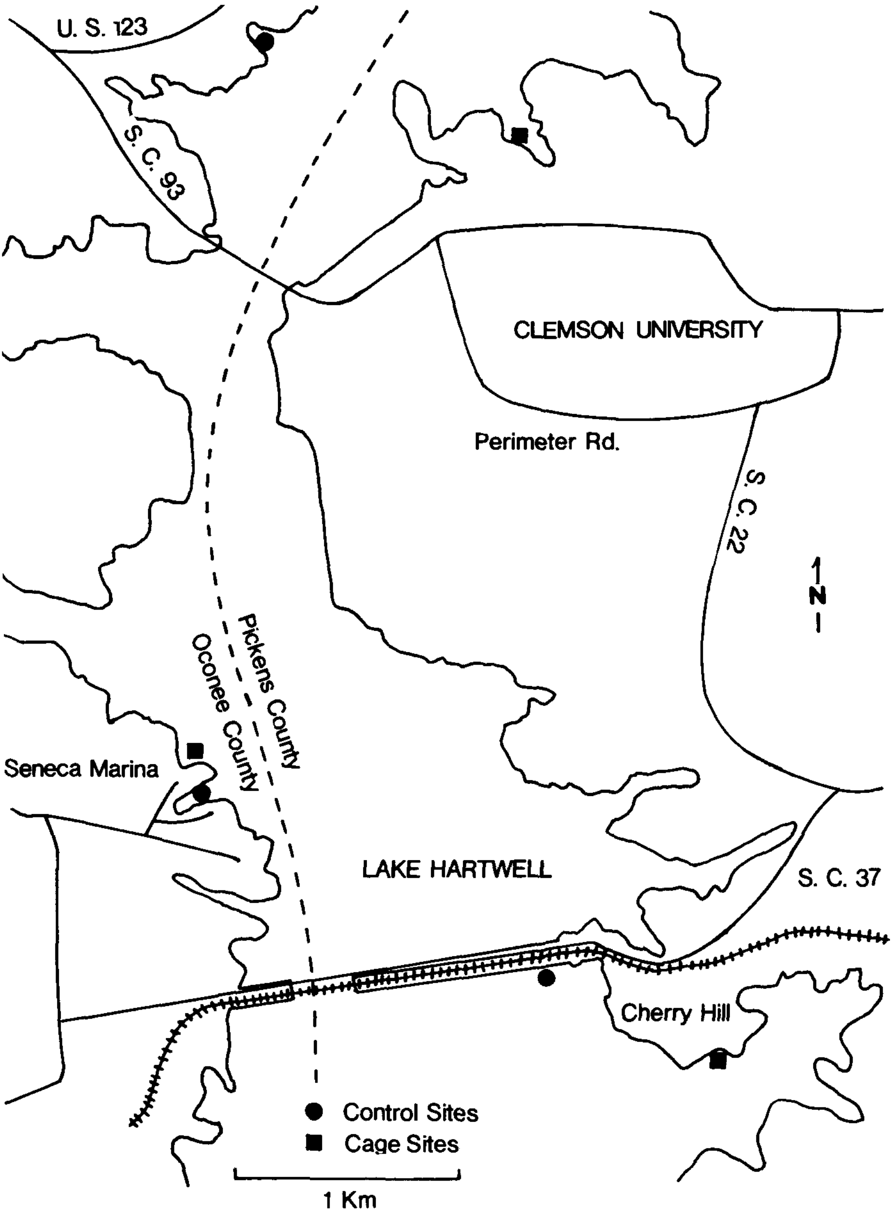

Figure 2. Sites for study of native fishes near catfish cages in Lake Hartwell, South Carolina. From Aldridge and Loyacano (1974).

