NOTES ON THE BIOLOGY AND COMMERCIAL FISHERY OF THE CATFISH OF THE JAMES RIVER, VIRGINIA

by

ROBERT WINSTON MENZEL

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INTRODUCTION

The catfish is one of the more important commercial fishes in the rivers of Virginia. In its restricted area of distribution the catfish ranks with the shad and rock in importance. The fishery in this state is centered mainly in two river systems, the James and Potomac.

In many states the catfish is highly esteemed as a food fish, but many people in Virginia do not regard it as such. This may be due largely to the abundance of other fish and also to the fact that many local people are not aware of its food value. It is often referred to as "nigger food". Pearson[1] in a review of colonial fishes and fisheries of Virginia states that the catfish was mentioned as early as 1614 as being one of the fishes occurring in the James River. Pearson[2] also tells of a writer in 1705 trying to revive the interest in commercial fishing for fish that were slighted, naming the sturgeon, thorn-ray, and catfish.

Smith described briefly the breeding habits of the yellow bullhead under aquarium conditions. Coker in 1929 and Murphree in 1942 working in the Mississippi watershed outline methods of propagating the catfish in artificial ponds. These studies together

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[1]Pearson, John C., "The Fishes and Fisheries of Colonial Virginia" (Williamsburg, Va., July, 1942), p. 215.

[2]*Ibid.* (January, 1943), p. 7.

with several brief accounts of the food of three species, namely, Ameiurus nebulosus LeSuer, A. natalis LeSuer, and A. melas Rafinesque, comprise practically the only work done in America on the biology of this group of fishes. Apart from scattered literature references, these constitute the main contributions to the breeding habits of the catfish. There have been several accounts of the food of the channel cat and the yellow bullhead. Little work has been done on the biology of the catfish in Virginia or elsewhere.

Despite the economic value of the catfish, among fresh water species in the United States second only to the lake trout in value, there is little attention in the literature on the commercial fishery, nor has there been any attempt to study the yearly fluctuations in abundance and in fishing effort so as to provide a basis for increasing the current supply. With the increasing demands for food arising out of the present war, a study of this particular fishery is considered timely.

BIOLOGY

OCCURENCE AND SPECIES OF CATFISH IN THE JAMES RIVER

The catfishes belong to the order Nematognathi. This order is divided by Jordan, Evermann, and Clark in their checklist of fishes into the Ariidae, sea catfishes, and Ameiuridae, bullheads and channel cats. The old family name, Siluridae, which formerly included all of the members of the order, is now applied only to a small group of large river fishes of Europe and Asia. Jordan, Evermann, and Clark list thirty-three species of catfish in the family Ameiruidae in the inland waters of the United States and two species of sea cats in the family Ariidae on the Atlantic coast.[1]

Of the family Ariidae, only Felichthys felis Linnaeus has been observed in the lower James River. It has been reported several times. Hildebrand and Schroeder list this species as occurring in the fishes of the Chesapeake Bay.[2] Truitt, Bean, and Fowler also list it for Maryland waters.[3] Smith lists two species of sea catfish Galeichthys milberti Curvier and Valenciennes

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[1]Jordan, David S., Barton W. Evermann, and Howard W. Clark, Check List of the Fishes and Fish-like Vertebrates of North and Middle America North of the Northern Boundary of Venezuela and Columbia (Washington, D.C., 1928), pp. 147 - 159.

[2]Hildebrand, Samuel F. and William C. Schroeder, Fishes of Chesapeake Bay (Washington, D.C., 1928), p. 127 - 28.

[3]Truitt, Reginald V., Barton A. Bean, and Henry W. Fowler, The Fishes of Maryland (Annapolis, Md., 1929), p. 34.

and *F. felis* as occurring in North Carolina coastal waters.[4]

All of the commercially important species belong to the family *Ameiuridae*. According to Norman only one species of this family is found outside of North America.[5] Species found in the James River are *Ictularus punctatus* Rafinesque, *Ameiurus nebulosus* Bean, *A. catus* linnaeus, *A. ponderosus* Bean, and *Schilbeodes*

Fig. 1

SPECIES OF CATFISH FROM LEFT TO RIGHT: CHANNEL CAT, *I. PUNCTATUS*; YELLOW BULLHEAD, *A. NEBULOSUS*; WHITE BULLHEAD, *A. CATUS*

[4]Smith, Hugh M., *Fishes of North Carolina* (Raleigh, N.C., 1907), p. 62 - 64.

[5]Norman, J.R., *A History of Fishes* (London, 1936), p. 278.

insignis Richardson. Of the above species only I. punctatus and A. catus are of commercial importance in the James River. A. nebulosus occurs rather abundantly in the James River basin where the water is very fresh but is not as important a fish as the other two. In the Potomac River A. nebulosus and A. catus are the important commercial species.

A. nebulosus and A. catus are native to the James River, whereas I. punctatus and A. ponderosus were both introduced from the Mississippi valley region. S. insignis is found infrequently in the very fresh and quiet waters, usually up small creeks, whereas F. felis occassionally wanders up the river only as far as the brackish waters, never in the fresh waters.

The species of catfish have many common names but some are often used for two different species. I. punctatus is often called willow cat, spotted cat, long cat, and Mississippi cat as well as channel cat. The yellow bullhead, A. nebulosus, which is the common bullhead, is also known as mud catfish, black catfish, and horned pout. A. catus is sometimes called broadhead, because of the adult's wide head, channel cat, or simply bullhead. The fishermen sometimes call the large I. punctatus, as well as A. ponderosus, blue catfish because, when I. punctatus gets larger, it often loses its spots and becomes quite blue but it has firm meat and a deeply forked caudal fin, whereas A. ponderosus has rather soft meat and a caudal fin that is not lobed, a characteristic of the genus Ameiurus. On the other hand, A. ponderosus has a flatter head than I. punctatus. In this report the species will called by the following names: *I. punctatus*, channel cat; *A. nebulosus*, yellow bullhead; *A. catus*, white bullhead; *A. ponderosus*, Mississippi cat; *F. insignis*, mad tom; and *F. felis*, sea cat.

REPRODUCTION

It has long been known that catfish brood the eggs and young. The scattered information on the reproduction of the catfish has been compiled and results of personal observation are presented.

Catfish probably spawn in the head waters of the rivers and hence, as the present work was done only where the catfish are caught commercially, not many observations were made on the actual spawning habits. Coker reported that the channel catfish spawns in the Mississippi River in the region of Keokuk Dam from the middle of June to the middle of July.[1] The writer's observations of the ripeness of the gonads and their disappearance from the fish indicate that the spawning in the James River occurs when the water reaches a temperature of from 25°C to 30°C.

Coker bred the channel cat in ponds, sinking open nail kegs in the bottom for nests.[2] Smith states that the yellow bullhead makes a nest in the gravelly bottom of a stream.[3] Murphree has successfully propagated the channel cat and has written a small

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[1]Coker, Robert E., Studies of Common Fishes of the Mississippi River at Keokuk (Washington, D.C., 1930), pp. 175 - 77.

[2]Ibid.

[3]Smith, Hugh M., The Fishes of North Carolina (Raleigh, N.C., 1907), p. 67.

booklet in which is described the culture of this fish. A few paragraphs are quoted.

> "The female fish is the lighter fish in color. The color runs silvery on the under side, and a light brown over the back. The head is narrower than her body at the top dorcel (dorsal) fin. The male is a much darker color than the female where the male and female have been taken from the same water. Another method used in determining the sexual differences of the fish is the examination of the reproductive vents. The male reproductive organ comes to a sharp point and the opening lies toward the end of the tail, while on the female the opening of her vent is more of an oblong slit, and usually shows some sign of irritation around the edges. Also, there is a small flap which covers the opening.
>
> "In pairing fish this is taken into consideration, and for quick distinction one can use a pencil point. By laying it into the slit on the female, the point will slip into the vent, while on the male it will not.
>
> "If fish have been taken from different streams, one of them muddy and one clear, one could not go by color in judging the different sex, because fish from muddy water will be lighter in color than those taken from clear water. This would have a tendency to make the male taken from muddy water look a lighter brown than the female taken from clear water.
>
> "The difference in the head sizes is easily distinguished. This is used more often than the color method for determining the male and female."[4]

Murphree also tells of the breeding of the catfish by placing them in pens and using a stone crock or nail keg for a nesting site. The male fish can be used to fertilize more than one spawn of eggs.[5] He gives a remarkable description of the courtship and mating of this fish.

> "Observation of the mating fish after they have been paired off and placed in the broodpens shows that the male prepares the nest. He scrubs the nest as thoroughly as if a

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[4]Murphree, John M., <u>Channel Catfish Propagation</u> (Durant, Okla., 1940), p. 5.
[5]<u>Ibid.</u>, p. 7.

cleaning compound had been used, and when he has finished the process of cleaning, the nest is spotlessly clean.

"During the mating time in the pens, the fish carry on a courtship, and the male stays close to the female. This 'love affair' may last for one or two weeks after the brooders are placed in the pens.

