into pond water, albinism in channel catfish will not prove in any way harmful to the growth and survival of the fishes. In fact one instance might lead us to believe that they are hardier in some respects, *i. e.,* two ponds containing both kinds of catfish were treated by mistake with "lexone." As you doubtless know, lexone is quite toxic to catfish. As a result of this application, we did lose several regular catfish but none of the golden. However, we could not say that this one observation would be conclusive. Due to the fact we did not want to lose any of the fish we had, we made no further tests. We hope to check further along these lines next year.

Though the skin of the golden channel catfish is transparent, it is much thicker than the normal colored individuals; does not adhere as closely thus making the fish more easily dressed. After being dressed, the golden specimen is not hard to spot as their meat is white; while the regular colored catfish meat carries a gray tinge. Last but not least is the eye appeal of this fish. From a commercial standpoint this is an asset. We have had numerous persons, who upon seeing the fish, remark on how attractive and clean they appear. Since our brood stock will be three years old this coming season, we feel our 1959 hatch should be sufficient that we can make the fingerlings available for stocking and breeding purposes.

WALLEYE HATCHING, REARING AND TRANSPORTING TECHNIQUES AS PRACTICED IN KENTUCKY

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ABSTRACT

This study revealed that walleye, *Stizostedion vitreum vitreum* (Mitchell), can be jar-hatched, stocked, and a portion raised to fingerling size, for an annual outlay of $1,000.00 or less.

Early returns indicate that walleye can be inexpensively established by stocking fry in either old or new lakes. The method used was to stock the fish in intermittent rows from a boat. Both openwater stocking and shoreline stocking were practiced successfully.

Two ponds were utilized for experimental walleye production in 1958. Walleye were produced at the rate of 21,255 fingerling walleye 1½ to 2 inches in length per acre in one experimental pond and 10,333 in another pond, without re-sorting to feeding with minnows. This seemed to indicate that walleye lend themselves to pond culture as far south as Kentucky. The experimental evidence concurred with the findings of Dobie (1956) in Minnesota and indicated that production was augmented by the use of organic fertilizers. The writer used hay and soybean meal. It was felt that hay was especially beneficial by helping to prevent phytoplankton blooms.

Both fry and fingerlings were hauled in station wagons in plastic bags placed in cardboard beer cases, a variation of the Ohio method.

The fry were hauled at an average of 36,000 per bag, 12 to 20 bags per station wagon. Various containers were used to carry the bags, and beer cases were found to be particularly tough and re-usable. They could be stacked 2 or 3 high and provided excellent insulation.

O-Tabs, made by Pemble Laboratories, were more successful than bottled oxygen for hauling fry. Buffers, such as dibasic sodium phosphate and sodium bicarbonate, were tried experimentally but were found to be unnecessary. Icing was also used experimentally and was successful but unnecessary.

Preliminary evidence indicated that fingerling walleye 1½ to 2 inches in length and weighing 728 per pound could probably be hauled at the rate of 7,000 to 9,000 per station wagon load. Buffers were needed for hauling fingerlings in plastic bags. Best results were obtained by using dibasic sodium phosphate, activated charcoal, and icing the bag.

INTRODUCTION

In 1956, the Kentucky Department of Fish and Wildlife Resources decided to experiment with low-cost walleye production. Results from 3 years of experimental production have far exceeded expectations.

There was interest in establishing the walleye as an additional predator in problem lakes, as well as trying them in several small, relatively new, state-owned lakes of 100 to 500 acres in size. Carlander (1957) presented evidence that big predatory fish such as walleye might be of value as an additional predator and have an effect upon the creel. Ohio reported that the walleye would spawn on the rock rip-rap of relatively small lakes in that state. Looking ahead, the U. S. Corps of Engineers were in the process of building 2 flood-control lakes of over 1,000 acres and had plans for additional ones. It was felt the walleye might spawn and maintain themselves in these lakes in the future.

PHYSICAL PLANT FOR WALLEYE HATCHING

In 1956 an experimental jar hatchery was built near Frankfort, Kentucky. The cost was kept at a minimum and the only expense to the Kentucky Department of Fish and Wildlife Resources was for supplies and eggs. There was no capital outlay that first year and very little during succeeding years. Experience at a private hatchery had taught the writer that most fish eggs are amazingly tough and need only clean, cool water, shade, and a helping hand in order to hatch. Therefore, an absolutely minimum physical plant was built.

It was found that a gravity-flow system had tremendous advantages over pumping, as it was relatively trouble-free. During egg incubation it was necessary to visit the area only one time in each 24 hour period.

Worthy of mention is that in this experimental project cylindrical, oval-bottomed plastic jars proved superior to three types of glass hatching jars.

CAPITAL OUTLAY FOR FISH HATCHING FACILITIES

There was no capital outlay for hatching facilities in 1956. Everything that was used in the construction of the hatching area was on hand in the Department, borrowed, or given to the project.

In 1957 the capital outlay was as follows:

Irrigation Pipe	$369.50
Lumber	81.94
Canvas	48.00
Fish Troughs	74.00
Metal Work	62.44
Gravel	75.00
Screens	10.60
Carpenters	55.00
Paint	9.00
Brass Spigots	15.00
	$800.48

In 1958 the capital outlay was as follows:

Irrigation Pipe	$ 93.80
Lumber	31.77
Hatching Jars	171.00
Aluminum Roof	49.33
Carpenters	44.00
Gravel	112.00
	$501.90

With the additions made in 1958, over 7,000,000 walleye fry were hatched in 34 jars, and the facilities will accommodate eggs for somewhat more than this number.

COST OF HATCHING, HAULING, AND POND CULTURE OF WALLEYE

The approximate costs of producing and stocking walleye fry and fingerlings, exclusive of salaries of Department personnel, for the three years were modest. In 1958, Kentucky brood sauger was exchanged for Ohio walleye eggs.

