average gross income of $1,751.00. After deducting operating expenses which included depreciation, outboard motor fuel and repairs to equipment, the average net income for all fishermen was $1,604.00; full-time fishermen earned an average net income of $1,991.00 and part-time fishermen earned an average net income of $1,281.00 (Table VIII).

DISCUSSION

Commercial fishing was a large business in the Tennessee Valley Area of Alabama during 1956. Through the harvest of an otherwise unavailable "crop," commercial fishing partially or totally supported 1,800 people living in the Tennessee Valley. Had it not been for commercial fishing 3,912,524 pounds of economical protein food material valued at $900,003.00 would have been unharvested and wasted. Indications were that the commercial fishery resource was under-exploited due to the fact that there was an insufficient market for the resource. T. V. A. records showed that there were approximately 25,000,000 pounds of harvestable size commercial fish available during 1956. This study indicated that only 15 percent of the harvestable size commercial fish were taken. Commercial fishing is limited by legislation and marketing facilities. Therefore, more liberal regulations and better marketing facilities will be necessary before the commercial fishing industry can reach its maximum potential harvest.

A PROPOSAL FOR THE MANAGEMENT OF RESERVOIRS FOR FISHERIES *

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ABSTRACT

A fisheries management plan for reservoirs is proposed which is dependent upon having a fish management pool and provision for drainage incorporated into the basic design. Justification is given to support the cost of having a cleared management pool in the bottom of the reservoir as well as drainage facilities. A plan is also proposed for selective clearing of reservoir basins.

The management program described is based on a philosophy of drastic manipulations of fish populations through fall and winter drawdowns, selective kills, partial kills, intensive sport and commercial fishing and other management practices designed to favor the carnivorous fishes and reduce the total number and pounds of all fish so as to bring about a balance of the predator fishes with their food supply and maintain expanding fish populations.

The drawdown is of paramount importance in the reservoir management scheme and, in the humid Southeastern United States, it should begin immediately after Labor Day. The water level should be lowered to the fish management pool by October 15th or November 1st. According to the size of the watershed, water levels can be allowed to return to normal after January 1st. Cost of carrying out the management techniques in the fish management pool are minimal and most effective.

INTRODUCTION

We believe that in the past 15 years, the various fishery workers over the country have begun to formulate in their minds certain basic theories concerning the management of the warm-water fisheries in reservoirs. These theories are based on the goal of providing good fishing for the sport fisherman, along with the wise utilization of a renewable natural resource. The objective is not to produce maximum pounds of all fish per acre per year, but rather to increase

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the yield and harvest of the more desirable species. We believe that we have at hand management techniques which will greatly aid us in our objective, but to date there has been a reluctance on the part of Fishery Biologists, Administrators and others to trust these practices and promulgate their use—until something better comes along.

In Arkansas a very definite fish management policy has become crystallized. An aggressive program is being carried out whenever and wherever the opportunity presents itself, on all reservoirs no matter how small or how large, and regardless of the primary purpose for which the reservoir was built.

A multiple purpose drawdown plan, with appropriate modifications, has been carried out successfully on farm ponds, certain relatively small hydroelectric reservoirs, flood-control reservoirs, recreational and fishing lakes, irrigation reservoirs and rice-fish reservoirs. In addition, beneficial fishery effects of unplanned drawdowns were also experienced when two large hydroelectric reservoir projects were drawn down to the bottoms of their respective power pools during the extended drought of 1954-1955.

You might ask, "Aren't you afraid to be so positive and definite in your management recommendations?" We would have to answer that we would be afraid not to have a positive program. Thousands of people each year are asking for advice and guidance, and if we, as the fishery experts, cannot give them definite, positive answers, then we have failed in our job. Everyone understands that what might be the approved management recommendations in the year 1958 will possibly be obsolete in the year 1968. However, it is our duty as professional fishery workers to give our people a positive plan of action now—and not waver in a sea of indecision. Thousands of acres of new waters are being created each year, and if the fishery professionals do not come forth with concrete management plans for these waters, then the engineers, agriculturists and water commissioners will go ahead, construct and operate these new water areas according to their designs. As a consequence, the potential fisheries benefits of these new waters may not be realized.

For our management plan to be effectively put into operation, there are two provisions that should be (and can be more conveniently) made during the construction phase. These are (1) a harvesting basin, or fish management pool, located in the very bottom of the reservoir, and (2) a drain pipe located at the lowest point in the dam.