"During this period, however, the male carries on his work of cleaning the keg, and occasionally he invites the female in to inspect his work. When the female finally approves the cleanliness of the nest, she swims out of the keg, raises slightly to the top of the water, fills herself with air, and swims back into the keg. She inhales the air in order to be able to exert pressure during the passage of eggs.

"The male, using his teeth, breaks the gelatin in the reproductive vent of the female, and then she begins the passage of her eggs. When she has laid a layer of eggs inside the keg, the male pushes her aside and begins the process of fertilization. When he has finished sperming the first layer, the female returns and lays another layer. This process is repeated until the female has laid all her eggs.

"After the female has finished laying her spawn, the male becomes the sole protector of the nest. He remains in the keg—fans and circulates the water, and is the attendant of the eggs until they are hatched. He does not permit the female to come back into the keg where he is tending the spawn. If a caretaker places a hand in the nest, the male is ready for a fight, which he does not usually delay in most cases.

"So far as is known, all attempts at artificially hatching channel catfish eggs have been found unsuccessful. The male hatches the eggs with such efficiency that it is doubtful if a better means will ever be found. On the average, he hatches about 99 percent of the eggs in his care. He is such a close observer of the spawn at all times, that if even one bad egg appears he sucks it from the batch without molesting the others.

"While the eggs are under the care of the male they are found to be in good condition at all times. He will not eat his own eggs, nor allow the female that laid them to eat them."[6]

The number of eggs per fish of the catfish is small as compared to some other fish, but due probably to the care taken of

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[6] *Ibid.*, pp. 9 – 10.

them by the parent, the percentage of fry from the eggs is high. Rennick states that 15,000 fry can be raised to 4 - 6 inches from 20,000 eggs. This is under ideal pond conditions where the predators are kept at a minimum.[7] Murphree gives the number of eggs found in the channel catfish.

TABLE I

SIZE AND CORRESPONDING NUMBER OF EGGS FOUND IN THE CHANNEL CATFISH

Weight in lbs.	Number of eggs
2	10,500
4	15,000
8	20,000
16	30,000
24	35,000
24-30	40,000
25-35	40,000-45,000[8]

Some counts were made of number of eggs of fish from the James River. The counts were made by determining the exact number

TABLE II

COUNTS MADE OF EGGS OF CATFISH ON APRIL 16, 1943

Species	Length in centimeters	Weight in grams	Diameter in millimeters	Number of eggs
I. punctatus	41.0	672	2.5	10,600
" "	41.5	744	2.5-3.0	5,500
" "	45.0	843	2.0	6,500
" "	46.5	935	2.0	4,200
" "	48.0	1106	2.5	6,800
" "	48.0	1206	2.5	7,650
" "	49.0	1056	2.5	7,950
" "	49.0	1103	2.5	8,300
" "	50.0	1040	2.5	8,200
" "	52.0	1521	3.0	10,600
" "	53.0	1665	2.5	4,500
A. catus	30.0	407	3.5	3,500
" "	32.0	328	3.5	3,200
A. nebulosus	22.0	....	1.0-1.5	2,400

7Rennick, Thomas J., "Channel Catfish Propagation," *Fur - Fish -*

of eggs needed to displace a certain volume of water. The entire gonad was then measured and the total number of eggs estimated. The diameter of the eggs was also determined. This sample was taken on April 16, 1943 when the eggs were not as large and fully developed as they would be during the spawning season. Seven of the twenty-six fish examined were found to be undeveloped but their sex could be distinguished.

Various observers have reported the fact of the caring for the young by the parent fish. This care by the yellow bullhead has been observed by the investigator on several occasions. In creeks of the Chickahominy River a dense school of the young fish, usually 1 to 1 1/2 inches long and numbering 500, have been seen swimming near the surface. Upon closer observations the parent fish could be seen several feet beneath the fry. At the slightest disturbance the parent fish quickly swims up in the school of young fish and then in an instant retreats to deep water. The sudden movement up and in the school of young fish scatters them so that they disappear almost as quickly as the parent fish.

Observations were made on the size of the fish at sexual maturity. From these observations and also from statements of the commercial fishermen the following deductions have been made as to the size of the fish upon reaching sexual maturity: channel catfish, 9 1/2 to 10 inches; white bullhead, 7 1/2 to 8 inches; yellow bullhead, 6 1/2 to 7 inches. These sizes seem to be average but of course some individuals may be precocious and others unusually large when sexually mature.

The eggs of the catfish are very deep yellow and, as the measurements indicate, are quite large. Some of the specimens measured in June 1941 had ripe eggs of the following sizes: channel catfish, 3.5 - 4.0 mm.; white bullhead, 4.0 - 4.5 mm.; and yellow bullhead, 2.0 - 2.5 mm. The gonad of the male is not as conspicuous as in most fish. It consists of a central mass from which arise small finger-like lobes. In fact, it is so inconspicuous and so unlike the typical gonad of male fishes that many fishermen are unaware of its existence and several have professed never to have seen the male fish. No description of the male gonad has been found in the literature.

The Fish and Wild Life Service raised and distributed from their federal fish hatcheries 6,673,000 fingerlings of I. punctatus, A. nebulosus, and Leptos olivaris Rafinesque (mud cat), in the fiscal year ending June 30, 1936.[9] Thomas J. Rennick, recognizing the commercial value of propagating catfish, plans to do so using the technique developed by John M. Murphree in the Oklahoma Fish Hatchery at Durant, Oklahoma.

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[9]Leach, Glen C. and M.C. James, Propagation and Distribution of Food Fishes (Washington, D.C., 1937), pp. 350 - 51.

[10]Rennick, Thomas J., op. cit., pp. 32,43.

DISTRIBUTION AND MIGRATION

Of the five species of catfish occurring in the James River area, only the sea cat, Felichthys felis, not a commercial form, occurs in salt water. The commercially important species are, in the main, confined to fresh water and brackish areas having a salinity of about 4 or 5 parts per mille. Consequently their migration is of limited extent. They apparently range on the Atlantic coast from Maine south to Florida but specific distribution records are not available. The principal commercial catches in the coastal states are taken from Florida, Virginia, Maryland, North Carolina, South Carolina, and Georgia, named in the order of the quantity caught. The largest catches, however, are made in the Mississippi River watershed.

Fishermen have reported catching catfish in the James River near Newport News at the time of large freshets. These may have come from the upper James or from the Pagan, Nansemond, or Elizabeth Rivers, which empty in the James near Newport News. Usually the salinity at Newport News is around 15 parts per mille. The fish are caught in the James River fairly regularly down to Fort Eustis. The salinity here ranges from 5 to 8 parts per mille.

The yellow bullhead, A. nebulosus, is found only in fresh water. It has never been reported from the pound nets that are located between Jamestown and Fort Eustis. This species is found in the James River above Sturgeon Point, in the creeks that empty in the James River north of Jamestown Island, and in the Chickahominy River. It is presumably present in all of the fresh waters of the river, although there are no catch records to substantiate this inference. It has an almost universal distribution over the entire country east of the Rockies and has been introduced in California where, together with the white bullhead, _A. catus_, it supports a commercial fishery in that state.

The channel cat and the white bullhead are found in the James River from Fort Eustis to Richmond and in the Chickahominy from its mouth in the James to Windsor Shades. Anglers have reported taking them above this point. Other observers have reported that the young of the channel cat are found higher in the heads of streams than the adults.

The channel cat, as its name implies, and the white bullhead seem to like swift moving water although both of these fish are caught up the creeks of the James and Chickahominy Rivers. The yellow bullhead seems to like the quieter waters of the creeks. It is said to be able to thrive in a sluggish, muddy body of water. In fact, it is often called the mud cat.

The yellow bullhead is thought not to have any migratory habits at all. There is evidence of some migration in the channel cat and the white bullhead which have a wider distribution in the river. The fishermen usually catch a larger quantity of bullheads in the spring in fyke nets than at any other time. This may be due to a general up-river migration to spawning grounds. The channel cat and white bullhead migrate up and down the rivers from shallow waters to deep waters and back again and in and out of creeks. Their movements are erratic and, except for a noticeable migration up-river in spring during the spawning season, they are seemingly influenced, in the main, by climatic conditions, conditions of the water such as high turbidity, and abundance of food.

Above Richmond the James River is closed to commercial fishing and acts as a resevoir for catfish. The catfish, especially the channel cat, move in front of the freshets which occur in the James in the fall and often in the spring. Hence, the fishermen usually catch a bountiful supply of catfish on the eve of a large freshet. Many of the catfish from above Richmond are frequently washed down in the freshets, appreciably increasing the commercial catches in the James River below Richmond.

GROWTH

Little is known of the growth of catfish. Since they are without scales, the scale method can not be used for age determination. The very small catfish are difficult to obtain and the larger fish do not appear to fall into size groups.

Murphree gives some information on the growth of the channel catfish. He states that the eggs begin to hatch nine days after spawning. After hatching the young fry takes three days to absorb the egg yolk and eats no food in this interim. He has found that the young fish average four inches in length at five months.[1] He also gives a table showing the weight of the channel catfish at certain ages.