In 1956 the costs were as follows:

Cost of Eggs	$ 34.00
Cost of Obtaining Eggs	67.55
Transportation	70.00
Supplies	153.10
	$324.65

In 1957 the costs were as follows:

Cost of Eggs	$128.00
Cost of Obtaining Eggs	94.80
Hauling Fry Expense	138.46
Fingerling Production Expense	44.64
Transportation	126.00
Supplies	115.20
	$690.46

In 1958 the costs were as follows:

Cost of Eggs	None
Cost of Obtaining Eggs	$ 93.60
Hauling Fry Expense	216.16
Fingerling Production Expense	38.38
Hauling Fingerling Expense	97.30
Transportation	137.00
Supplies	112.80
	$697.94

From these figures it is believed that the cost of hatching, hauling, and pond culturing walleye, with a unit the size of the one used in Kentucky, need not exceed $1,000.00 per year.

These figures would indicate that a considerable production of walleye fry and fingerlings can be achieved with material costs of less than $1,000.00 per year.

HATCHING AND HANDLING OF WALLEYE EGGS AND FRY

As the subjects of stripping and water hardening of eggs are well covered in the literature, the writer will describe only his handling procedures from the time of arrival at the hatching site. Following the recommendation of Davis (1953), the eggs were carefully tempered before placing them in the hatching jars. In 1956, three quarts of eggs were placed in each of 10 jars. An additional 5 quarts of eggs were hatched in the collection tanks. The eggs in the tanks were stirred once a day and nearly as large a percentage hatched as hatched in the jars.

Cummins (1954) reported on the use of malachite green oxalate to control fungus on walleye eggs. In our experiment 7 grams of malachite green mixed in water solution in the head trough was used for the first 3 days and reduced to 3 grams for the next 3 days.

In 1957, three quarts of eggs were placed in each glass open-mouthed hatching jar and 2 quarts were placed in each McDonald jar. There were 29 quarts of green eggs and 7 quarts of advanced eggs. It was necessary to pour malachite green into the individual jars of green eggs that were on the same hatching rig as the advanced eggs, as the latter began hatching on the day of arrival. The fry from these advanced eggs did not seem as strong as fry hatched from green eggs.

In 1958, 78 quarts of eggs were used. Initially 3 quarts of eggs were put in the new plastic hatching jars, but as they water-swelled it became necessary to siphon some of the eggs into extra jars. Six grams of malachite green were poured into each head trough every day until the eggs eyed out.

Each year glass wool was used to filter iron precipitates from the artesian water before it reached the head trough. Such a filter will also remove other matter in suspension. The filter design found adequate was 4 feet long, trough-width wide, 5 inches deep where the water spills, and tapered to 2 inches deep at the other end.

The newly hatched fry were removed from the collecting tanks each day and either taken to lakes or stocked in rearing ponds.

The following techniques were used for removing fry from the tanks. First, they were crowded by running a short seine slowly through the tank. Then they were siphoned from the crowded area into plastic bags. Occasionally they were so thick in the tank that crowding was unnecessary. Finally, by using an 8 by 10 inch scap net, the number of fry in the bags was increased to full carrying capacity. When fry were loaded after dark, they were concentrated in a flash-light beam, a technique suggested by George Scruggs.

To insure plenty of oxygen in a crowded fry-collecting tank a carburetor was installed where the sheet metal fry-conducting trough enters the collecting tank. It was constructed by putting an 8-inch-long piece of wood the width of the carrying trough at an angle where the trough meets the tank. This board also cuts down the current from the large flow of water entering the relatively small collecting tank.

In 1957 test jars were used to determine if other water supplies available would hatch walleye eggs. In so doing we were much impressed with the importance of good water and adequate aeration. While at least 4 different water supplies hatched eggs, there was a marked difference in the quality of fry hatched under various conditions. Eighteen hours after hatching, fry hatched on the artesian well water were twice the size of the fry in the trough next to them, which were hatched on spring-fed reservoir water. Also, they had absorbed their yolks and were strong swimmers. The writer made no detailed study of this rapid growth, but as this difference may have a pronounced effect in establishing fisheries through fry stockings, further studies should be conducted to determine what constitutes optimum hatching water. Presumably this rapid growth was caused by the absorption of dissolved solids. Krogh (1939) found that the skin, mucous membranes, and gills of fish are permeable to ions and he emphasized the significance of the calcium ion for osmotic regulation in aquatic animals. Phillips et al. (1954, 1955, 1956), showed that the concentration of the calcium ion in the water altered the active uptake by brook trout of the calcium ion itself and of the cobalt ion. Phillips et al. (1956), pointed out the connection between dissolved calcium and dissolved phosphorus and concluded that their metabolism appears to be interdependent.

The artesian well water used in this study was high in calcium and magnesium salts and also had a rather high sulphate content. The dissolved solid content was 1563 p.p.m. (Table I). The analysis of the reservoir water in the adjoining hatching rig may have been inaccurate as the spring which feeds the reservoir was running when the fry were hatched but had slowed or quit by the time the analysis was made (Table I).

Another important consideration in the quality of fry produced is the amount of dissolved oxygen. In 1956 only 12 feet of aerating trough was used, with the water falling 3 times. Later analysis showed that the water contained only 3 p.p.m. dissolved oxygen at 57° F. at the jars and less than 3 p.p.m. at the collecting tank. That year the fry did not appear as strong and did not survive as well in the tank as in the succeeding 2 years when 36 feet of aerating trough was used. Van Horn and Balch (1956) called attention to the effect of low oxygen concentration upon walleye fry. Surber (1935) found that carbon dioxide had an effect upon the survival of trout eggs and the same may hold true for walleye eggs.