THE HARVESTING BASIN

In planning for the future fisheries management of a reservoir, we need to plan for what may be needed to meet the conditions prevailing 15, 25 or even 50 years from now. One thing that we know for sure is that fishes produced should be harvested. Fish are a renewable resource. Conservation means wise utilization. We can speculate that sometime in the future every source of high quality protein will be tapped to its fullest extent.

It is stimulating to imagine that new and exciting methods of fish capture, such as by electrical shocking, drawing to electrodes, driving by sound and radio waves and application of chemicals will be developed. However, to remain practical, we must base our plans on present conventional methods of fish harvest and construct our reservoirs so that the fishes can be harvested by the most efficient means now being employed.

The present day harvest of fish is facilitated by several means: (1) by concentration—this can be accomplished by providing drainage facilities in the dam so the water level in the reservoir can be dropped, resulting in reduction of both surface area and volume; (2) by providing cleared and clean harvesting areas, portions of which, when possible, can be seined by large commercial seines; and (3) by attraction—in open water, with a clean bottom devoid of cover, certain species can be attracted by brush shelters specifically placed for that purpose.

In present day reservoir planning and construction, the harvesting area is the most neglected fish management consideration. Except possibly for fish attractors constructed of brush, the harvesting area of a reservoir should be as clean and free of standing timber, logs, stumps and other obstructions as possible. All commercial fishing gear suitable for use in a reservoir (seines, gill-nets, trammel-nets, snag-lines and trot-lines) require a relatively clean lake bottom for effective use. It is unlikely that any method of fish harvest will be devised that would not be facilitated by concentration of the fishes into a clean harvesting pool.

There is considerable evidence that a *moderate* number and poundage of the important commercial food fishes (catfishes and buffalo-fishes) can be produced in a sport fishing lake without having any deleterious effect on the sport fishing. The limited crop of commercial food fishes can be thought of as a *bonus crop*, superimposed on the sport fish population, and occupying ecological niches not especially used by any of the game species. There are substantial indications that most of these more important food fishes have a difficult time maintaining their numbers in a "clear-water game-fish lake". From a fish management

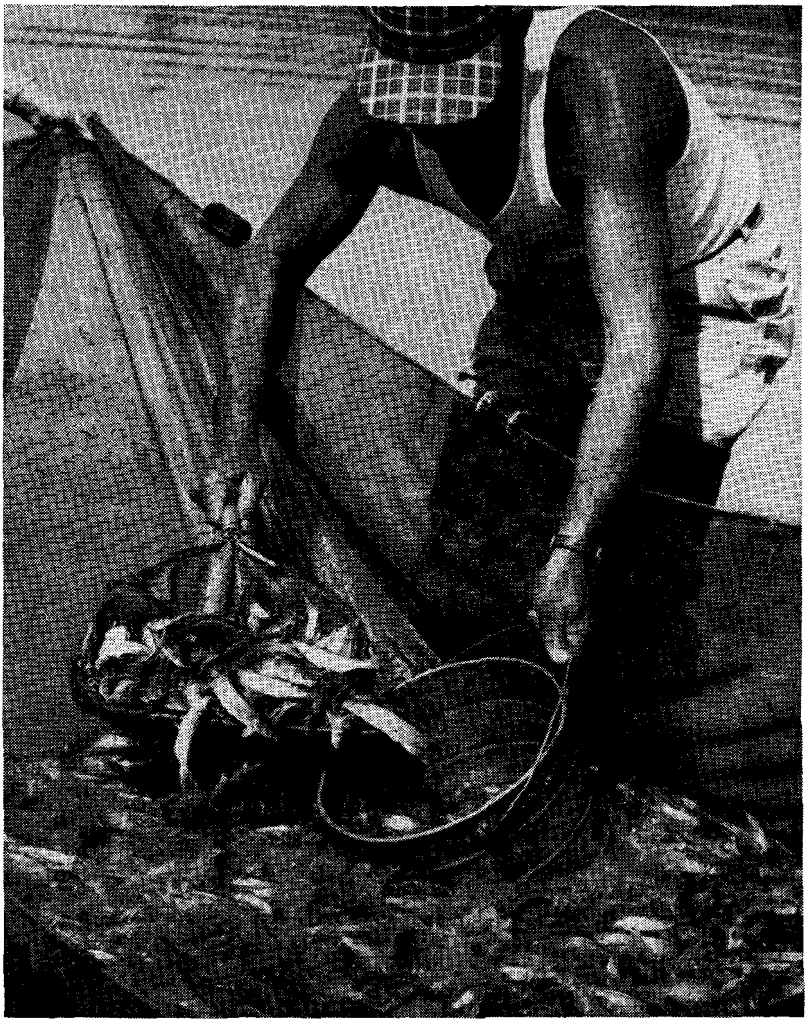


Fig. 1. Commercial production of channel catfish fingerlings, Anderson's Minnow Farms, Lonoke, Arkansas. (Photo by Jack Atkins, Arkansas Game and Fish Commission.)