TABLE III

AGE AND WEIGHT OF CHANNEL CATFISH

Age in yrs.	Weight in lbs.
2	2
3	4
4	8
5	16
6	20
7	24-30
8	25-35 [2]

The length - weight relationships of the channel cat and white

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[1] Murphree, John M., Channel Catfish Propagation (Durant, Okla., 1940), pp. 11, 16.

[2] Ibid., p. 24. (Table modified).

bullhead have been determined in this study. The fish examined were taken from a commercial fish house and measured to the nearest 1/2 cm. and the weight determined to the nearest gram. Afterwards three size groups of one centimeter interval were averaged together; i.e., the group of 21 cm. would be an average of the fish falling into 20, 21, and 22 cm. sizes. An average was obtained for twelve or more fish for each interval.

TABLE IV

LENGTH - WEIGHT RELATIONSHIP OF CHANNEL CAT AND WHITE BULLHEAD

Length in cm.	<u>I. punctatus</u> Weight in grams	<u>A. catus</u> Weight in grams
18	....	50
21	60	90
24	85	150
27	135	240
30	180	340
33	250	470
36	370	700
39	500	1000
42	650	....
45	825	....
48	1025	....
51	1300	....
54	1625	....
57	2000	....
60	2500	....

As shown in the table, the white bullhead is a much heavier fish than a channel cat of the same length. The white bullhead is a rather thick, robust fish and, when adult, has a very broad head because of which it is aptly called the "broadhead". The channel cat is a trimmer fish.

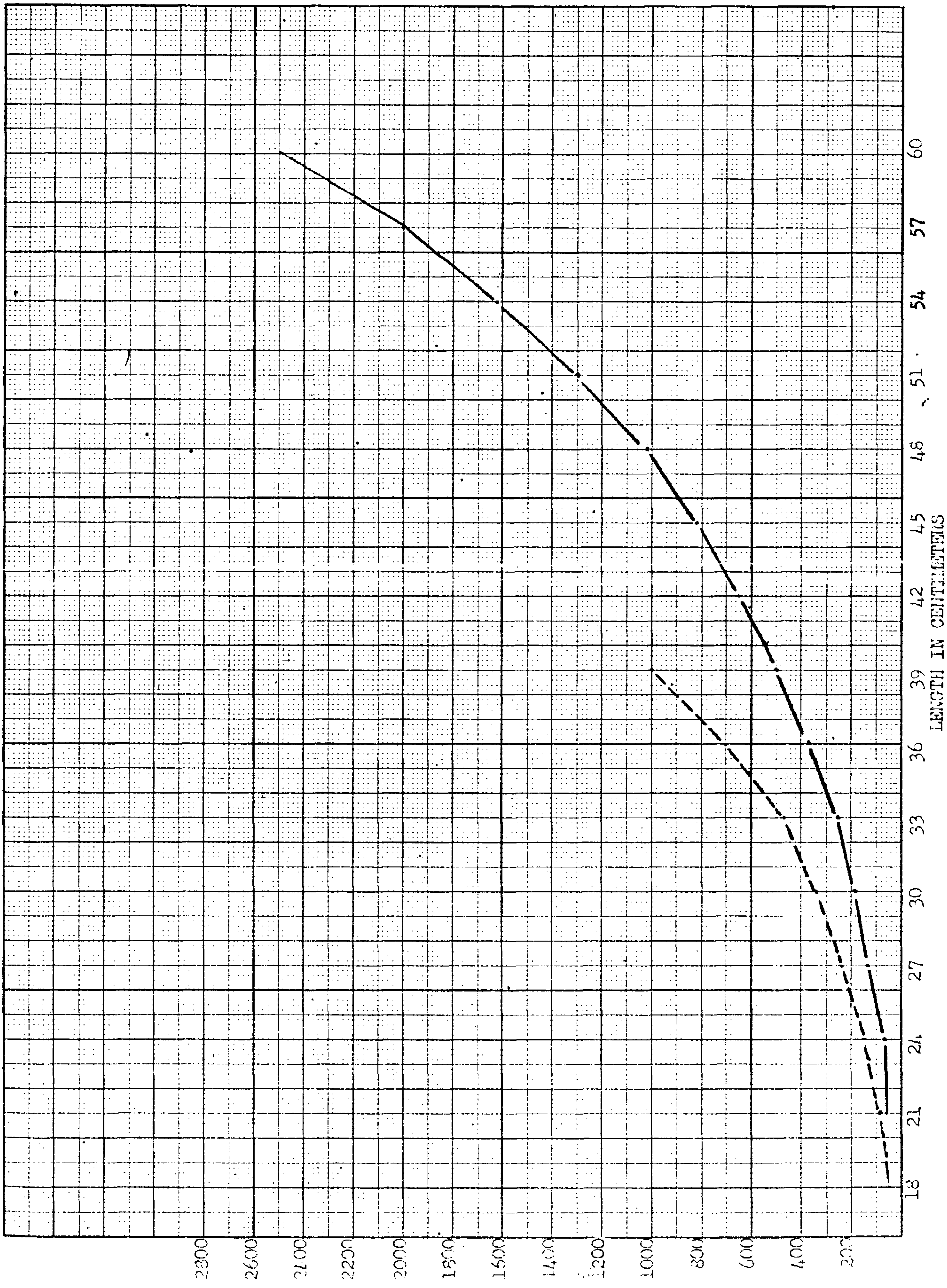
The average weight of the fish last mentioned is about a

Fig. 2

Graph showing the length-weight relationships of the channel cat, _I. punctatus_, and the white bullhead, _A. catus_.

The solid line refers to the channel cat; the broken line to the white bullhead. (see table I V)

Fig. 2


LENGTH IN CENTIMETERS
18
21
24
27
30
33
36
39
42
45
48
51
54
57
60
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800

pound in the James River so that a fish weighing 10 pounds is considered a "big one". Large fish above 15 pounds are rarely seen but the writer has seen a 23 pound channel cat and the channel cat may weigh as much as 30 or 35 pounds (13,500 - 16,000 grams). The white bullhead rarely exceeds 10 pounds whereas the yellow bullhead has a maximum weight of 1 1/2 to 2 pounds.

From observations made on the young of channel catfish, both those taken in minnow seines and also those from commercial nets, it is concluded that the fish will reach a marketable size of 10 inches in two years. The age of bullheads at the time they reach commercial size (9 inches) is not known.

FOOD

Catfish are usually considered to be scavengers. Louella E. Cable, working in South Dakota in 1926, made extensive analysis of the food eaten by bullheads A. nebulosus and A. melas and discovered that, while they prefer animal food, eating mainly insect larvae, pupae, and nymphs, crustaceans, and molluscs, they take other forms of animal matter and also vegetable matter. She points out that the catfish do not eat the eggs or young of other fish except in small amounts.[1] Murphree in raising channel catfish in a pond, feeds the young fry on dried, skimmed, powdered milk plus egg yolk and cod liver oil.[2] Smith states that A. catus feeds on the spawn of white perch, shad, herring, yellow perch, and other species.[3] Forbes found that the channel cat eats a variety of foods including vegetable matter, fish, both dead and alive, both univalve and bivalve molluscs, and stray bits of animal flesh and insects. He found that insects are the principal food and that the young feed on them almost entirely.[4]

Observations were made by the writer on the food of the channel cat and the white bullhead. In July 1934, eleven barrels of

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[1]Cable, Louella E., Food of Bullheads (Washington, D.C., 1928), p. 41.

[2]Murphree, John M., Channel Catfish Propagation (Durant, Okla., 1940), p. 14.

[3]Smith, Hugh M., The Fishes of North Carolina (Raleigh, N.C., 1907), p. 66.

[4]Forbes, S.S., Studies of the Food of Fresh-Water Fishes (Peoria, Ill.), pp. 457 - 59.

the channel cats were taken on the flats of the Chickahominy River, all of which had been feeding on filamentous green algae. They appeared in large aggregations to feed in the localized area where the algae occurred, gorging themselves on this plant and eating little else.

White bullheads caught in fyke nets in the spring of 1940 were found to have in their stomachs herring, vegetable debris, small crustaceans, and a few aquatic insects. Fish taken from pound nets in September 1941 had stomachs distended from eating great quantities of small menhaden. Twelve channel catfish were caught on a trot line on February 14, 1943 and their food content analyzed. One large channel catfish, weighing nine pounds, contained three blue crabs Callinectus sapidus Rathbun, each about 50 mm. wide. Another one had the remains of a small fish. Still another catfish, which weighed only about three pounds itself, had an almost intact perch Morone americana Gmelin 125 mm. long. A week later five fish were examined. Three were found to contain small crabs. One fish had three crabs, and the other two had one crab apiece. No distinguishable food was found in the two remaining fish. A commercial fisherman reports that channel catfish caught in fyke nets in January and February of 1943 were "full" of small minnows, mainly killifish.