This study indicated a real value in having 2 separate water supplies. It is unlikely that both would stop during the hatching operation. As the temperature of the two is not likely to be the same, particularly where one is well water and the other is from a spring-fed reservoir, the period of hatching is spread out,

TABLE I

PARTIAL CHEMICAL ANALYSES OF CERTAIN WATER SUPPLIES USED FOR HATCHING AND RAISING WALLEYE WHEN TESTED IN SEPTEMBER, 1958

Artesian Well

	p.p.m.
Total Hardness	610
Temporary	52
Permanent	558

MATERIALS

	p.p.m.
Iron and Aluminus Oxides	7.0
Silica	32
Cal. Oxide	227.6
Magnesium Oxide	204.6
Chlorides	16.0
Sulphates	725.4
Total Solids	2,252
Dissolved Solids	1,563
Suspended Solids	689

Spring-Fed Reservoir

	p.p.m.
Total Hardness	146
Total Alkalinity	168

Main Fork of Elkhorn Creek

	p.p.m.
Total Hardness	166
Total Alkalinity	157
PO_4	0.92

S. Elkhorn Creek

	p.p.m.
Total Hardness	184
Total Alkalinity	178
PO_4	1.10

making it far easier to handle the fry and transport them. For example, in 1958, the hatching period was extended from May 2 through May 12, making it possible to rid an experimental pond of a phytoplankton bloom and attain a zooplankton bloom before stocking.

Since temperature is such a determining factor in the length of time needed to hatch fish eggs, and little has been reported on hatching walleye eggs in the South, the daily temperature readings and the dates of hatching of 3 groups of eggs hatched in different water supplies were recorded. The shortest hatching period occurred in the group of eggs which hatched 10 days after stripping and were in the jars for 7 days. The longest hatching period occurred in a group of eggs which hatched 13 days after stripping and were in the jars for ten days (Table II).

TABLE II

TIME REQUIRED TO HATCH EGGS WITH SOUTH ELKHORN CREEK WATER IN 1957

Status of Eggs	*Date*	*Temp.*	*Time of Day*	*No. of Days*
Stripped	May 3	..	....	1
Water Hardened	4	..	....	2
Put in Jars	5	55°	1:00 p. m.	3
	6	60°	4:20 p. m.	4
	7	62°	3:00 p. m.	5
	8	58°	7:00 a. m.	6
	9	60°	7:45 a. m.	7
	10	..	....	8
	11*	64°	....	9

TIME REQUIRED TO HATCH WALLEYE EGGS FOR TWO WATER SUPPLIES AND DIFFERENT TEMPERATURES IN 1958

Status of Eggs	*Date*	*No. of Days*	*Artesian Temp. in F.*	*Date*	*No. of Days*	*Spring Water Res.*	*Air Temp.*	*Lake Erie Temp.*
Stripped	4-22	1	..	4-22	1	..	51°	48°
Water Hardened	4-23	2	..	4-23	2	..	..	48°
Put in Jars	4-24	3	58°	4-24	3	54°	57°	..
	4-25	4	56°	4-25	4	54°	47°	..
	4-26	5	54°	4-26	5	52°	48°	..
	4-27	6	56°	4-27	6	55°	60°	..
	4-28	7	58°	4-28	7	56°	69°	..
	4-29	8	54°	4-29	8	54°	52°	..
	4-30	9	55°	4-30	9	53°	54°	..
	5- 1*	10	56°	5- 1	10	54°	62°	..
	...	..	..	5- 2	11*	55°	65°	..

* Date hatching began.

FRY HAULING TECHNIQUES

After being deluged with fry in 1957, it was learned that it is very important to have plenty of help organized for deliveries during the hatching period. On a good hatching day 2 station wagons were loaded in the morning and 1 in the afternoon each with 12 to 20 bags with 36,000 to 42,000 fry in each bag.

Clark (1957) reported on the use of polyethylene bags for hauling walleye fry in Ohio. A variation of his method was used in this study in 1957. These bags had many advantages, one being that only one man and a station wagon could handle a load of fry. The efficiency of using plastic bags can be attested to the fact that 1 group of 9 cases was loaded 1 night at 9:00 p.m., and carried 250 miles the next day to be stocked in Greenbo Lake. Flood waters prevented delivery so the fry were taken back to Frankfort. The following day they were hauled to another lake. Almost no fry died during this time.

In the first use of this method oxygen was injected into the bag in the air space above the water then the bag was sealed by wrapping a heavy rubber band around the neck of the bag, doubling the neck over and rewrapping it. There were severe losses in some of the first 36 bags. The rest of 1957 and all of 1958 the use of 1 O-Tab in each bag proved successful.

Buffering experiments were tried using 10 bags with dibasic sodium phosphate, 10 with sodium bicarbonate and 10 bags with ice. Each of these methods was successful in that they were harmless, but they were also unnecessary.

In 1958 the plastic bags of fry were experimentally carried in cardboard beer cases and in large metal lard cans. The beer cases proved far superior to ordinary cardboard carriers and to the lard cans. They were easily stacked 2 or 3 deep, they absorbed dampness without falling apart, they were fairly well insulated, and they had convenient handles. One set lasted throughout the delivery period. The lard cans held more water and fry, and were satisfactory for short runs, but they warmed up rapidly in transit and were seldom used for long hauls (Table III).

Tempering the fry at the lake was simple. The plastic bags full of fry were dropped overboard and allowed to float until their temperature equalled that of the lake water. In most cases little tempering was required as arrival temperatures of the bags was close to the lake temperature (Table III).

