periods of time. It would be especially valuable if such intensive studies could be carried out on lakes where the history of the fish population and sport fishery were known for at least several years prior to the initiation of the removal operations. It is also necessary that such studies be carried out over an extended period of time as results obtained from one or two years of study can be misleading.

ACKNOWLEDGMENTS

We wish to thank Dr. Leslie Glasgow and Dr. Bryant A. Bateman, Louisiana State University, for their criticisms and suggestions on an earlier draft of the manuscript.

This report is a contribution of Louisiana Federal Aid in Fish Restoration, Project F-1-R.

LITERATURE CITED

Lambou, Victor W. and Herbert Stern, Jr. 1958. Creel Census Methods Used on Clear Lake, Richland Parish, Louisiana. Presented at the Twelfth Annual Conf. S. E. Assoc. Game and Fish Comm., Oct., 1958 (processed)

Swingle, H. S. 1956. Appraisal of Methods of Fish Population Study—Part IV Determination of Balance in Farm Fish Ponds. Trans. 21st No. Am. Wildlife Conf.

THE EVALUATION OF CHEMICAL AQUATIC WEED CONTROL IN GEORGIA FARM PONDS *

By ALEX B. MONTGOMERY* and HOWARD D. ZELLER

Georgia Game and Fish Commission

Atlanta, Georgia

ABSTRACT

Aquatic weed control has in recent years developed into one of the most important phases of farm pond management in Georgia.

Properly constructed ponds with adequate fertilization which were chemically treated four years ago show no reinfestation at this time. On the other hand, in experimental ponds which were not properly fertilized the results of chemical weed control were of extremely short duration.

The more frequently used herbicides, Sodium arsenite, 2,4-D (ester and amines), 2,4-D-2,4,5-T combinations, and Copper sulphate are considered with regard to methods of application, cost of treatments, effectiveness on different plant species and duration of successful weed elimination.

Sodium arsenite was found universally effective in the control of most submerged aquatic plant species. However, its toxicity to warm blooded animals and the caution necessary in its application and handling restrict its use to experienced technicians. Careless handling of this material in Georgia has resulted in injury to personnel as well as the loss of livestock in one instance. Growth regulating 2,4-D and 2,4,5-T compounds were effective in the control of most broad leafed emergent aquatics. The use of both oil and water carriers was evaluated. To achieve complete control, more than one application was usually required. Copper sulphate was found to be the most economical and effective algicide.

Some of the newer aquatic herbicides, Dowpon, Pelletized 2,4-D, Kuron, Novon and Delrad are discussed in relation to their effectiveness. Particular emphasis was placed on the control of Manna grass *(Glyceria sp.)* with these chemicals. Those showing promise are further evaluated as to effectiveness on a large variety of plants.

Dowpon appeared very promising in the control of aquatic grasses. Pelletized 2,4-D and Kuron, formulated for use on submerged aquatic species, gave ex-

* This work was undertaken with Federal Aid to Fish Restoration funds under Dingell-Johnson Project F-6-R-4, Evaluation of Pond Management Practices.

* Presently employed as Aquatic Biologist, Chemical Insecticide Corp., Metuchen, New Jersey.

cellent preliminary results. Cost of treatment per acre with these materials is somewhat higher than with sodium arsenite, however, certain advantages offered by these chemicals may offset increase in cost. Delrad was found to be effective in the control of most species of filamentous algae. The use of this material in Georgia was virtually prohibited because of rapid reinfestation following treatment, poor availability, and a high per acre cost of treatment.

Aquatic herbicides were found to be an effective and economical means of eradicating most aquatic nuisances. The advantages and disadvantages of most materials are discussed and the newer herbicides are considered with regard to their use in future aquatic weed control work.