The herring and shad, when they ascend the river to spawn, are followed by the catfish which feeds on this spawn. Commercial fishermen have reported that when the herring "run" is on they are not as successful with the baited pot in the capture of catfish. All fish examined were from the areas below the spawning grounds and no fish eggs of any kind were ever found.

Catfish are attracted by a variety of baits. Fishermen take them by using fish, such as menhaden, herring, and mud shad, and soybean and cotton seed meal cakes. In the commercial fishery the use of the "bean cake" (soybean and cotton seed meal) attracts a much higher percentage of small catfish than the use of fish bait. Another fisherman reports good results by using stale cheese. At times the catfish is attracted by most kinds of meat and will often take meat that is slightly putrid. Catfish feed mainly at night as the fishermen report that, except on rainy days, most of the fish enter the pots at night. The catfish can be called an omniverous feeder and is not very selective in the food it takes. As one fisherman puts it, "The catfish will eat anything the Lord puts in its mouth".

ENEMIES AND DISEASES

The enemies of the adult catfish are probably few. In the Mississippi River the silver lamprey eel preys extensively on the catfish.[1] On two occasions the investigator has witnessed the common water snake Natrix sipedon L. in the act of destroying catfish. The number of catfish destroyed in this way is probably negligible.

The enemies of the helpless fry and young are much more numerous. These enemies would include most of the predacious animals inhabiting fresh waters. In fact, the catfish itself may destroy its own young but this is under unusual conditions. However, the young catfish fare much better than most fish because the eggs and later the young are brooded and protected by the parent fish.

The catfish is menaced by various diseases. Murphree gives some of the diseases of the channel cat raised under artificial conditions in a pond, but these are not very serious in nature. Osborn in 1925 reported a black tumor occurring on the bullhead A. nebulosus. This disease is a bacterial tumor of slow growth that makes a smooth black patch similar to a fungus infection.[2]

The only disease of the catfish noticed locally occurs in the

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[1]Schrenkeisen, Ray, Field Book of Fresh-Water Fishes of North America (New York, 1938), p. 6.

[2]Osborn, Raymond C., Black Tumor of the Catfish (Washington, D.C., 1925), pp. 9 - 10.

yellow bullhead. No report of this disease has been found in the literature, but it is probably a bacterial infection. It is characterized by open lesions around the gill openings and fins and results in the death of the fish. Several years ago, the yellow bullhead was quite numerous in the Chickahominy River but since the advent of the disease, and possibly by reason of it, the quantity of fish has greatly decreased. However, this fish was never of much importance commercially so that the decrease did not affect the income of the fishermen.

Catfish are not materially affected by predators or disease. However, in the instance of the bacterial infection in the yellow bullhead, disease played an important part. The natural hardiness and ability to live under conditions not highly favorable to other fish may help to explain the abundance of the catfish population.

COMMERCIAL FISHERY

METHODS OF CAPTURE

The catfishes are considered game fish as well as important commercial fish. The bullhead is rarely considered a game fish but the channel catfish is definitely a game fish and in various localities is much sought after by anglers. In fact, in many of the states of the Mississippi valley region, this catfish has been reserved for the sportsman and prohibited from commercial capture.

Before the turn of the century trot lines were used in the commercial capture of catfish. This was before the channel cat had been introduced to the James River and most of the fish caught were white bullheads. In the lower Mississippi valley trot lines are still used to take the catfish. The wire catfish pot is now used chiefly in the fishery on the James River. A small percentage of the fish are caught in pound nets, fyke nets, and haul seines.

The fishery lasts from about February 15 to December 1, depending on the water temperatures. The fish seem to hibernate when the water is very cold and so not many are caught. This is true especially in capture by the baited trap or catfish pot. In the coldest part of winter only a few are caught in the fyke nets. Even in late spring, after the fishery with baited pots has started, a heavy snow reduces the catch.

Pots are baited either in the body of the pot or between the funnels. Pressed soy bean meal and pressed cottonseed meal in cakes are used by some fishermen but this "bean cake" is used mainly when fish bait is difficult to obtain. The fish bait used is largely from the herring group, i.e., mud shad, menhaden, and herring.

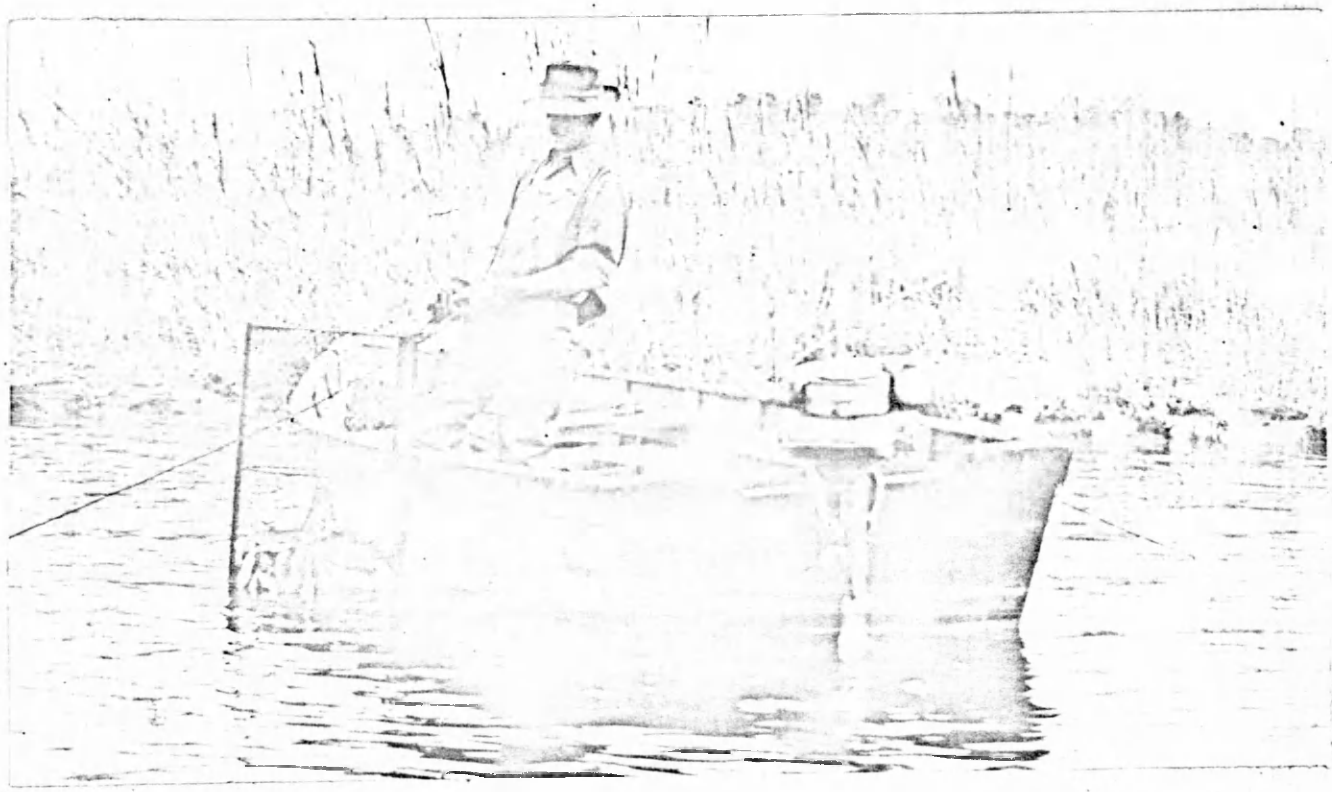

Fig. 3

RAISING A CATFISH POT - BRINGING IT OUT OF THE WATER

The mud shad and herring for bait are caught in fyke nets and haul seines. The menhaden are usually bought from the salt water pound net fishermen. James River, where the pound net fishermen caught an abundance of fish in 1941, supplied no bait in 1942 as the menhaden, often called "Olewives" or "Bunkers", did not "run" up the river in this year. Fishermen had to go as far afield as Colonial Beach on the Potomac River and Bayside on the Mobjack Bay to secure the bait.

The price paid for the bait varies. An average of $0.75 per

100 pounds was paid in 1940 and 1941 and $1.50 per 100 pounds in 1942. In the spring and fall when the water is cool less bait is used and the traps are raised about three times a week. In the summer the pots are lifted daily and more bait is used per pot and the fishermen generally use fresh bait, whereas in the early spring and late fall "ripe" bait is used. One fisherman puts in an average of about 10 to 20 pounds of bait in a pot depending on the season and the size of pot, as all of his pots are not the same size. The bait is well chopped in spring and fall but some fishermen prefer not to chop it in summer because the chopped bait attracts so many eels and crabs.