TABLE III

1958 WALLEYE FRY HAULING IN PLASTIC BAGS
(All Bags Contained One O-Tab and Water)

Container	*Date*	*No. Ctn.*	*Apx. No. Fry Per Ctn.*	*Water Temp. at Loading*	*Air Temp.*	*Bag Temp. on Arrival*	*Lake Temp.*	*Approx. Travel Time*	*Cond. of Fish at Arrival*
Beer	5-2-58	11	36,000	57° F.	65° F.	.....	.....	4 Hrs.	Excellent
Ctn.*	5-2-58	8	36,000	57° F.	64° F.	60° F.	64° F.	1½ Hrs.	Excellent
	5-3-58	11	36,000	57° F.	69° F.	63° F.	61° F.	1½ Hrs.	Excellent
	5-3-58	12	36,000	57° F.	69° F.	72° F.	60° F.	5 Hrs.	Excellent
	5-4-58	8	36,000	56° F.	66° F.	.....	.....	3 Hrs.	Fair
	5-4-58	9	36,000	57° F.	70° F.	65° F.	66° F.	1½ Hrs.	Excellent
	5-5-58	5	36,000	55° F.	55° F.	61° F.	69° F.	4 Hrs.	Excellent
	5-5-58	18	36,000	55° F.	55° F.	59° F.	66° F.	2 Hrs.	Excellent
	5-5-58	4	36,000	55° F.	55° F.	57° F.	58° F.	3 Hrs.	Excellent
	5-6-58	12	36,000	53° F.	44° F.	.....	.....	4 Hrs.	Excellent
	5-6-58	4	36,000	51° F.	44° F.	55° F.	61° F.	2 Hrs.	Excellent
	5-6-58	3	36,000	51° F.	44° F.	52° F.	56° F.	2 Hrs.	Excellent
	5-6-58	3	36,000	51° F.	44° F.	.....	56° F.	1 Held	Excellent
								37 Hrs.	Excellent
								2–2 Hrs.	Excellent
	5-8-58	8	36,000	53° F.	56° F.	58° F.	61° F.	2 Hrs.	Excellent
	5-8-58	10	36,000	52° F.	56° F.	.....	.....	4 Hrs.	Some Loss
	5-9-58	9	36,000	53° F.	59° F.	61° F.	57° F.	4 Hrs.	Excellent
Lard	5-3-58	2	42,000	57° F.	69° F.	65° F.	61° F.	1½ Hrs.	Excellent

* 5 gal. water per bag.

TABLE III—*Continued*

1958 WALLEYE FRY HAULING IN PLASTIC BAGS

(All Bags Contained One O-Tab and Water)

Con-tainer	Date	No. Ctn.	Apx. No. Fry Per Ctn.	Water Temp. at Loading	Air Temp.	Bag Temp. on Arrival	Lake Temp.	Approx. Travel Time	Cond. of Fish at Arrival
Cans †	5-3-58	17	42,000	57° F.	69° F.	67° F.	61° F.	1½ Hrs.	Excellent
	5-4-58	4	42,000	56° F.	66° F.	.....	.....	3 Hrs.	Some Loss
	5-4-58	1	42,000	57° F.	70° F.	68° F.	66° F.	1½ Hrs.	Excellent
	5-5-58	14	42,000	55° F.	55° F.	58° F.	58° F.	1½ Hrs.	Excellent
	5-6-58	4	42,000	51° F.	44° F.	.....	61° F.	2½ Hrs.	Excellent
	5-6-58	2	42,000	51° F.	44° F.	.....	56° F.	2 Hrs.	Excellent
	5-6-58 } 5-7-58 }	8	42,000	51° F.	44° F.	54° F.	56° F.	37 Hrs.	Excellent

† 6 gal. water per bag.

One technique that is vital to successful fry hauling in plastic bags is for the fry collecting *tanks to be drained and all egg shells cleaned out each day* after the fry are removed. In this study hauling losses occurred only twice in 1958 and in both cases decaying egg shells were thought to be the cause. This procedure also gets rid of the few remaining fry which have grown large enough to prey on the younger fry as they hatch off.

NUMBERS OF FRY STOCKED IN VARIOUS LAKES

The number of fry stocked in lakes and federal hatchery ponds for 1956, 1957, and 1958 are recorded (Table IV). Also shown are the number of trips made to each area stocked, the total number taken to each place, and the number in each load. The number of fry stocked is of importance as walleye have been established in several of the lakes.

RESULTS OF THREE YEARS OF WALLEYE STOCKING

Herrington Lake, an old reservoir of about 3,600 acres, was first stocked in recent times with nearly a million walleye fry in 1957. At the time of fry stocking the lake was clear and full of white bass fry (Table IV). Only three walleye have been recovered from this first stocking. One 10.5-inch walleye was killed in the fall of 1957 during the selective shad killing operation. The second walleye (11 inches) was taken in a fish population study, May 20, 1958 and still a third was caught on June 4, 1958 to a fisherman.

In 1958 Herrington Lake was turbid at the time the fry were being stocked. The turbidity lasted from May 2 until May 12. This muddy water, coupled with the observation that few other kinds of fry were hatching at the time of the first stocking, resulted in a good fry survival (Tables IV and V). It is noteworthy that 163 walleye 4 to 5 inches in length were taken from a cove approximately 1 acre in size on July 12, 1958 (Table V). Considering that seldom are young-of-year walleye recovered in population studies at Cumberland Lake and Dale Hollow Reservoir, where there are well-established walleye fisheries, these returns are striking.

There is little chance that the fish released in Herrington Lake in 1957 could have spawned in 1958. Deason (1933) found that all males under 11 inches and all females less than 12 inches were sexually immature.

At Dewey Lake, a 1,200-acre flood control reservoir with an established fish population was clear when stocked in 1957 (Table IV). One walleye 6.5 inches long was recovered in the fall of 1957 following the selective shad kill there. Dewey Lake was also turbid when stocked in 1958 (Table IV).

In 1958, two walleye, 5.6 inches and 6.5 inches, were taken on August 20 (Table V). It is possible that these 1958 returns could have resulted from spawn in the reservoir, because 102 fingerling walleye were stocked in 1956.