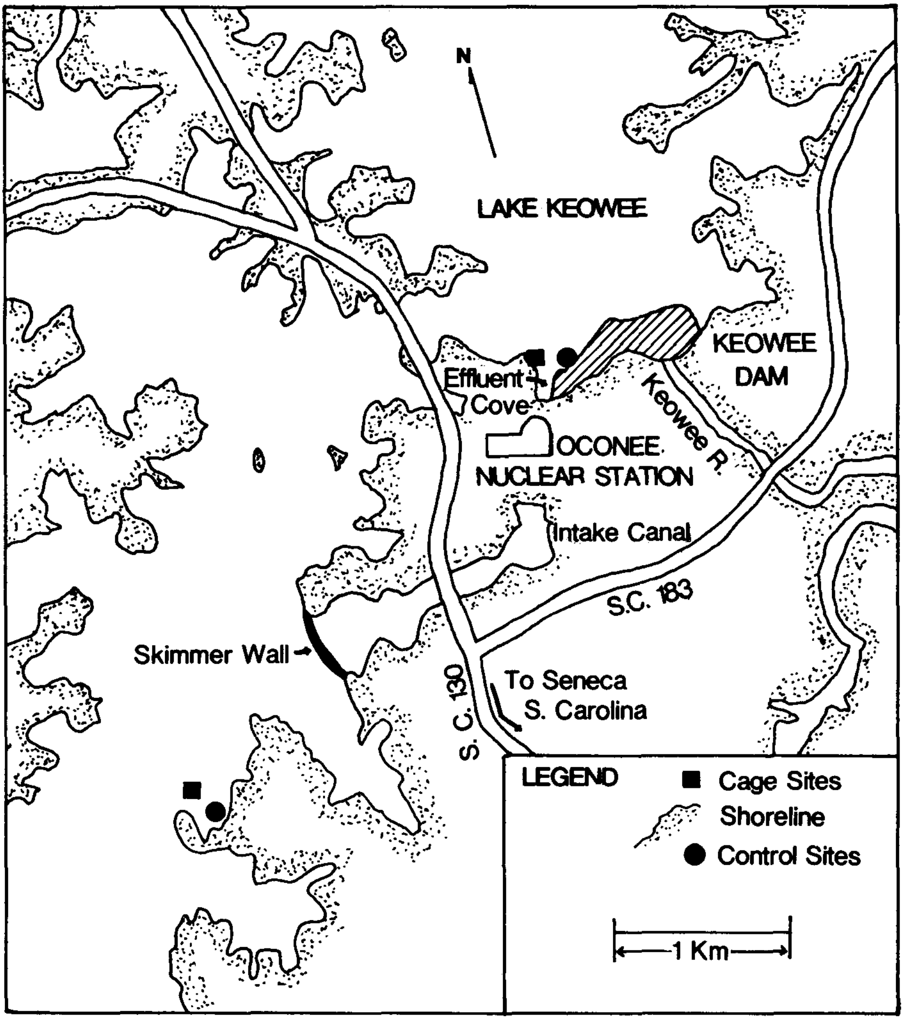

Figure 3. Sites for study of native fishes near catfish cages in Lake Keowee, South Carolina. From Burch (1975).

In Lake Keowee native fish were collected from February 1973 through July 1974. The nets were set perpendicular to shore with the small-mesh end tied at the shore and the large-mesh end anchored offshore. At cage sites the nets were adjacent to the cages.

All fish were identified according to Eddy (1969), Moore (1968), and Yerger and Relyea (1968); counted; measured to the nearest millimeter; and weighed to the nearest gram. Common names were taken from American Fisheries Society (1970).

Data were subjected to chi-square or analysis of variance as appropriate. Differences at the 0.05 level of probability were considered significant. Prestocking data were tested as a covariate. Data were tested both arithmetically and logarithmically.

Numbers and weights of gizzard shad, carp, white bass, bluegill, and black crappie from Lake Hartwell, and threadfin shad, carp, bluegill, and largemouth bass from Lake Keowee were analyzed separately by species.

RESULTS

Lake Hartwell

Number and weight for each species collected at cage and control sites before stocking cages, after stocking, and after harvest are shown in Table 1. Gizzard and threadfin shad, carp, quillback, white bass, and bluegill were the most numerous species, and gizzard shad, carp, quillback, bullhead (snail, brown, and flat), white bass, striped bass × white bass, and largemouth bass accounted for most of the weight.

There was no significant difference in number or weight of captured fish between cage and control sites for the overall experimental period. Although numerical differences in weights were great (Table 1), weight differences between cage and control sites were not significant ($P=0.05$) for any of the three separate periods. Numbers of fish caught were not significantly different between cage and control sites before stocking and after harvest, but they were significantly greater at cage sites than at control sites after stocking.

Number and weight of gizzard shad, when treated logarithmically, were significantly greater at cage sites than at control sites after stocking, but there were no other significant treatment differences for this species. Number and weight of bluegill were much greater at cage sites than at control sites after stocking. There were no treatment differences for any of the periods for either carp, white bass, or black crappie, except that the number of black crappie was significantly greater at cage sites than at control sites after harvest.

Lake Keowee

Number and weight for each species collected at cage and control sites before and during culture of catfish are shown in Table 2. Carp, silver redhorse, flat bullhead, bluegill, and largemouth bass were the most numerous species, but in addition to those, quillback and spotted sucker, accounted for most of the weight.