The eels and crabs, though both commercial seafoods, are not of much importance to the catfish fisherman. The eels are usually

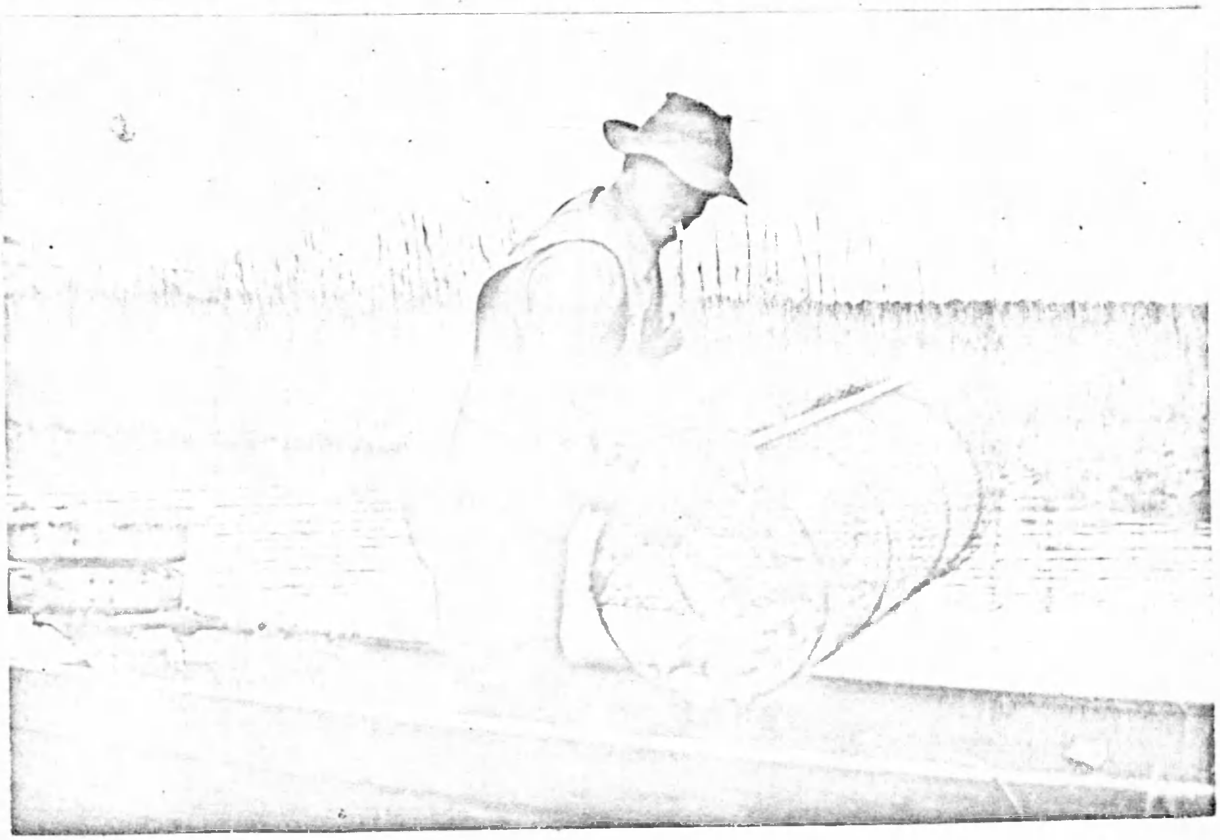

Fig. 4

RAISING A CATFISH POT - EMPTYING FISH IN BOAT small and many escape through the one inch mesh. Crabs are usually abundant, especially in the more brackish waters and are destructive to the catfish pot. The crabs with their claws gradually scrape off the tar and, by using the pincher, weaken or loosen the bars where the wire is woven together. Hardware cloth was used by an outfit almost exclusively but, because of the crabs, the fisherman now uses woven wire entirely. The hardware cloth is merely wire put together as cloth would be with the strands of wire 1/2 to 1/4 inch apart. The strands are united where they cross by small amounts of solder and the crabs soon break this union so that the strands slip, causing large holes and loss in strength.

The catfish pot catches only catfish and a few eels. The hardware cloth pots of smaller mesh catch many more eels than the ones made of inch mesh wire. This is due to the fact that all but the large eels can go through the inch wire of the woven-wire pot and that the eels seem to prefer dark places.

In pound and fyke nets the percentage of white bullheads caught is about the same as that of the channel cat but in the catfish pot, chiefly channel cats are taken. This may be due to two factors: first, the channel catfish seems now to be the most abundant of the species occurring in the James River; second, the pots, either because of their construction or the bait, do not attract the white bullhead.

Catfish pots and fyke nets are used, without restriction, on all commercial areas. Pound nets, however, are fished only below Jamestown as their use is prohibited by law above this point. Haul seines are in general use in the James River but the total amount of catfish caught in them is negligible. On a basis of available information it appears that the catfish pot accounts for more than three-fourths of the total catch on the James River.

Fig. 5

A FYKE NET STAND

The pound net, which is fished below Jamestown, catches the channel cat and white bullhead. Sometimes in September and October huge quantities of bullheads are caught. In general larger catfish are caught in the pound net than in the pot. They are caught together with such salt water forms as trout and menhaden. The pound nets also catch rock and perch. Limited quantities of all three commercial species of catfish are caught in the fyke, as well as most of the fresh water species. The yellow bullheads and channel cats are the only two species caught in any quantity in the haul seine.

In the Potomac River where the white bullhead and yellow bullhead are the commercial species of catfish, the catfish pot is not used. Here the white bullhead is caught in the river proper, whereas the yellow bullhead is taken in the creeks. The white bullhead is often called the "river cat" and the yellow bullhead, the "creek cat". The pound net and the fyke net are used in the river and the fyke net and haul seine are used in the creeks.

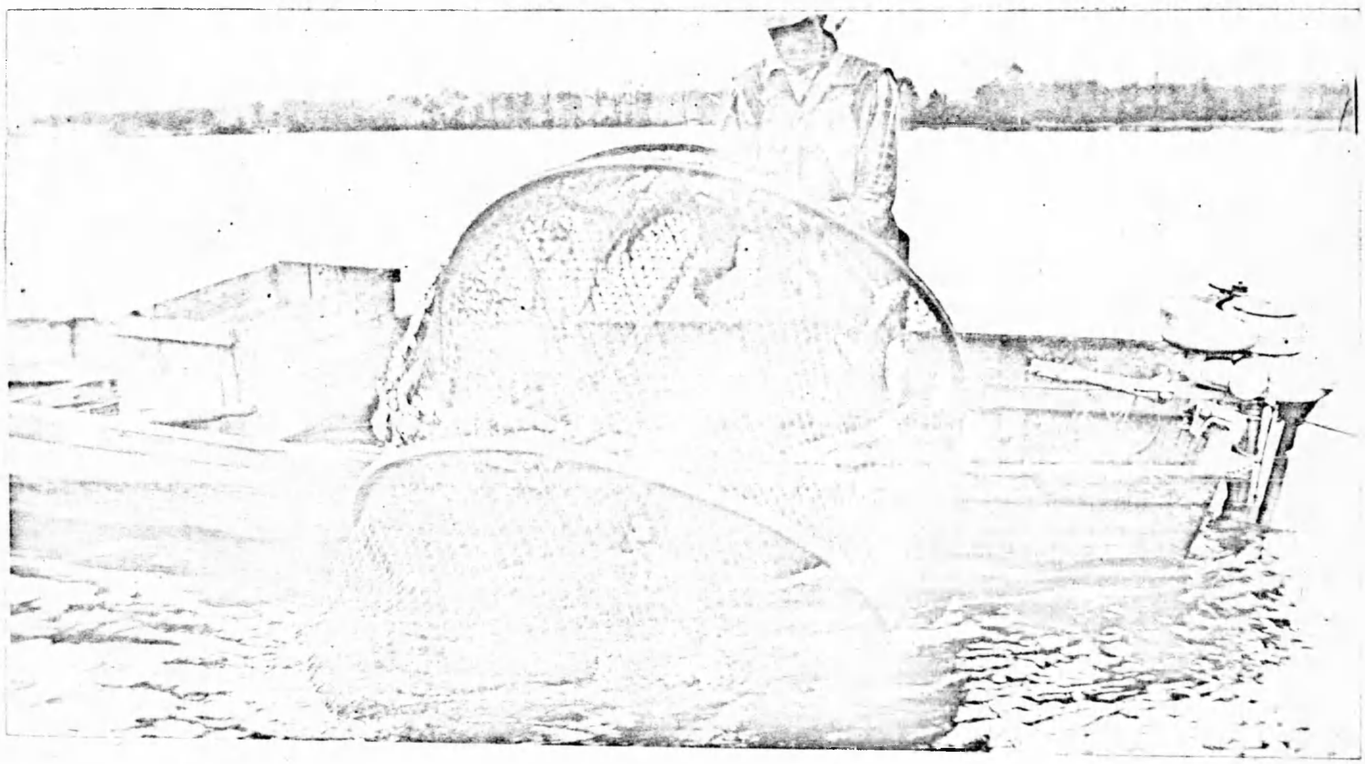

Fig. 6

LIFTING A FYKE NET

METHODS OF HANDLING

Catfish are sold fresh, either dressed or in the rough. Most of the fishermen are shipping their fish directly to the market already dressed. The shipper is paid per pound at the shipping point and express charges on the parts of the fish that would be lost in dressing are saved.