standpoint, this could be considered a fortunate circumstance. That is, the desired food fishes can be propagated artificially in hatchery and nursery ponds and raised to a desirable "stocking" size economically (Figures 1 and 2). Therefore, such lakes could be stocked periodically with the proper number and size of commercial food fishes, based upon the number harvested and the natural fertility of the reservoir.

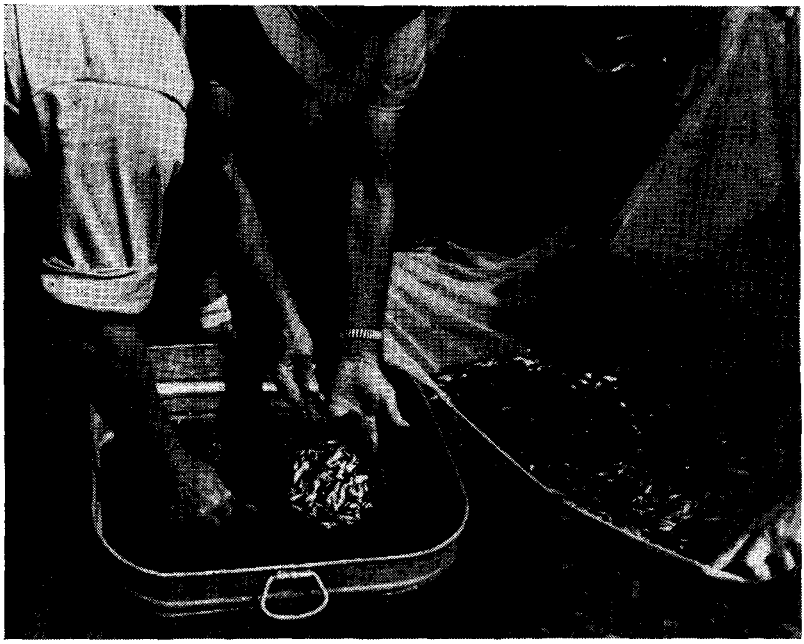


Fig. 2. Successful production of bigmouth buffalo fingerlings, State Fish Hatchery, Lonoke, Arkansas. In Arkansas there are several private hatcheries producing buffalo fingerlings. (Photo by Jack Atkins, Arkansas Game and Fish Commission.)

An additional argument for a clean harvesting basin is the fact that there is always a resident population of rough and commercial food fishes present in the larger streams when they are impounded. These fishes usually reproduce successfully the first year after impoundment, if at no other time. Therefore, in these reservoirs, after a few years, there will be a large poundage of food fish present. Since most of these species have long life cycles (some living as long as 25–30 years) they will be present over a considerable period of time. They are a crop that should be harvested; not wasted by allowing them to die natural deaths.

The harvesting basin is a safety factor in event a reservoir becomes overpopulated with undesirable or scrap species of fish. These undesirable fishes will not only ruin the particular reservoir but could act as a source of infestation to other lakes and streams.

It is strongly recommended that a completely cleared harvesting basin (except possibly for fish attractors constructed of brush) be included in all plans for reservoirs.

THE FISH MANAGEMENT POOL

The cleared and "clean" harvesting area constructed in the very bottom of a reservoir could also be called the fish management pool, and we propose that it be called such. In this residual water area, fishery management can be carried out cheaply and effectively. The size of the fish management pool will vary according to the topography of the land and the specific purpose of the reservoir. (In rice-fish reservoirs, the fish management pool may be only 1/20th the size of the entire field under water.) Here in this reduced water area and volume where the fish are concentrated, the fishery manager may recommend, among other things, a harvest of commercial food fishes (Figure 3); a harvest of game or sport fishes; a selective kill of shad or other species (Figure 4); a partial kill of all fishes; that an electric shocker be employed to remove certain species; or a complete kill. There are few tools, if any, that might be applied to manipulate a fish population that would not be easier to use in a greatly reduced water area and volume that has been cleared of all standing timber and is open and clean for the use of boats and other equipment.