Table IV

Walleye Fry Stocking in Various Lakes for the Years 1956, 1957 and 1958

Date	Lake Stocked	Lake Area in Acres	No. Fry Released	Water Condition	Type of Release: Shore-line	Type of Release: Open Water	Lake Age: Old	Lake Age: New	Remarks on Biological Conditions	Results
5- 6-56	Williamstown Reservoir	305	60,000	Turbid	x	—	—	x	A few adult green sunfish	A few walleye creeled
5- 6-57	Herrington Lake	3,600	60,000	Clear	x	—	x	—	Large numbers fry hatched in Lake	A few walleye
5-11-57	Herrington Lake	3,600	200,000	Clear	x	x	x	—	Large numbers fry hatched in Lake	A few walleye
5-14-57	Herrington Lake	3,600	700,000	Clear	x	x	x	—	Large numbers fry hatched in Lake	A few walleye
5- 7-57	Dewey Lake	1,200	10,000	Clear	x	x	x	—	Some fry hatched in Lake	One walleye
5-10-57	Dewey Lake	1,200	200,000	Clear	x	x	x	—	Some fry hatched in Lake	One walleye
5-13-57	Dewey Lake	1,200	300,000	Clear	x	x	x	—	Some fry hatched in Lake	One walleye
5-19-57	Dewey Lake	1,200	400,000	Clear	x	x	x	—	Some fry hatched in Lake	One walleye
5- 7-57	Bullock Pen Lake......	178	200,000	Clear	—	x	x	—	Bass fry hatched in Lake	No walleye
5-12-57	Greenbo Lake	225	225,000	Clear	—	x	x	—	Little zooplankton. No fry hatched	No walleye
5-16-57	Shanty Hollow Lake ...	107	118,000	Clear	—	x	x	—	Bass fry abundant	Two walleye in creel
5- 2-58	Herrington Lake	3,600	288,000	Turbid	x	x	x	—	No fry visible in Lake	
5- 3-58	Herrington Lake	3,600	480,000	Turbid	x	x	x	—	No fry visible in Lake	Many walleye
5- 3-58	Herrington Lake	3,600	714,000	Turbid	x	x	x	—	Fry in upper lake thought to be	returns from
5- 5-58	Herrington Lake	3,600	648,000	Turbid	x	x	x	—	buffalo fry	population studies
5- 6-58	Herrington Lake	3,600	312,000	Turbid	x	x	x	—	” ” ” ” ”	and selective
5- 7-58	Herrington Lake	3,600	330,000	Turbid	x	x	x	—	No fry visible in Lake	shad kill
5-10-58	Herrington Lake	3,600	180,000	Clear Where	x	x	x	—	No fry hatched in this area	
5-12-58	Herrington Lake	3,600	72,000	Released	x	—	x	—	No fry hatched in this area	
5- 2-58	Dewey Lake	1,200	432,000	Turbid	x	x	x	—	No fry observed or reported	Numerous walleye
5- 3-58	Dewey Lake	1,200	432,000	Turbid	x	x	x	—	No fry observed or reported	returns
5- 6-58	Dewey Lake	1,200	432,000	Turbid	x	x	x	—	No fry observed or reported	” ” ”
5- 4-58	Severn Creek Lake	138	336,000	Turbid	x	—	—	x	Many zooplankton. Also walleye fry	
5- 5-58	Severn Creek Lake	138	180,000	Turbid	x	—	—	x	released in creek above the Lake	No study
5- 6-58	Severn Creek Lake	138	192,000	Turbid	x	—	—	x	” ” ” ” ”	
5- 8-58	Severn Creek Lake	138	324,000	Turbid	x	—	—	x	” ” ” ” ”	
5- 5-58	Bullock Pen Lake	178	588,000	Turbid	x	—	x	—	No fry hatched	No walleye
5- 4-58	Williamstown Lake	305	456,000	Turbid	x	—	x	—	....	No study
5- 5-58	Shanty Hollow Lake ..	107	180,000	Clear	—	x	x	—	....	No walleye
5- 8-58	Rough River Reservoir.	Dam Not	360,000	Clear	x	—	—	x	....	No walleye
5- 9-58	Rough River Reservoir.	Closed	324,000	Clear	x	—	—	x	....	No walleye

Table V

The Walleye Recovered as a Result of Rotenoning Coves Approximately One Acre in Size in Two Relatively Old Lakes During 1958

Herrington Lake (3,600 Acres)

Date	*Name of Cove*	*Walleye Recoveries*	*Size Fish*	*Condition*
5-13-58	Bryant's Cove	No walleye recovered	—	—
5-20-58	Rock Fork	One walleye	11 inches	Poor
6-11-58	McKecknie Branch	No walleye recovered	—	—
6-18-58	Gary's Hollow	No walleye recovered	—	—
7- 1-58	Ballard's Cove	No walleye recovered	—	—
7- 2-58	Ballard's Cove	163 walleye 2nd day	4 to 5 inches	Healthy
7-23-58	Cove behind Gwinn Island	No walleye 1st day	—	—
7-24-58	Gwinn Island	3 walleye recovered	4.5, 5 & 6.3 in.	Healthy
7-30-58	Bryant's Cove	No walleye recovered	—	—
8- 5-58	Dennis Cove	No walleye 1st day	—	—
8- 7-58	Dennis Cove	One walleye 2nd day	5.8 inches	Healthy

Dewey Lake (1,200 Acres)

Date	*Name of Cove*	*Walleye Recoveries*	*Size Fish*	*Condition*
5-27-58	Gobel's Branch	No walleye recovered	—	—
7- 8-58	Cpooerras Cove	No walleye recovered	—	—
8-19-58	Clark's Branch	No walleye 1st day	—	—
8-20-58	Clark's Branch	2 walleye 2nd day	5.6 & 6.5 in.	Healthy
9- 8-58	2nd Cove up from Dam on Left	No walleye recovered	—	—

The 1958 fall "selective" gizzard shad kills resulted in killing hundreds of 6 to 9 inch walleye in Herrington and Dewey Lakes (Personal communications).

Williamstown Lake, a new 305-acre reservoir, was stocked May 6, 1956, with 60,000 fry. It was turbid at the time and the only fish present were green sunfish from ponds on the watershed. The fry were stocked along the shoreline (Table IV). In 1957, when the lake was opened to fishing, 16 walleye 10 to 13 inches long were taken the opening day. In 1958, eight walleye ranging from 13 to 19 inches were caught. No walleye fry were stocked in Williamstown Lake in 1957.

Shanty Hollow Reservoir, a small 118-acre lake with an established fish population, was stocked in 1957 with 118,000 fry by open-water sowing (Table IV). This method was used because at the time of stocking there was a band of bass fry all along the shoreline. Fishermen had caught 2 walleye 10 and 13 inches long by the spring of 1958. No walleye were taken in fish population studies in 1957 and 1958.

No walleye have been recovered at Bullock Pen Lake and Greenbo Lake.

It would appear from our small amount of evidence that if walleye fry are stocked several years in succession, persistence will pay off with a walleye fishery. Turbidity at the time of stocking seems to increase the chances of success.