The skin of the catfish is removed, as well as the head and visceral mass, resulting in the loss of approximately half of the weight. Because the bullheads have relatively large heads, they lose slightly more in weight than the channel catfish. A good "skinner" can dress from 350 to 500 pounds of catfish in an eight hour working day, varying according to the size of fish.

Fig. 7

DRESSED CATFISH: _I. PUNCTATUS_ AND _A. CATUS_

When the dressing is completed the fish are iced and shipped by railway express to insure prompt delivery, the last half of the trip being made in refrigerator cars.

EQUIPMENT

One of the most important items in a survey of the commercial aspects of the catfish fishery is equipment. This includes the actual fishing gear, such as pots, nets, boats, and other paraphernalia, shore equipment, and transportation facilities for marketing the fish.

The pot is the most characteristic unit of catfish gear used in the James River and hence is described here. It is built somewhat on the plan of the eel pot, but each fisherman has his own

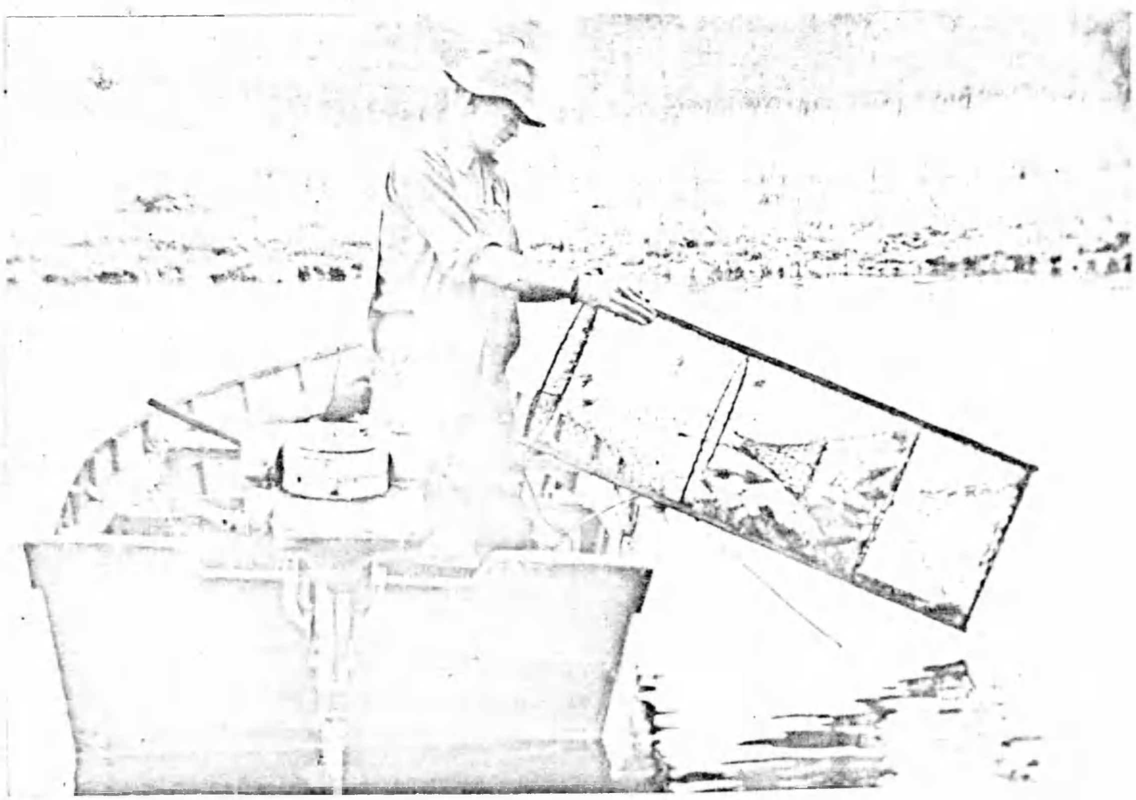

Fig. 8 .

LIFTING CATFISH - SHOWING CONSTRUCTION OF THE POT design. Typically it is 3 - 4 feet long and 18 - 20 inches in diameter. One inch woven wire of 18 to 20 gauge or one half inch hardware cloth of 20 gauge is usually used. Eighteen gauge "double-dipped" galvanized before and after weaving, known as poultry netting, makes a strong, substantial pot. A pot contains four or five hoops which may be made from 3/16 to 5/16 inch iron rods or heavy wire of 5 - 9 gauge. The pots made with iron hoops are more rugged than those of wire.

The pot contains two funnels that may be made of all wire, part wire and part netting, or all netting. In making the all-wire funnels 20 gauge wire is almost invariably used because it is more supple and will allow the passage of the fish better than the heavier 18 gauge wire. The first or front bunnel is set in one end and the other funnel, which is the middle or back funnel, is about one third of the distance of the entire pot from this end. The fish are trapped between the back funnel and the back end. In this end a covered opening is made to facilitate the removal of the fish.

The pots are tarred to make them last longer. A pot usually lasts from one to two seasons, depending on where it is fishes and how it is tarred and other factors. The saltier the water, the quicker they deteriorate. The funnels are usually the first part of the pot to wear out. There are several reasons for this: In the all-wire funnel the wire is of lighter material than the body of the pot; The funnels receive harder wear than the other ~~the other~~ parts of the pot because of the movements of the fish through them. New funnels can be installed in the old pot so that the life of the pot is increased.

For each pot a line is secured for attaching to a stake which is placed near the shore, the pot being stretched out from it into the water. Usually the pot has a weight for preventing shifting by the currents. Sometimes only one pot is attached to a line but often two pots are used, one at the midway point and one at the end. Some fishermen fish a line of pots and the line sometimes stretches across the river with a half dozen or more pots attached at intervals.

Fyke nets are fished throughout the James River and the Chickahominy River where possible and these account for a small portion of the fish caught. The haul seine is used for other fish but the catch of catfish in it is only incidental and the total quantity caught negligible.

The fishermen use outboard motors on open boats for the fishing of catfish pots almost exclusively. A man using an outboard motor can raise from 50 to 75 nets a day, whereas by using a larger boat with an inboard motor the number of nets fished would be much less.

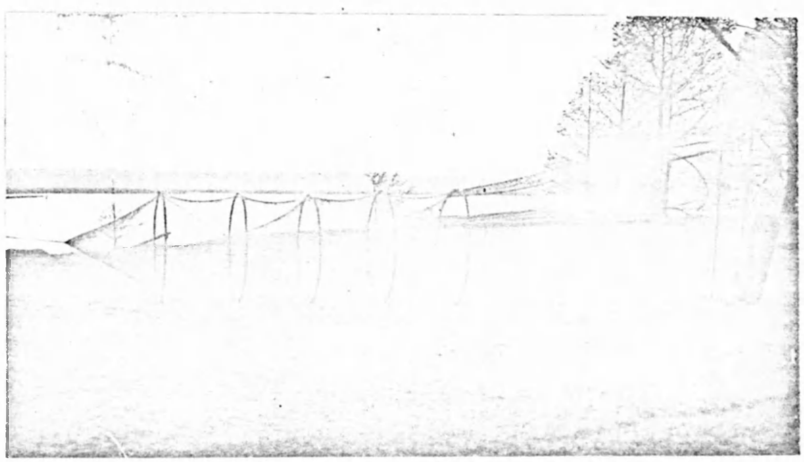

Fig. 9

A FYKE NET

The fisherman constructs his own nets from the raw materials of wire, hoops, netting, and rope. Some fishermen are naturally more dexterous in this than others but in the trade of fishing most fishermen know how to construct, mend, and maintain gear. The fisherman not only constructs his own pots ~~and tars them~~ but also uses a preservative on them. The fisherman usually has a building which is used as a store house for materials and surplus supplies mentioned and many necessary incidental items and also a work shop and a "tar pot".

The fish are dressed and packed in a fish house and the fisherman must either have his own ice house or else have the use of an ice storage plant, because it is impossible to always dress and ship the fish the same day they are caught.

All of the fishermen operate some distance from a railway shipping point; hence, they must have some means of shipping their fish as well as transporting ice, empty fish containers, and construction materials. Small trucks of half ton to one ton capacity are used.

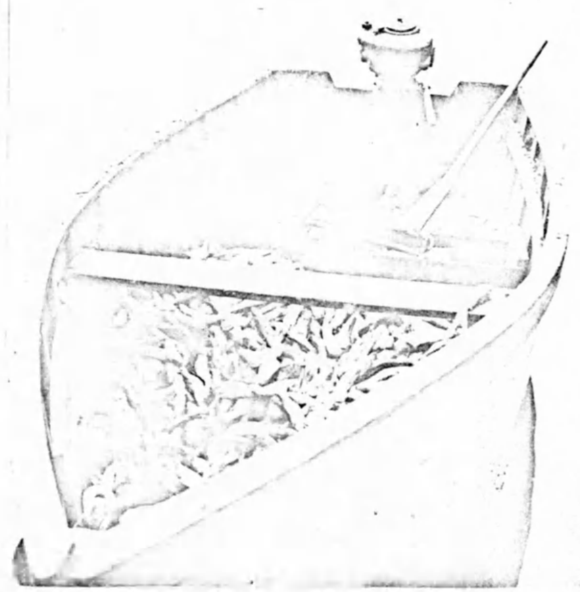

Fig. 10

BOAT LOAD OF CATFISH SHOWING

ORGANIZATION OF OUTFITS AND USE AND COST OF EQUIPMENT

An outfit fishing for catfish on the James River has many factors to consider in organization, capital outlay, and operating expenses. Many catfish outfits fish for other kinds of fish as well but the organization is usually integrated so that the other fisheries complement the catfish fishery.