Fig. 3. Commercial and rough fish harvest in Blue Mountain Reservoir during draw-down, 1956-57. (Photo courtesy U. S. Corps of Engineers.)

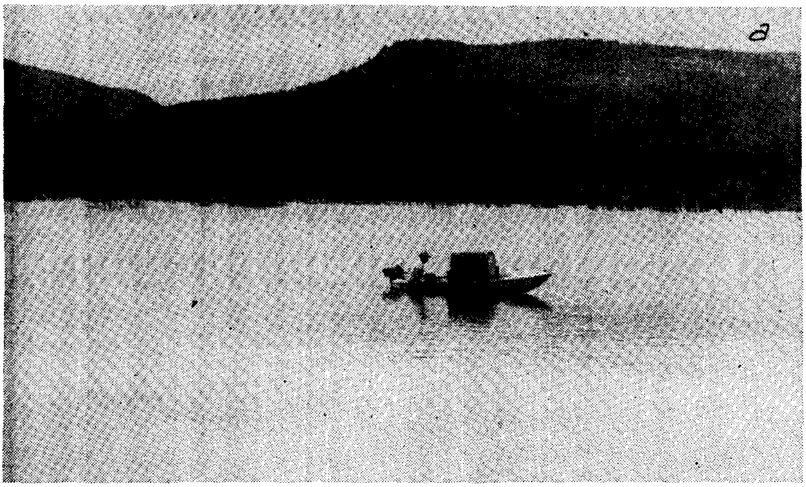
THE DRAIN PIPE

In the planning stages for reservoirs, recognition should be taken of the possibility that they will be drawn down periodically in order to concentrate the fish population as well as for other purposes. If necessary, the basins should be so modified that good drainage will be had into the harvesting areas and fish will not be stranded in shallow depressions, "cut-off" from the main body of water. Fish salvage operations are very difficult and costly.

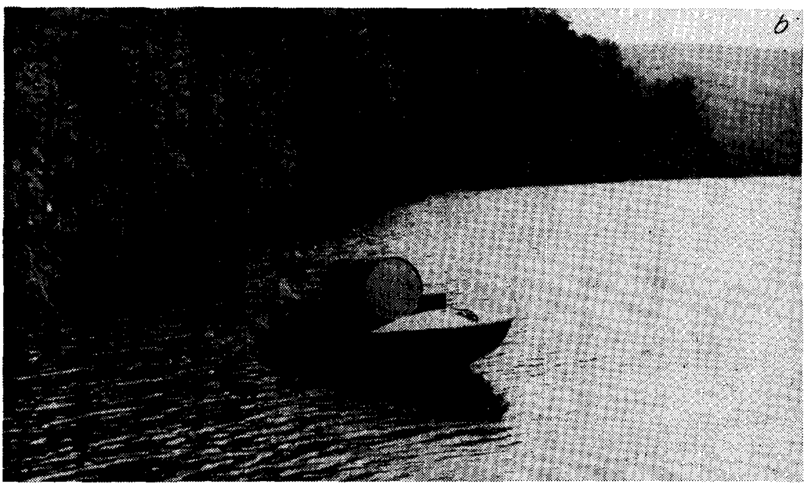
In order to drain a reservoir, there must be a drain pipe with necessary control valves. It is important that this drain pipe be located in the dam or levee at the lowest possible point.

CLEARING OF RESERVOIR AREAS

The entire reservoir basin to be inundated need not be completely cleared of all timber; just the fish management pool and other specific areas. The clearing of stream channels for use as boat roads and the construction of boat trails through exceptionally large tracts of "emergent" timber is desirable and necessary. In certain types of large impoundments, additional cleared areas will be needed to aid in the harvest of food and rough fishes. It is recognized that some clearing may be necessary from other than a fishery standpoint, *e. g.*, cleared areas around access points, swimming beaches and clearing from a health stand-



Figs. 4a and b. Carrying out a selective fish kill in the cleared fish management pool of a drawn-down reservoir. Note the dead timber that is submerged at normal water level. (Photo by Don Brown, Arkansas Game and Fish Commission.)



point. It is our feeling that much of the clearing, proposed in the past from a health standpoint, is subject to question.