The question as to which is the better, shoreline or open-water stocking, is not yet solved. Success was reported at Williamstown Lake with shoreline stocking, while at Shanty Hollow Reservoir open-water stocking proved successful, but at Herrington Lake and Dewey Lake no chances were taken and both methods were used.

FINGERLING PRODUCTION OF WALLEYE

Each year of this study, the U. S. Fish and Wildlife Service has made experimental ponds available at the Frankfort station.

The 1956 walleye fingerling culture was a dismal failure (Table VIII). Reasons for failure were that the ponds were not prepared sufficiently far enough in advance of stocking to insure adequate zooplankton. Combinations of fertilizers were used that Smith and Moyle (1953) found unsatisfactory; and the ponds were stocked several days in succession and left in production too long.

Thirty pounds of calcium metaphosphate and 125 pounds of soybean meal were used in a 0.9 acre pond. In a 0.1 acre pond 10 pounds calcium metaphosphate and 50 pounds of soybean meal were used. It was felt this type of fertilization was a mistake.

In 1957 the fertilization methods were changed. Dobie (1956) emphasized the role of organic matter in producing walleye. Russell Fielding (personal communication) called this to the writer's attention and recommended using hay. Ten bales of spoiled alfalfa hay were used in 1 pond and produced 1,532, 1.5- to 2.0-inch walleye (Table VIII). The other pond was accidentally drained with the screen off the bottom, so results from it were negligible.

Well in advance of stocking in 1958, six hundred pounds of hay was used in the pond which had produced the greatest number of fingerlings, 200 pounds of hay in the other pond, 200 pounds of soybean meal and 28 pounds of 8-0-2 inorganic fertilizer in each pond.

One of the things learned was the value of keeping ponds in production no longer than a month (Table VIII).

In 1957 and 1958 the longest a pond was kept in production was 34 days. Also, fry of nearly the same age were stocked all on the same date in 1958 (Table VIII).

TABLE VI

WALLEYE FINGERLING PRODUCTION

1956

	Fry Stocked				Fingerlings Removed					
Pond No.	*Size*	*Date Filled*	*Date Stocked*	*No. of Fry Stocked*	*Date*	*Days in Produc.*	*No.*	*Wt.*	*No. Per Acre*	*No. Per Lb.*
28	.9	....	5-4-56	....	7- 5-56	51	96	...	106	..
.	.	.....	5-5-56	180,000 Est.	.....	..	....	...	...	..
Estil	.	.....	5-7-56	....	.....	..	....	...	...	..
Pond	.1	.....	5-3-56	10,000 Est.	7-17-56	74	6	...	60	..

1957

	Fry Stocked				Fingerlings Removed					
Pond No.	*Size*	*Date Filled*	*Date Stocked*	*No. of Fry Stocked*	*Date*	*Days in Produc.*	*No.*	*Wt.*	*No. Per Acre*	*No. Per Lb.*
26	.9	.....	5-7-57	40,000 Est.	.....	..	....	...	...	..
.	.	.....	5-8-57	1,000 Est.	.....	..	....	...	...	..
.	.	.....	5-9-57	20,000 Est.	6- 6-57	30	167	...	184	..
28	.9	.....	5-7-57	80,000 Est.	6- 4-57	28	1,532	...	1,685	..

1958

	Fry Stocked				Fingerlings Removed						
Pond No.	*Size*	*Date Filled*	*Date Stocked*	*No. of Fry Stocked*	*Date*	*Days in Produc.*	*No.*	*Wt.*	*No. Per Acre*	*Wt. Per Acre*	*No. Per Lb.*
29	.9	4-11-58	5-8-58	40,000 to 72,000	6-11-58	34	19,130	21.7	21,255	24.1	880
30	.9	4-11-58	5-8-58	20,000 to 40,000	6- 3-58	26	9,300	13 lbs. 1 oz.	10,333	14.4	728

It is felt that hay is extremely important not only in producing zooplankters but in helping to prevent phytoplankton blooms. Prior to the application of hay one of the ponds had a heavy phytoplankton bloom and almost no zooplankters. Forty-eight hours after the application of 12 bales of spoiled Kentucky 31 fescue hay, the pond was deeply stained and the phytoplankton bloom was suppressed.

Irwin and Stevenson (1951) showed the effect of hay on increasing bicarbonates, bacterial pulses, CO_2, and hydrogen ion concentrates. They also noted the abundance of zooplankters in some ponds after the application of hay.

Periodic use of ½ p.p.m. copper sulphate also helped prevent green blooms.

The 1958 production rate was 21.255—1.5- to 2.0-inch fish per acre in 1 pond and 10,333—1.5- to 2.0-inch fish per acre in another (Table VIII). The poundage production was beginning to compare favorably with Minnesota production (Dobie, 1956).

The necessity of keeping the predacious insect population at a minimum immediately before and after stocking newly hatched fry can not be stressed too much. Applications of kerosene were used each year prior to stocking for insect control.

Inorganic fertilizers containing phosphorus were not used because the creek feeding the federal hatchery is high in phosphates (Table I).

Nearly everyone who has had experience with raising walleye has let his ponds run until they reach the "point of diminishing returns" as a result of cannabalism. The writer was no exception. Should the writer raise walleye again he would stock heavily, check daily, harvest when the fingerlings reach one inch, and restock a portion of the one-inch fish in a prepared pond full of minnow fry.

The writer put 400 advanced fry walleye in a .1-acre pond of fathead minnows and a seine check 38 days later revealed they had reached lengths up to 4 inches.

It is not felt that the 1958 production approached the ultimate capacity for Kentucky ponds, either in numbers of fingerlings or in poundage.

The production achieved by Stan Hudson at Ozark Fisheries in Missouri is further evidence that walleye lend themselves to pond culture. He produced approximately 360 pounds of 3- to 7-inch walleye in a 0.97-acre pond. He believes he could have exceeded this by harvesting slightly sooner. He fed his walleye fathead minnow fry by the bucketful as soon as they were able to eat them (Personal conversation).