A unit of five men will be considered in describing the organization and expenses of an outfit which fishes for catfish together with the other fishes. Of this outfit two men are employed full time on the river tending the nets and two work on the shore dressing and packing the fish. Often when many fish are caught an additional man is employed to help dress the fish. The man who is general supervisor of the fishery markets the fish, secures the ice and containers, and directs the construction and repair of the nets. In the fall, the man handling the shipping also buys the bait but, because not as many fyke nets are fished at that time, one of the men tending these nets aids in buying the bait. The men working on the river often aid in preparing the fish for market. In fact, when the occasion arises, all the workers cooperate in doing a special job. For instance, the "skinners" aid in tarring the nets.

This outfit fishes fyke nets and a haul seine as well as pots. Herring and mud shad, which are caught in the fykes and the haul seines, are used for bait in the pots. Thus it is not necessary for the fisherman to buy bait for the catfish pots except on occasions when not enough "bait" fish are caught. The fisherman considers the fykes and haul seine self-supporting in that the other fish caught are sold for a profit. The "bait" fish that are caught are extra profit for the fisherman as he does not have to spend extra effort and money to buy bait.

The fykes are fishe~~s~~d mainly in the spring, although some are fished in late summer and fall. Not many fykes are fishe~~s~~d in the middle of the summer or the middle of the winter because in the summer the netting of the fykes rots very quickly and in the winter time there is the danger of ice forming and crushing the stands. In the spring this outfit fishes about twenty stands whereas in late summer and fall only eight or ten stands are fished. The haul seine is fished intermittently in the summer and fall. In these two types of gear only a small percentage of the total quantity of catfish are caught but they are important to this outfit in the fishery for catfish because they supply the majority of bait which is used in the catfish pot.

This outfit fishes from 100 to 125 pots. Twenty-five to thirty are available for replacement. In the spring when the heavy fyke net fishing is being done, not as many pots are fished as in the summer and fall. Three outboard motors are used interchangeably with three open, 15 to 18 foot boats. Two motors are in operation and one is kept in reserve. A larger inboard motor boat is used for operating the haul seine and "setting" the fyke nets.

A small fish house is used for immediate storing, skinning, and packing of the fish, as well as for the storage of outboard motors, ice, and fishing paraphernalia. For the transportation of ice, containers for fish, and materials for construction and maintenance but mainly for hauling fish to the shipping point two half ton trucks are employed.

The costs of equipment and labor have increased considerably since the beginning of the war. The main capital outlay of this outfit is the actual fishing equipment. About $1000 is invested in the pots and their auxiliary equipment. With careful construction and proper care, however, they will not have to be replaced every year. For the fykes there is an outlay of about $2000 but of course these are used not only for securing bait for the pots but for taking other types of fish. The haul seine, which also captures other commercial fish as well as securing bait, costs about $200. The three outboard motors can be obtained for $375 and the boats on which these motors are used cost about $150. The inboard motor boat represents an investment of nearly $500 when new but can be used over a period of years. The fish house was built by this outfit at a cost of about $600. The cost of the two trucks used in this business amounts to over $1200. To these expenditures must be added operating expenses such as the cost of labor, gas, ice, boxes, repair, and many incidental items.

Cost of labor constitutes a primary item of expense. The rate of pay varies with the type of work. Men who work on the river command salaries ranging from $35 to $50 a week during the fishing season. The "skinners", who are usually negores, work at piece rates and get from two cents to three cents a pound for dressed fish. The war has raised the cost of both labor and materials. Before the war men who worked on the river received from $20 to $25 a week whereas the "skinners" got from one to two cents a pound for dressing fish.

Another outfit consisting of from seven to eight men fish only for catfish, using only the catfish pot. They fish chiefly on the James but also on the Mattaponi and Pamunkey Rivers. Two or three men do the fishing and four or five are employed as "skinners". The owner supervises the fishery and looks after the marketing, securing of bait, and construction and maintenance of fishing equipment. This outfit buys all of its bait, usually from salt water pound net fishermen. The fish used for the bait is mostly menhaden.

The cost of equipment in this instance is rather large since about 150 catfish pots are used. The investment for pots plus auxiliary equipment amounts to about $1000 and about $2000 is invested in boats and motors and another $2000 in four trucks required for such a large scale operation.

All of the men employed are paid on a piece work basis. The men fishing are paid by the pound for the fish they catch. When the fish are "biting good", one man may make as much as $50 to $60 a week. As in the previous outfit, the "skinners" are paid per pound for the fish dressed.

The operating costs of this unit are much higher than those of the outfit described first. The fish are caught over a wider area of water and the cost of transportation to the point of dressing is therefore greater.

Thus it is seen that the investment needed to catch and ship catfish is relatively high for a localized river fishery. Not only must the fisherman have considerable equipment but he must also have suitable landing points for preparing the fish for market as well as available territory in which to fish. This last item is of importance as now almost the entire available waters of the James River and its tributaries are under intensive fishing operations for catfish.

ECONOMIC IMPORTANCE

In recent years the catfish fishery in the James River has received a decided impetus. This has been due mainly to the fishermen finding a stable market for their fish in the large cities of the Mississippi River basin.

The catfish is one of our most valuable fresh water fishes. It ranked second in value in 1940, being exceeded only by the lake trout. Only these two fishes have a total value of over one million dollars. In 1940 over five million pounds of seven fresh water species were caught. Of these, the catfish ranked fourth in total quantity, being exceeded in poundage by the whiting, lake herring, and carp respectively.

TABLE V

WEIGHT AND VALUE OF CATCHES OF CATFISH IN THE U.S. IN CERTAIN YEARS FROM 1928-1940

Year	Pounds	Value
1928	17,581,000	$1,215,000
1930	15,562,000	$1,100,000
1931	16,836,000	$1,205,000
1932	16,665,000	$1,123,000
1940	18,960,000	$1,230,000

[1]

[1]Compiled from Bureau of Fisheries, Fishery Industries of the United States (1928, 1930, 1931, 1932, 1940).

In 1939, catfish had a value of $27,448 in Virginia and ranked eleventh among commercial fishes of the state. (See TABLE VI)

The price received for dressed catfish has increased considerably since 1940 when one outfit first began to ship its fish west. In 1940 the catfish brought from 10 to 12 cents per pound whereas in 1941 the price had increased to 15 to 18 cents per pound. In 1942 the fishermen were receiving 15 and 25 cents per pound for the fish. The reason for the wide range in price was that the fish were graded for size, the smaller fish (9 inches and under) bringing the lower price.

In this study specific records have been gathered from one outfit in James City County that fished in the Chickahominy River from 1929 to 1942. These statistics are shown in TABLE VII together with the number and type of gear and other pertinent information. Total catch records for James City County based on Federal statistics are given in TABLE VIII.

A comparison of TABLE VII with TABLE VIII shows that this one outfit caught more fish from 1929 to 1936 than was listed for all outfits in the entire county. During this period four outfits were fishing in this county with pound nets and several smaller outfits were operating fyke nets. Although no written records are available, the pound net fishermen report having caught as many fish as this single outfit on the Chickahominy River. Thus, it seems clear that at least five times as many fish were caught in the county as were recorded in the Federal statistics. Certainly the annual catch of catfish for the entire state is much larger than the federal records indicate.

TABLE VI

WEIGHT AND VALUE OF ANNUAL CATCHES OF CATFISH IN VIRGINIA WATERS DURING PERIOD 1918 - 1939

Year	Weight in pounds	Value in dollars	Price per lb. in ¢	Rank in state
1918	806,485	$48,343	5.8	12
1925	534,330	$32,057	6.0	11
1930	417,787	$15,471	3.8	13
1931	609,644	$25,451	4.0	8
1932	695,857	$21,200	3.0	12
1933	718,408	$22,351	3.1	11
1935	481,800	$15,880	3.0	13
1936	429,500	$13,729	3.0	12
1937	607,100	$21,468	3.0	12
1938	644,200	$26,447	4.0	14
1939	584,300	$27,448	5.0	11

[2]

[2] *Ibid.*, 1918, 1925, 1930 - 33, 1935 - 39.