There are many benefits to be derived from leaving large uncleared areas at elevations above the fish management pool. (1) Leaving a large uncleared area will mean a substantial saving in the total cost of a reservoir, as compared to complete clearing; (2) the timbered shoal areas will tend to keep wave action down and prevent the waves from eroding the dam and shoreline; (3) the dead timber and litter will retard erosion when the shoal areas are exposed during drawdowns; (4) the organic material will produce carbon dioxide (from decomposition) which will help flocculate the colloidal clay turbidity; (5) the standing timber, litter and debris will tremendously increase the surface area exposed to the water for attachment of peri-phyton and other organisms, thereby increasing the productivity of the reservoir; and (6) the timbered areas will give a different type of fish habitat than the open water areas. There will still be sufficient open water available for trolling and plenty of sheltered fish attracting areas for the still fisherman.

Figure 5 is a hypothetical sketch of a basin of "any" reservoir, showing the areas where it is deemed advisable that the timber be cleared and where timber should and/or could be left standing. It will be noted that it is recommended that timber be left in the upper profile or shoal areas of the reservoir instead of in the very bottom of the basin, as has been the practice in the past. Attention is invited to the present trend toward minimum clearing in large reservoirs recently constructed by the Corps of Engineers. The cleared fish management pool of a reservoir need not, in our thinking, be more than 1/5th the area of the normal pool and can be much less. However, on some of these large multiple-purpose Federal reservoirs, the cost of clearing the fish management pool will be considerable, and it is our responsibility to justify the additional costs involved in such clearing.

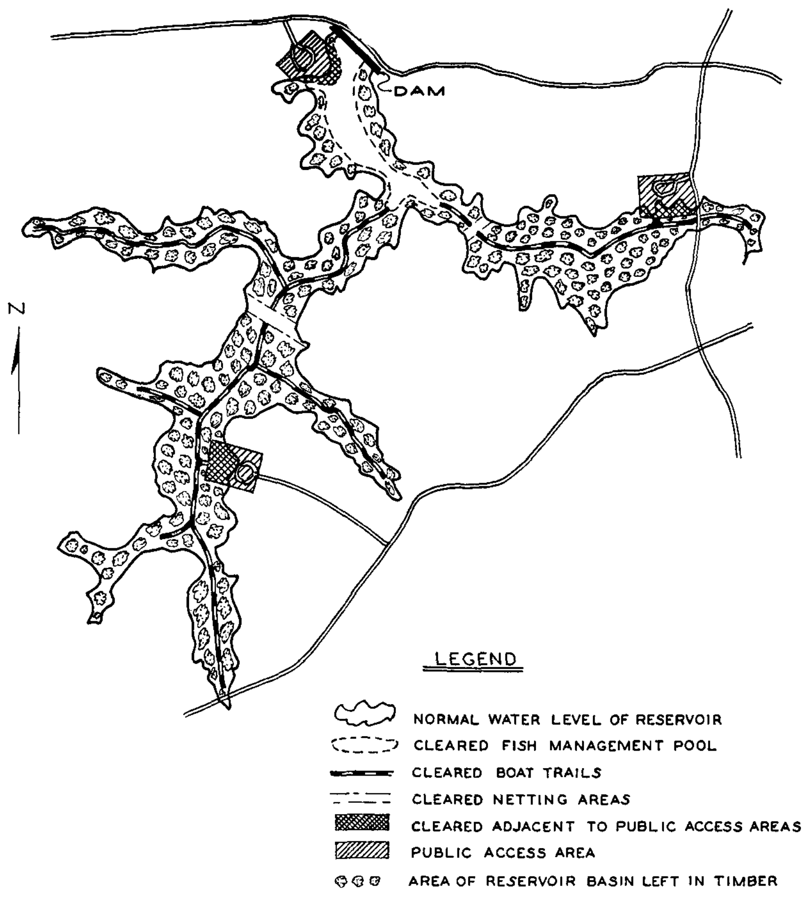


Fig. 5. A hypothetical sketch of a reservoir basin showing the clearing recommended for fish management purposes.

THE DRAWDOWN

The late summer, fall and winter drawdown is used for a variety of purposes in Arkansas where several dozen reservoirs, both public and private, have been drawn down in the past six years. We have achieved control of a number of troublesome aquatic weeds including coontail, *Ceratophyllum demersum*,[1] fanwort, *Cabomba caroliniana*, waterweed, *Elodea* species, parrot-feather, *Myriophyllum species*, water hyacinths, *Eichornia crassipes*, and water shield, *Brasenia schreberi*, by late summer, fall and winter drawdowns. I do not mean to say that we have completely eradicated these plants, but we have brought them under control so that swimming, boating and fishing could be resumed in lakes that had become completely choked for years. The beneficial effects of freezing would, of course, be lacking in the extreme southern areas of the United States.