HAULING FINGERLING WALLEYE IN PLASTIC BAGS

In 1958 experiments were made with hauling fingerling walleye in polyethylene bags. Too few tests have been made to date to be definitive. Because of the value of these fish not too many were used as controls, nor did the writer vary the tests as much as he would have liked. The tests were run under field conditions so that chemicals to buffer carbon dioxide or anesthetize fish could be measured easily in the future. For example, it is easier to carry a set of measuring spoons than a platform balance. An alternative would have been to measure the chemicals in advance and put them in waterproof containers. All tests were run with 5 gallons of water per plastic bag. The hauling water was somewhat alkaline (Table I). This alkalinity probably buffered the accumulation of carbon dioxide to a certain extent.

Sodium bicarbonate served well to carry fish for a few hours in plastic bags Tables VII, VIII, X, XI), Welch (1935) mentioned experiments which indicated that in certain fishes resistance to lack of oxygen is increased by the injection of sodium bicarbonate. Perhaps the soda also reduces bacterial action within the bag.

In limited tests dibasic sodium phosphate appears to be a better buffer than bicarbonate of soda (Table IX).

Nemoto (1957) used oxygen, dibasic sodium phosphate, and activated charcoal with good results. This combination, together with icing, appears to be satisfactory for walleye hauling (Table IX). If the ice is placed inside the bag the pieces should be allowed to melt before closing the bag. The writer iced only from 72° F. down to between 64° and 59° F. (Table IV).

By using O-Tabs, dibasic sodium phosphate, and activated charcoal in addition to icing, one should be able to carry 7,000 to 9,000 walleye fingerlings 1½ to 2 inches in length per station wagon load.

M. S. 222 and the tranquilizer Equanil showed enough promise at 0.1 to 0.2 grain per bag to encourage further tests (Table X). Thorazine killed fish at concentrations of 0.1 and 0.2 grain.

Table VII

Field Tests Using O-Tab, Two Tablespoons Bicarbonate of Sodium, Activated Charcoal (Fish Weight 728 Per Pound)

No.	*No. of Fish Per Bag*	*Apx. Size of Fish*	*Time in Bag*	*Temp. at Loading*	*Temp. at Arrival*	*No. Dead*
1	300	1½–2″	1 Hour	72° F.	78° F.	0
2	300	1½–2″	1 Hour	72° F.	78° F.	1
3	250	1½–2″	1 Hour	72° F.	77° F.	1
4	200	1½–2″	1 Hour	72° F.	77° F.	0
5	200	1½–2″	1 Hour	72° F.	77° F.	0
6	200	1½–2″	1 Hour	72° F.	77° F.	0
7	300	1½–2″	1 Hour	72° F.	77° F.	0
8	300	1½–2″	1 Hour	72° F.	77° F.	0
9	250	1½–2″	1 Hour	72° F.	79° F.	0
10	300	1½–2″	1 Hour	72° F.	79° F.	0
11	300	1½–2″	1 Hour	72° F.	79° F.	2
12	200	1½–2″	1 Hour	72° F.	79° F.	0
13	300	1½–2″	1 Hour	72° F.	79° F.	297
14	200	1½–2″	1 Hour	72° F.	79° F.	0
15	250	1½–2″	1 Hour	72° F.	79° F.	0
16	250	1½–2″	1 Hour	72° F.	77° F.	0
17	200	1½–2″	1 Hour	72° F.	77° F.	1
18	300	1½–2″	1 Hour	72° F.	77° F.	0
19	250	1½–2″	1 Hour	72° F.	77° F.	1
20	100	1½–2″	1 Hour	72° F.	77° F.	1
21	100	1½–2″	1 Hour	70° F.	74° F.	1

Table VIII

Field Tests Using O-Tab, Two Tablespoons Sodium Bicarbonate, Charcoal (Fish Weight 880 Per Pound)

No.	*Approx. No. Fish Per Bag*	*Approx. Size*	*Time in Bag*	*Temp. at Loading*	*Temp. at Arrival*	*No. Dead*	*Condition*
1	330	1½–2″	5 Hours	72° F.	.....	7	Fair
2	220	1½–2″	5 Hours	72° F.	.....	2	Very Active
3	220	1½–2″	5 Hours	72° F.	79° F.	1	Active
4	330	1½–2″	5 Hours	64° F. Iced	76° F.	10	Fairly Active
5	660	1½–2″	5 Hours	64° F. Iced	75° F.	0	Excellent
6	330	1½–2″	5 Hours	72° F.	79° F.	270	Surfaced
7	330	1½–2″	5 Hours	72° F.	.....	5	Active
8	440	1½–2″	5 Hours	62° F. Iced	74° F.	3	Active
9	440	1½–2″	5 Hours	72° F.	80° F.	220	Surfaced
10	330	1½–2″	5 Hours	.....	.....	6	Surfaced
11	330	1½–2″	5 Hours	63° F. Iced	73° F.	3	Surfaced

Table IX

Plastic Bag Field Tests Using O-Tab, ¾ Teaspoon Dibasic Sodium Phosphate, Activated Charcoal (Fish Weight 880 Per Pound)

No.	*Approx. No. Fish Per Bag*	*Approx. Size*	*Time in Bag*	*Temp. at Loading*	*Temp. at Arrival*	*No. Dead*	*Condition*
1	330	1½–2″	5 Hours	72° F.	.....	6	Alert
2	220	1½–2″	5 Hours	72° F.	.....	10	Alert
3	440	1½–2″	5 Hours	60° F. Iced	71° F.	0	Alert
4	330	1½–2″	5 Hours	59° F. Iced	71° F.	0	Fair

Plastic Bag Field Tests Using O-Tab, 1½ Tsp. Dibasic Sodium Phosphate

1	330	1½–2″	5 Hours	72° F.	.....	6	Active
2	220	1½–2″	5 Hours	72° F.	.....	2	Very Active
3	220	1½–2″	5 Hours	72° F.	.....	10	Very Active
4	220	1½–2″	5 Hours	72° F.	.....	5	Very Active

Table X

Plastic Bag Field Tests Using O-Tab, Two Tablespoons Sodium Bicarbonate, Activated Charcoal and M.S. 222
(Fish Weight 880 Per Pound)