The total number and weight of native fish captured were significantly greater at cage sites than at control sites for the entire experimental period and after stocking the cages, but there were no significant treatment differences in number or weight before stocking (Table 2). Number and weight of threadfin shad after stocking were significantly greater at cage sites than at control sites. No shad were collected prior to stocking. This species was introduced after the experiment began. There were no treatment differences in number or weight of carp for any of the periods. Number and weight of bluegill were significantly greater at cage sites than at control sites after stocking, but there were no differences before stocking or overall. The number of largemouth was insufficient to test by chi-square for before or after stocking, but for the entire period the number and weight of largemouth bass were significantly greater at cage sites than at control sites.

DISCUSSION

This experiment has shown that the numbers of wild fish at a site are increased by cage culture, and although the substantial numerical increase in weight was not statistically significant in Lake Hartwell, it was significant in Lake Keowee.

The plankton feeding shad may have been attracted to the fine particles of feed that drifted downward as the pellets disintegrated in the water. Burch (1975), however, found no increase in turbidity at cage sites. Although gizzard and threadfin shad provide no fishery, they are important prey for white bass and largemouth bass, neither of which was attracted to the cages in Lake Hartwell.

Table 2. Total numbers and weights (grams) of native fishes caught in gill nets at cage and control sites in Lake Keowee before and during culturing catfish in cages in 1973 and 1974

	Before				During			
	Cage		Control		Cage		Control	
Species	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
Threadfin shad	0		0		16	123	8	63
Chain pickerel	0		1	506	1	225	0	
Carp	21	11320	21	9019	21	10992	11	5900
Golden shiner	0		4	427	1	130	0	
Spottail shiner	0		0		2	16	0	
Whitefin shiner	1	12	0		11	159	1	8
Quillback	1	386	1	383	6	4720	0	
Spotted sucker	1	403	2	1076	2	1090	1	680
Silver redhorse	0		10	4055	15	11730	8	5145
Smallfin redhorse	0		0		0		2	1305
Brown bullhead	0		0		0		1	255
Flat bullhead	5	630	2	432	11	1985	2	404

Table 1. Total numbers and weights (grams) of native fishes caught in gill nets at cage and control sites in Lake Hartwell before, during, and after culturing catfish in cages in 1972 and 1973

	Before				During				After			
	Cage		Control		Cage		Control		Cage		Control	
Species	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
Longnose gar	0		0		0		0		1	1200	1	1960
Gizzard shad	9	2384	17	5470	74	19387	16	4002	28	7590	20	6820
Threadfin shad	97	706	108	825	99	1073	9	90	9	76	1	7
Chain pickerel	0		0		0		0		1	540	0	
Goldfish	0		0		0		0		1	920	1	1080
Carp	12	13740	10	12190	13	14885	7	7255	2	4120	4	4620
Silvery minnow	0		0		0		0		1	20	0	
Golden shiner	3	194	0		16	1371	3	201	3	238	0	
Whitefin shiner	1	7	0		4	41	0		2	23	0	
Quillback	20	21350	6	5560	3	3600	22	20700	5	5710	3	3060
Silver redhorse	2	1870	0		0		0		0		0	
White catfish	1	180	1	280	5	1532	5	1140	0		2	780

Table 1. (Continued)

	Before				During				After			
	Cage		Control		Cage		Control		Cage		Control	
Species	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
Bullhead [a]	5	1040	12	2527	16	2627	5	1000	9	2175	14	1769
Channel catfish	0		0		1	320	0		0		0	
White bass	20	13945	21	13960	4	1700	3	1780	43	26222	15	9650
Hybrid bass [b]	13	20080	8	12080	2	1660	0		7	12328	1	960
Redbreast sunfish	0		0		0		0		1	40	0	
Pumpkinseed	0		0		0		1	290	0		0	
Warmouth	0		0		1	6	0		0		0	
Bluegill	10	750	8	461	38	4498	6	343	2	280	1	120
Redeye bass	0		0		0		0		1	380	0	
Largemouth bass	1	1100	6	4640	7	1927	7	2592	7	5590	5	2030
White crappie	1	370	0		0		1	160	3	385	1	70
Black crappie	12	1876	5	292	9	1538	4	610	15	2190	6	1160
Yellow perch	6	51	2	20	8	106	1	9	6	53	3	70
Walleye	0		0		1	10	3	4320	4	4760	4	4660
TOTAL	213	79643	205	58215	301	56281	93	44492	154	75008	82	38816

Table 1. (Continued)

[a] Snail bullhead, brown bullhead, and flat bullhead were combined in the field.