In early fall, duck and goose food plantings can be made on the exposed bottom. Plantings of rye grass have been made on exposed flats (Figure 6) for the purpose of producing carbon-dioxide, through decay, when the reservoir is reflooded, in order to control colloidal clay turbidity and add fertility. An extended drawdown will tend to clear the water in a reservoir, even without such plantings.

Fig. 6. Rye grass planting on exposed flats during draw-down of Nimrod Reservoir, 1956-57. (Photo courtesy U. S. Corps of Engineers.)

A drawdown will expose tons upon tons of organic deposits to aeration. Through the process of oxidation, organic and mineral fertilizer nutrients are released, and when the bottom is reinundated, these nutrients are made available for the growth of micro-organisms and will increase the productivity of the water. We have obtained plankton blooms through this process in some "organic" lakes that have very satisfactorily controlled the regrowth of certain aquatic weeds, such as fanwort, coontail and waterweed.

We have used the drawdown to bring submerged aquatic vegetation under control in small high-use lakes so that a fertilization program could be undertaken.

The best use of the drawdown is for fish population manipulations (balancing the fish population and maintaining expanding populations).

We believe that drawdowns should start immediately after Labor Day or by September 15th. At this time of year the water is still warm and walleye, *Stizostedion vitreum*,[2] black bass, *Micropterus* species, white bass, *Lepibema*

[1] Nomenclature is that used by Fassett in A Manual of Aquatic Plants, 1940.
[2] Nomenclature recommended by the Committee on Common and Scientific Names of Fishes, Spl. Publication No. 1, American Fisheries Society, 1948.

chrysops, crappie, *Pomoxis* species, and other predator species and sizes will begin to feed heavily upon the small (forage) fishes and the various other aquatic animals. In most cases, a drop of six inches to one foot a day has been found to work well. We have had almost no trouble from stranding fish. By October 15th or November 1st, the water has cooled and the fall turnover has occurred, therefore, there is little danger of an oxygen depletion. Many people have worried about fish passing out of the lake through the drain pipe. Let me say here that in many cases the fish manager would consider the loss of a sizeable percentage of fish as desirable, however, we have little evidence that large numbers of fish are lost. We usually lose fish from our lakes during the spring and summer, when heavy rains cause a large volume of water to pass through the spillways.

Ordinarily the reservoir should be held to the fish management pool (by dewatering after every rain) until January 1st or February 1st, at which time the valves can be closed and the lake allowed to refill. It should be understood that the time and extent of a drawdown is dependent upon the size of the watershed and the amount and season of rainfall. Generally speaking, the plan offered here would work well for the humid Southeastern United States.

The predation obtained during the September 15th to January 31st period is astounding. In Bear Creek Lake, a 640-acre recreational lake, built by the Soil Conservation Service and now operated by the Federal Forest Service, one relatively "mild" drawdown reduced the standing crop of intermediate sunfish, *Lepomis* species, from 344 per acre to 66 per acre.

A "selective shad kill" was planned for Blue Mountain Lake, a 2,900 acre Corps of Engineers flood-control reservoir, during the second drawdown. It was calculated that a shad kill would cost $5,000.00 if the reservoir was full, but if the reservoir was drawn down, the kill would cost only $1,000.00. However, when trial checks were made, it was found that very few shad had survived the predation, making a selective kill unnecessary. Thus by draining out a few thousand acre-feet of water, to the benefit of the stream below, the Commission was saved the cost and trouble of a shad kill.

On Nimrod Reservoir where previous to the second drawdown we found an average of 44 pounds of native minnows per acre during population samples, we found after the second drawdown less than 0.2 pounds per acre.

The good spawn and high survival of bass and crappie observed after drawdowns is phenomenal. Following the refilling of Bull Shoals Lake from a natural drawdown due to drought in 1955, our rotenone population samples showed that the number of young-of-the-year black bass jumped from 413 per acre in 1954 to 1375 per acre in 1955.

Tri-County Lake, a 350 acre "wooded" fishing lake built by the Arkansas Game and Fish Commission, was drawn down in the fall of 1956. Young-of-the-year crappie jumped from a total of 41 per acre in 1956 to 230 per acre in 1957.

These are but a few examples that I have taken from our fish management files. Good spawns of white bass, walleyes and flathead catfish, *Pilodictis olivaris*. have been noted following drawdowns.

As mentioned previously, when the reservoir is drawn down to the fish management pool, fishery management techniques such as intensive commercial fishing and selective shad kills can be carried out cheaper, easier and more effectively.