INTRODUCTION

Fishery biologists have long recognized aquatic weed control as one of the most important fish pond management problems needing more research. Weed infestations in farm ponds in addition to drastically interfering with fish management, make conditions undesirable for all types of recreational activities, clog irrigation systems, impede general farm water uses, create mosquito breeding areas and make useless many potentials which should be realized. Aquatic weeds seldom present a problem in properly constructed ponds which are adequately fertilized. However, long growing seasons and the large variety of aquatic plant species found in Georgia quickly create troublesome weed problems in all but the most diligently managed ponds. At the present time a high percentage of Georgia's farm ponds are infested with weeds to some degree. When noxious weeds become established, summer fertilization merely furnishes additional nutrients and further promotes the growth of these plants. Of the several weed control methods available, the use of chemicals appear to be the most effective means of rapid elimination.

For the past five years, Georgia's fishery biologists working on the evaluation of all phases of fish pond management have conducted chemical weed control experiments in numerous farm ponds. Work has been done on a large variety of submerged, emergent and floating aquatic weed pests using many of the available chemical herbicides. The program has included not only the more commonly used aquatic herbicides with emphasis toward increased effectiveness through improved techniques of application, but also treatments with the newer weedicides, especially where weed species resistant to normal treatments were concerned.

EVALUATION OF THE MORE COMMONLY USED AQUATIC WEEDICIDES

Of the many chemical herbicides in use, only a few have been found applicable in aquatic weed control. The materials must effectively eradicate the plants growing in water, must be readily available and reasonably priced, must not be harmful to existing fish populations in the concentrations used, should be harmless to livestock and should be compatable with normal farm water uses. At the present time, very few chemicals have been found to meet these qualifications, the three most commonly used being sodium arsenite, 2,4-D compounds and copper sulphate.

Sodium Arsenite

Liquid sodium arsenite containing either four or nine pounds of As_2O_3 per gallon was found available on a commercial basis in Georgia. However, only four pound material was used due to its being readily available. This material was found effective in the control of most types of underwater weeds. In spring and early summer applications, concentrations of four to five ppm. effectively eradicated even the heaviest infestations of Parrot's Feather, Coontail, Water Starwort, Fanwort, Najas and certain others of the pond weed group. Plants such as Bladderwort, Watercelery and Waterweed which were found particularly susceptible to sodium arsenite were eliminated with a 2 ppm. concentration. Treatments made in late summer and early fall on mature, tough plants were found to require concentrations of 7-8 ppm. for effective control.

During the past five years, a total of 78 ponds have been treated with sodium arsenite during spring and early summer. The effects of sodium arsenite were very rapid and the plants sank to the bottom and began decomposition shortly after application. Ponds containing heavy plant infestations necessitated two treatments (one-half of the pond per treatment) to avoid oxygen depletion fish kills resulting from decomposition. Usually within a week following treatment, an algal bloom appeared, apparently due to a nutrient release from decomposition and/or arsenic displacement. Initial results were excellent in all properly treated areas, however, regrowth rapidly appeared in ponds where preventative fertilization was neglected. In most ponds which were properly fertilized following sodium arsenite treatment, regrowth was completely discouraged.

The introduction of sodium arsenite into the water was made by one of two methods depending upon the particular situation involved. Where normal water circulation was restricted, such as in coves and areas of excessive plant growth reaching the surface, spot treatments were possible. In making spot treatments, each patch of weeds was treated in its entirety with the exception of a band 2-4 feet wide around the outside edge. This band served to prohibit dilution of the concentration and the plants in this area were usually killed by the gradual spread of the chemical. Introduction of material was made either by spraying or by use of a gravity flow "T" boom-type arrangement which sprinkled the material on the water surface. Fairly even distribution was found necessary and where materials were sprayed sodium arsenite was diluted arbitrarily to assure adequate coverage. Ponds in which the majority of plant growth was several feet below the surface necessitated treatment in their entirety. In these situations the majority of the chemical for the whole pond was concentrated on the particular weedy areas. Attempts to spot-treat areas of this nature resulted in dilution of the chemical below toxic levels. In these situations introduction of material was made by a gravity flow system (¾ inch gate valve and 10 feet of ¾ inch garden hose) connected directly to the drum and with the outflow hose end fastened to the outboard motor decavitation plate. In treating entire ponds receiving any appreciable inflow of water, a drawdown and a five to seven day retention period was incorporated during treatment. It was necessary to make chemical compensation for water inflow into an area being treated.