No.	*Approx. No. Fish Per Bag*	*Approx. Size*	*Time in Bag*	*Temp. at Loading*	*Temp. at Arrival*	*No. Dead*	*Condition*
			0.1 Grain M.S. 222				
1	330	1½–2″	5 Hours	62° F. Iced	73° F.	1	Excellent
2	330	1½–2″	5 Hours	72° F.	77° F.	0	Excellent
			0.2 Grain M.S. 222				
1	330	1½–2″	5 Hours	72° F.	78° F.	2	Excellent
			Plastic Bag Tests Using O-Tab, Two Tablespoons Bicarbonate of Soda, and 0.1 Grain Equanil				
1	330	1½–2″	5 Hours	72° F.	75° F.	0	Good
2	330	1½–2″	5 Hours	62° F. Iced	72° F.	0	Excellent

Table XI

Plastic Bag Field Tests Using O-Tab and Activated Charcoal
(Fish Weight 728 Per Pound)

No.	*Approx. No. Fish Per Bag*	*Approx. Size*	*Time in Bag*	*Temp. at Loading*	*Temp. at Arrival*	*No. Dead*	*Condition*
1	250	1½–2″	1 Hour	72° F.	79° F.	4	Fair
2	250	1½–2″	1 Hour	72° F.	79° F.	3	Fair
3	250	1½–2″	1 Hour	72° F.	79° F.	4	Fair
			Plastic Bag Field Tests Using O-Tab and Two Tablespoons Sodium Bicarbonate				
1	350	1½–2″	1 Hour	72° F.	78° F.	0	Excellent
2	350	1½–2″	1 Hour	72° F.	78° F.	1	Excellent
3	350	1½–2″	1 Hour	72° F.	78° F.	1	Excellent
4	250	1½–2″	1 Hour	72° F.	79° F.	0	Excellent
5	300	1½–2″	1 Hour	72° F.	79° F.	5	Good
6	250	1½–2″	1 Hour	72° F.	79° F.	0	Excellent
7	300	1½–2″	1 Hour	72° F.	79° F.	0	Excellent
8	250	1½–2″	1 Hour	72° F.	79° F.	1	Excellent
9	250	1½–2″	1 Hour	72° F.	79° F.	1	Excellent

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LITERATURE CITED

Carlander, Kenneth D. 1957. Disturbance of the Predator-Prey Balance as a Management Technique. Trans. Amer. Fish. Soc., Vol. 87 (1956), pp. 34-38.

Clark, Clarence F. 1957. Experiments in the Transportation of Live Fish in Polyethylene Bags. Pp. 4 and Tables Attached, 19th Annual Meeting, Milwaukee, Wisconsin.

Cummins, Robert, Jr. 1954. Malachite Green Oxalate Used to Control Fungus on Yellow Pikeperch Eggs in Jar Hatchery Operations. Prog. Fish-Cult., Vol. 19, No. 2, pp. 79-82.

Davis, H. S. 1956. Culture and Diseases of Game Fishes. Univ. of Calif. Press., Berkeley and Los Angeles, California, pp. 1-332.

Deason, Hilary J. 1933. Preliminary Report on the Growth Rate Dominance and Maturity of the Pikeperches (*Stizostedion*) of Lake Erie. Trans. Amer. Fish. Soc., Vol. 63 (1932), pp. 348-360.

Dobie, John. 1956. Walleye Pond Management in Minnesota. Prog. Fish-Cult., Vol. 18, To. 2, pp. 51-57.

Irwin, W. H. and James H. Stevenson. 1951. Physiochemical Nature of Clay Turbidity with Special Reference to Clarification and Productivity of Impounded Waters. Bull. Okla. Agri. and Mech. Coll., Vol. 48, No. 14, pp. 1-54.

Krogh, A. 1939. Osmotic Regulation in Aquatic Animals. Cambridge Univ. Press, London.

Nemoto, Carl M. 1957. Experiments with Methods for Air Transport of Live Fish. Prog. Fish-Cult., Vol. 19, No. 4, pp. 147-157.

Phillips, Arthur M., F. E. Lovelace, D. R. Brockway, H. A. Podoliak and G. C. Balzer. 1954. Cortland Hatchery Report No. 23. New York Conser. Dept., Albany, N. Y.

——————. 1955. Cortland Hatchery Report No. 24.

——————. 1956. Cortland Hatchery Report No. 25.

Phillips, Arthur M., Jr., Donald R. Brockway and Ray R. Vaughn. 1957. Cortland Hatchery Report No. 26.

Surber, Eugene W. 1935. Effects of Carbon Dioxide on the Development of Trout Eggs. Trans. Amer. Fish. Soc., Vol. 65 (1934), pp. 194-203.

Van Horn, W. M. and Robert Balch. 1956. The Reaction of Walleye Pike Eggs to Reduced Dissolved Oxygen Concentrations. Proc. Eleventh Indus. Waste Conf., May 15, 16, 17.

Welch, Paul S. 1935. Limnology. McGraw-Hill Book Co., New York and London, pp. 1-471.

FINAL REPORT ON THE SUCCESS OF LARGEMOUTH BASS-BLUEGILL AND LARGEMOUTH BASS-SHELL-CRACKER RATES AND RATIOS IN KENTUCKY FARM PONDS

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ABSTRACT

In order to test the relative success of various stocking rates of largemouth bass, *Micropterus salmoides* (Lacepede)-bluegill, *Lepomis macrochirus* Rafinesque, combinations and largemouth bass-shellcracker, *Lepomis microlophus* (Gunther), in farm ponds in Kentucky, 574 ponds were stocked with these fishes in the following combinations and rates: fry bass: fingerling bluegill 30:400, 50:500, 80:500 and 100:500 per acre; fry bass: adult bluegill 100:30, 100:50 and 100:70 per acre; fry bass: fingerling shellcracker 50:300 and 50:600 per acre; fry bass; fingerling shellcracker + mosquito fish, *Gambusia affinis* (Baird and Girard), 50:300 + 400 and 50:600 + 400 per acre.