There are many secondary (bonus) benefits accruing to a late summer, fall and winter drawdown, some of which may have little to do with fishery management, such as enabling property owners to clean up along their shoreline, cut brush, repair boat docks, improve swimming areas, deepen the shoreline and repair dams. The value of the fall drawdown as an aid in flood control is unquestionable.

FISHING SUCCESS

At this point, you are wondering about the effects on fishing. I have no table of figures to show you, but in one case the local warden called for help. It seems that tons and tons of fish were being caught from a 350-acre lake that had been drawn down to about 40 acres. The warden claimed that he could not make the fishermen abide by string limits and certain people were worried that all the fish were going to be caught. We have found that a drawn-down lake repels most fishermen because it looks so ugly, however, those that do go fishing catch fish.

RESTOCKING

If restocking a lake with a depleted species or the introduction of a new species would ever do any good, it should, theoretically, work better following drawdowns, selective kills and other "thinning" operations, when the total population of fish has been drastically reduced in both numbers and pounds and the relative abundance of the various fishes has undergone considerable change. Our current practice is to restock these managed lakes with yearling predator species, *i. e.,* largemouth bass, *Micropterus salmoides,* and crappie. Introductions consisted of channel catfish, *Ictalurus lacustris,* threadfin shad, *Signalosa peterensis,* and walleye.

FREQUENCY OF THE DRAWDOWN

How often should a reservoir be drawn down? This is still, like many others, an unsolved problem. After a couple of drawdowns in a row, we have tried to set several reservoirs up on alternate year drawdowns. These reservoirs, set up on an every-other-year proposition, are the kind that tend to become overpopulated with sunfishes, or are good producers of buffalo, *Megastomatobus cyprinella,* and *Ictiobus* species, and other food fishes.

Reservoirs that are primarily deep, clear game-fish reservoirs, and where the principal rough fish is gizzard shad, *Dorosoma cepedianum,* may not need a drawdown but once in every five or six years. Many of our multi-purpose hydroelectric reservoirs would fall in this category. A drawdown program on this type reservoir with attending intensive removal of commercial food fishes, a selective kill of shad and possibly the restocking of depleted species once every five years, should produce a dominant year class of game fishes that would help control the shad and commercial food fishes and furnish good sport fishing in the intervening years.

JUSTIFICATION OF DRAWDOWN ON HYDROELECTRIC, WATER SUPPLY AND IRRIGATION RESERVOIRS

When we are able to demonstrate that a fish management drawdown on any particular reservoir does not seriously conflict with the purposes for which the reservoir was authorized and constructed; or when we can prove that fisheries benefits resulting from such drawdowns outweigh the inconveniences caused, the risks taken, or the value of the water involved (if it had been used for project design purposes); then, and only then, will we be able to apply this management procedure on all reservoirs.

What is the value of a rejuvenated reservoir to a community dependent upon good fishing? What would be the value of the commercial harvest of food fishes that will be made when the water is low? The commercial harvest of food fishes from Blue Mountain Reservoir in 1956-57, when the water was drawn down 13 feet resulting in an 80 percent reduction in surface area, amounted to 123,000 pounds having a wholesale value of $24,000.00. In addition, an estimated 37,000 pounds of gar were destroyed (Crawford, 1957). What will be the savings in cost of chemical for a selective shad kill carried out in the reduced water volume? A ten-foot drawdown on Lake Hamilton, a privately owned hydro-power project near Hot Springs, Arkansas, saved approximately $4,000.00 on the cost of a shad kill and enabled a more efficient operation to be carried out (Hulsey and Stevenson, 1958). A drawdown and attending fish management program should have lasting benefits for several years, and it should not be too hard to justify such an operation, from a dollars and cents standpoint, on many "previously" single-purpose reservoirs.

CONCLUSIONS

Since World War II, important and significant progress has been made in fish management. Previously, when fishermen complained of poor fishing, the usual practice was to send a load of hatchery fish (fingerlings) to the water in question. Now the fishery biologist, to improve fishing, attempts to manipulate the fish population and influence the ecological relationships that exist in a body of water. Fertilizer, corrective stocking, introductions, partial kills, selective kills, commercial fishing, weed control and other techniques are used in an effort to improve fishing. Many of these techniques were developed and have been found useful and economical in the management of small water areas, namely, farm ponds. Even the custom of using bluegill sunfish, *Lepomis macrochirus,* as both a sport fish and a forage fish (for the bass and crappie) got its start in farm pond work. Several of the intensive management techniques used for small farm ponds do not fit well into a management plan for a large reservoir.