[b] Striped bass x white bass.

Table 2. (Continued)

	Before				During			
	Cage		Control		Cage		Control	
Species	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
Redbreast sunfish	0		1	215	0		0	
Green sunfish	0		0		2	11	0	
Warmouth	4	75	0		4	128	0	
Bluegill	6	223	8	1181	12	2101	2	194
Dollar sunfish	0		0		1	57	0	
Redeye bass	0		0		2	313	0	
Largemouth bass	9	1104	1	85	7	1199	2	425
Black crappie	2	260	0		2	289	3	380
Yellow perch	3	699	2	370	0		3	890
TOTAL	53	15112	53	17749	116	35268	44	15649

Largemouth bass were more numerous at cage sites than control sites in Lake Keowee, before and after the cages were installed.

The fact that carp were not significantly more abundant in gill net catches from cage sites than at control sites was surprising, because carp were very much in evidence throughout the period that catfish were fed in cages. They swarmed around the cages at feeding time and were observed sweeping the area taking pellets at the surface and showing little concern for the movements of the feeding boat.

Reports from local fishermen indicated that bluegill fishing was excellent near the catfish cages. Although the catch of bluegill in gill nets was not very great, it did demonstrate that bluegill were more abundant near the cages than elsewhere in both lakes. This agrees with observations by Collins (1971).

Although an efficient, properly managed caged catfish operation could not tolerate the loss of appreciable amounts of feed, there would almost certainly be some small particles that would escape from the cages into the surrounding water. Whether this food or an increase in natural food organisms resulting from the metabolic wastes of the catfish and the surface area of the cages attracted native fishes, the ultimate result could be an overall increase in productivity of the water in that immediate area, increased growth rate of the fish and a concentration of sport fish that would be more susceptible to angling. Except in a eutrophic lake, the cage culture of fish should be desirable, as it allows more efficient utilization of the water column by both the fish farmer and the sport fisherman without necessarily destroying water quality (Burch 1975) or increasing incidence of parasites on native fishes (Aldridge and Loyacano 1974).

LITERATURE CITED

Aldridge, E. C., and H. A. Loyacano. 1974. Parasites from fish collected in proximity to catfish cages. Proc. Southeastern Assoc. Game and Fish Comm. 27:630-642.

American Fisheries Society. 1970. A list of common and scientific names of fishes from the United States and Canada. Amer. Fish Soc. Spec. Pub. 6 150 pp.

Burch, M. M. 1975. Cage culture of channel catfish, *Ictalurus punctatus*, and resulting water quality in the effluent of Oconee Nuclear Station, South Carolina. M.S. Thesis. Clemson University.

Collins, R. A. 1971. Cage culture of catfish in reservoir lakes. Proc. Southeastern Assoc. Game and Fish Comm. 24:489-496.

Eddy, S. 1969. How to know the freshwater fishes. W. C. Brown Co., Dubuque, Iowa. 253 pp.

Hickling, C. F. 1962. Fish Culture. Faber and Faber, London. 295 pp.

Holmes, D. W., V. M. Douglass, and R. T. Lackey. 1974. Pond and cage culture of channel catfish in Virginia. J. Tenn. Acad. Sci. 49(2):74-78.

Lewis, W. M. 1969. Cage culture of channel catfish. The Catfish Farmer 1(4):5-9.

Moore, G. A. 1968. Fishes. Pages 21-165 *in* Blair, W. F., A. P. Blair, P. Brodkord, F. R. Cagle, and G. A. Moore, Vetebrates of the United States. McGraw-Hill Book Co., New York.

Murrell, J. L. 1973. The intensive cage culture of channel catfish, *Ictalurus punctatus* (Raf), in the intake and discharge canals of a steam electric generating station, Trinidad, Texas. M.S. Thesis. Texas A&M University.

Pagan, F. A. 1969. Cage culture of tilapia. FAO Fishculture Bull. 2(1):6.

Schmittou, H. R. 1970. The culture of channel catfish, *Ictalurus punctatus* (Rafinesque), in cages suspended in ponds. Proc. Southeastern Assoc. Game and Fish Comm. 23:226-244.

Yerger, R. W., and K. Relyea. 1968. The flat-headed bullheads (Pisces: Ictaluridae) of the southeastern United States, and a new species of *Ictalurus* from the Gulf Coast. Copeia 1968:361-384.