TABLE VII

CATCH OF ONE OUTFIT OF TWO MEN OPERATING ON JAMES RIVER FROM 1929 - 1941

Year	Weight in pounds	Value	GEAR					
			Pots		Fykes		Haul Seine	
			No.	% of catch	No.	% of catch	No.	% of catch
1929	32,000	1,280	25	....	6	.....	1	......
1930	32,000	480	25	....	6	......	1	......
1931	32,000	320	25	....	6	......	1	......
1932	35,000	350	25	....	6	......	1	......
1933	35,000	350	25	75	6	5	1	20
1934	40,000	800	35	55	6	10	1	35
1935	50,000	1,250	50	55	6	10	1	35
1936	50,000	1,250	50	55	6	10	1	35
1937	30,000	900	50	90	6	8	1	2
1938	45,000	1,125	50	90	8	8	1	2
1939	30,000	900	50	90	9	8	1	2
1940	40,000	1,200	50	90	6	8	1	2
1941	80,000	3,200 ~~32,000~~	75	95	10	4	1	1
1942	64,000	3,200 ~~32,000~~	100	95	12	5	1	less than 1

TABLE VIII

WEIGHT AND VALUE OF CATFISH CAUGHT IN JAMES CITY CO., VIRGINIA DURING PERIOD 1921 - 1938

Year	Pounds	Value
1921	61,300	$4,716
1930	18,500	555
1931	14,700	512
1933	20,330	519
1935	9,400	318
1936	36,900	1,147
1937	39,800	1,154
1938	77,000	3,080

[3]

According to the records secured from the nine outfits, their total catch of catfish in the James River during 1942 was 579,624 pounds. The total amount of gear used consisted of 375 catfish pots, 10 pound nets, and 22 fyke nets. There are no actual records available but according to a rough estimate obtained from the fishermen themselves these nine concerns caught an estimated two-thirds of the catfish caught in 1942 in the James River. On this basis a total of 750,000 pounds of catfish is conservatively estimated to have been taken from the James River and tributaries in 1942 valued at $45,000.

These figures show clearly that the catfish industry is a significant one locally and ranks with the shad in importance on the James River. Above Fort Eustis the fishermen state that the catfish is their most important fish. The many fishermen who fish

[3] Ibid., 1921,1930 - 33, 1935 - 38.

seasonally for shad only were not contacted.

In the Federal statistical report the Potomac River fishery was recorded as larger than the James River fishery during 1929 to 1933 and was again greater in 1938. The Rappahanock and York Rivers furnished a small portion of the total amount of fish caught. In TABLE IX is shown these catch records and the value received for the fish.

TABLE IX

WEIGHT IN POUNDS AND VALUE IN DOLLARS OF CATFISH OF VIRGINIA FROM 1929 - 1938

	James River		Potomac River		Rappahanock River		York River*	
Year	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1929	111,100	$8,266	179,485	$10,182	....	....	35,000	$ 2,100
1930	162,900	4,582	166,687	7,456	23,300	$1,915	22,000	850
1931	139,004	5,823	298,940	17,794	16,700	801	47,400	1,816
1933	157,857	5,586	460,887	13,104	75,100	3,229	21,206	437
1935	200,600	5,070	182,700	7,657	85,400	2,656	23,200	956
1936	183,400	5,977	163,400	5,937	36,700	1,042	18,600	558
1937	270,300	11,229	240,200	7,124	26,400	872	23,500	919
1938	160,900	11,039	300,900	12,73[illegible]	25,800	1,032	23,800	778

[4]

* Mattoponi and Pamunkey Rivers

Thus it is seen from TABLE IX that in 1938 only 160,900 pounds of fish are listed as from the James River. Unfortunately, fish catch statistics of this year could not be collected by the writer but it may be assumed that many more fish were caught.

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[4]<u>Ibid.</u>, 1929 - 31, 1933, 1935 - 38.

PRESERVATION OF THE FISHERY

CONSERVATION

Many problems arise when an effort is made to arrive at a sound basis for proper utilization of a fishery. Especially is this true in the case of the catfish, since it is not only fished intensively but the fishery is restricted to a small area.

Evidence has been found that the catfish industry is in need of wise conservation measures. While accurate statistical records are lacking, certain trends in the population and in the volume of catch and amount of gear used have been indicated during the course of the study. Available federal catches records indicate that the total volume of the catch during the period 1925 - 39 remained fairly stable. However, the amount of fishing effort as shown by the amount of gear employed increased significantly. The reason the yield has been maintained is mainly that the fishermen use more nets, move them more often. and fish a longer season. One fisherman is now fishing 120 catfish pots, whereas in the early 1930's he fished only 35. He is catching many more fish but admits that he is catching less fish per trap. This condition seems to prevail quite generally. Another fisherman is fishing 50 catfish pots who formerly fished only 15.

The average size of the catfish taken is, according to most reports, decreasing. Reports from about two thirds of the commercial fishermen of the region indicate a decrease estimated as from

1 1/2 to 1 pound in average size during the last ten years.

The fishery is still a profitable one and may remain so for some time, depending on several factors. The headwaters of the James River and also the Chickahominy River are closed to commercial fishing. This is undoubtedly of great value in providing a breeding ground and also a resevoir of fish for the lower parts of the rivers.

There is need for a minimum size limit in Virginia. Maryland has a law placing the minimum size at seven inches, seemingly too low. The majority of the fishermen consulted agree that there should be a minimum legal limit. Many of the responsible fishermen realize that it is a bad business procedure to destroy the young fish and they regularly return undersized fish to the water. Those who fail to do this make the far-seeing ones less conscientious since they realize the futility of their conserving small fish while other fishermen catch and sell them.

The catfish industry is in need of measures that would insure future abundance and prosperity of this local but important fishery. Most conservation measures are taken only after the depletion of resources is so deep-seated that such remedial measures are imperative and must of necessity work a hardship on the industry if recovery is to be brought about quickly. Now is the time to take these measures before the fishery becomes seriously endangered.

SUMMARY

In this paper the biology and the commercial fishery for the catfish have been treated. The species of catfish found in the James River are: channel cat, Ictularus punctatus; yellow bullhead, Ameiurus nebulosus; white bullhead, A. catus; Mississippi cat, A. ponderosus; salt water catfish, Felichthys felis; and mad tom, Schilbeodes insignis. Of these only the channel cat, yellow bullhead, and white bullhead are common.

Observations of other authors on the breeding habits of the catfish are given as well as the investigations of the writer. Migrations are probably not extensive as commercial catfish of the James River are restricted in their distribution mainly to fresh water.

It has been observed that the catfish will take a variety of foods, including both plant and animal matters.

Channel catfish reach a marketable size at an age of two years. They do not seem to have many enemies, especially in the adult stage. The yellow bullhead, however, has been afflicted by a bacterial disease in the last several years, which has depleted the local population. In general, the James River is considered to be particularly favorable for the maintenance of a large catfish fishery. Most species seem to thrive in it, especially the introduced channel cat.

Since the catfish pot is the most important item of gear used in the capture of catfish a rather detailed description of this fishery is given.

The catfish is the most important fresh water fish in Virginia and among the commercial fisheries of Tidewater it ranks about tenth, the annual production according to Federal statistics being somewhat less than 600,000 pounds valued at less than $30,000 in 1939. The results of this study indicate that the Federal catch records are considerably below the actual quantities produced. Thus, the 1942 records collected during the study indicate a catch of 750,000 pounds, valued at $45,000 in the James River area alone.

Field records gathered during this study indicate (1) that while the volume of catch during the period 1925 1939 has, on a basis of Federal statistics, remained fairly uniform, the fishing intensity has significantly increased; (2) the average size of catfish making up the commercial catch has decreased from about 1 1/2 to 1 pound during the last ten years.

It is clear, therefore, that the cost of fishing per unit of effort is gradually increasing, thus signifying the need for conservation measures to maintain the fishery on a profitable economic basis.

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VITA

Name: Robert Winston Menzel.

Born: January 29, 1920 - James City County, Virginia.

Parents: George E. and Susie Gary Menzel.

Training: College of William and Mary. 1936 - 40.

B.S. degree, June 1940.
Concentrated in biology, botany sequence.

Course work for M.A. degree, 1940 - 42.
Concentrated in biology, fishery biology sequence.

Positions held: 1939-1940: Student assistant, Department of Biology, College of William and Mary.

July 1, 1940 - July 1, 1942: Assistant biologist, Virginia Fisheries Laboratory, Commission of Fisheries of Virginia.

September 15, 1942 to present date: Assistant biologist, Virginia Fisheries Laboratory, College of William and Mary.

Papers presented at Scientific meetings: "Observations on Populations of the Ribbed Mussel, Volsella Demissus Dillwyn", John H. Lochhead and Coit M. Coker, co-authors, 1941 meetings of the A.A.A.S., Dallas, Texas.

"The Catfish Industry of the James River", annual meeting of the Virginia Academy of Science, Roanoke, Virginia, May, 1942.

"Variation in the Time and Survival of Oyster 'Strike' in the York River near Seaford, Virginia", annual meeting of the Virginia Academy of Science, Richmond, Virginia, May, 1943.

Candidate for the Master of Arts Degree from the College of William and Mary, 1943.