In Arkansas and a few other states, there has evolved a concept of fish management that is relatively new. Very little costs are involved. All that is necessary is that the reservoir be equipped with a drain valve and a fish management pool. The idea is to have a lake full of water during the spring spawning season and during the summer growing season. In early fall, after the summer crop of food (various insects and small forage fishes) has been produced, the water level is lowered and the fishes concentrated. The predator species (bass, crappie, large bream, channel catfish and others) will eat most of the "bugs" and small forage fishes. As a result, the bass and crappie grow faster and bigger, and since the bream are thinned, those remaining will eventually grow to a larger size which makes them more desirable to the fisherman. When the reservoir refills with spring rains, a very successful spawn of bass and crappie usually occurs because the small fishes that prey on their eggs and young have been drastically reduced in numbers.

While the water level is lowered, the fishery manager has an opportunity to carry out his trade in a much reduced water area and volume. Selective fish kills, intensive commercial fishing and the like can be accomplished much cheaper and more effectively. This aggressive management scheme provides for maximum use and harvest of the fishes produced, serves to interrupt "natural cycles" and maintains fish populations of desirable species and size.

There are many secondary benefits to a fall and winter drawdown. The bottom mucks are exposed to the air and mineralization of the organic matter proceeds rapidly. As a result, mineral and organic fertilizer nutrients and growth substances are released to the water when the lake refills. Certain forms of vegetation can be controlled and even eradicated by freezing and drying. While the shoal areas are exposed, clean-up and maintenance operations can be carried out, such as repairing the swimming area and deepening the shoreline. Sport fishing is usually good during and following the drawdown.

When the fishery manager is able to show in dollars and cents that the value of the drawdown is worth more for the fishery benefits received than the risks taken, the inconvenience caused or the value of the water involved for irrigation, domestic and industrial water supply or hydroelectric power, then he will be able to justify drawdowns on these type reservoirs. On Federal projects, statutory limitations can be changed by Acts of Congress when economically justifiable.

ACKNOWLEDGMENTS

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SHAD MANAGEMENT IN RESERVOIRS *

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ABSTRACT

Management of some form is mandatory for the continuance or restoration of successful fishing in the majority of reservoirs in the Southern States. The selective killing of gizzard shad and some species of rough fish with rotenone shows promise as a management tool for some reservoirs. The use of rotenone as a selective toxicant in four Kentucky reservoirs is discussed. The total poundage of gizzard shad was drastically reduced in three reservoirs and this species was eliminated from a fourth reservoir. A definite improvement in fishing success was noted as a result of this chemical reduction of shad, buffalo, and carp. Also, an increase in the spawning success and apparently better survival of bass occurred following the selective kill.

INTRODUCTION

It has long been apparent that some form of management is necessary if satisfactory fishing is to be restored or maintained in the majority of reservoirs in the Southern States. It is generally thought that control or partial eradication of such species as the gizzard shad, *Dorosoma cepedianum*, buffalo, *Ictiobus*, species, and carp, *Cyprinus carpio*, which dominate many of these reservoirs, would favorably influence fishing success. Swingle (1950) states that "large groups of unharvested adult fishes, regardless of whether they are bluegills or gizzard shad or another species, have a depressing effect on the "C" groups in a population which could be dissipated if harvesting were practiced." Removal, whether by netting, partial eradication or other means, of species which are undesirable or which rank low on the palatability scale is essentially a form of harvest of these species.

Methods of harvest, or controls, for this group of fishes fall into three general categories: physical, biological, and chemical. Physical methods include netting, gigging, drawdowns, etc. Biological methods are presently focused on the introduction of non-indigeneous piscivorous species such as walleye, *Stizostedion vitreum*, white bass, *Roccus chrysops*, and, more recently, a freshwater race of the striped bass, *Roccus saxatilis*. Chemical controls at present are primarily restricted to the use of rotenone compounds, applied in such a manner and quantity that the effect is largely that of a selective toxicant. It is, however, highly probable that other chemical compounds providing more effective control at lower cost will be available in the future. Such dividends could come from such a program (presently engaged in by the U. S. Fish and Wildlife Service) of testing various toxicants for a selective kill of undesirable fishes.

There is currently considerable interest in the selective killing of gizzard shad with rotenone. At least six states have participated in such operations to date. The present paper deals with the selective killing of gizzard shad in four Kentucky impoundments. Inasmuch as the work is still in progress, the results are of a preliminary nature.

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