The cost of sodium arsenite treatment varied with the severeness of infestation, the plant species involved, amount of inflow and the physical nature of the pond. The average cost of treatment was $15.00 per acre. This was based on an average depth figure of five feet which was near the mean of Georgia ponds.

Although sodium arsenite is at present the most effective chemical for control of underwater weeds, it has undesirable features which should be considered when contemplating its use. The material is extremely toxic to both humans and livestock. Personnel must use protective equipment (respirators, rubber aprons and gloves) and extreme care must be exercised in its application. Several members of the Georgia Game and Fish Commission were severely burned and in one instance 4 cows were killed by sodium arsenite. These mishaps resulted from negligence, however, this does not lessen the danger in using it. Livestock must be excluded from the treated areas and there is little information concerning the time lapse necessary before treated water may be used for irrigation purposes. Otherwise, benefits from weed control outweigh the trouble and detrimental effects encountered in its use. However, if less dangerous materials were made useable in underwater weed situations, it is felt that its replacement would be desirable.

2,4-D Emulsions

Translocated growth regulating 2,4-D emulsions containing 40% ester of 2,4 dichlorophenoxyacetic acid were effective in the control of most broadleaf emergent plants, however, several applications (2 to 5) were usually necessary for complete eradication. Thorough coverage of the exposed vegetation with mixtures of 1 pt. 2,4-D (ester or amine) or 2,4-D- 2,4,5-T combinations plus 1 pt. detergent (as spread-sticking agent) in 10 gallons of water effectively eradicated Arrowhead *(Sagitaria)*, Pickerel weed *(Pontadaria)*, Smartweed *(Polygonium)*, Watershield *(Brasenia)*, Lotus *(Nelumbo)*, and Waterlilies. Bullrush *(Scirpus)*, Cattail *(Typha)*, Parrot's Feather *(Myriophyllum)* and

Duckweed *(Lemna)* were more effectively controlled with mixtures of 1 pt. 2,4-D in 10 gallons of #2 fuel oil. Observations indicated that complete coverage with only #2 fuel oil was as effective in the control of Duckweed as treatment with 2,4-D in fuel oil.

The effects of 2,4-D became visible when the time lapse was sufficient for translocation of the chemical throughout the plant system. This was generally accompanied by accelerated growth and eventually the death of the plant. It was generally noted that plants treated while in full bloom died and began decomposing shortly after being sprayed. Persistent treatment with 2,4-D gave excellent results in eliminating most broadleaf emergent vegetation, but reinfestation was very rapid in the absence of proper fertilization. Properly constructed ponds which were adequately fertilized following 2,4-D treatments remained free of infestation.

All applications of 2,4-D were made by spraying. Pressure type spray units with adjustable nozzles were found best in producing the desired fine, mist-like spray. Treatments made during extremely hot weather on bright, quiet days were found more effective than those made either in the spring or fall. Plants were thoroughly sprayed, and allowed to remain undisturbed until the effects were realized, and the same process repeated on regrowth as many times as was necessary to completely eliminate all plant growth. To avoid poor results, extreme care was exercised not to disturb plants either before or after spraying, and boat trails used during the initial application were sprayed when the second treatment was made. There were indications that using oil as a carrier, except on those plants mentioned previously, and more concentrated spray solutions, would, upon contact burn the leaves to the extent that they could not function in translocating the chemical.

The average cost per acre of 2,4-D treatment was approximately $10.00. This allowed enough ingredients (2,4-D and detergent) for mixing 120 gallons of spray solution. The cost varied according to the particular plants being treated.

Liquid 2,4-D compounds when properly applied, were very effective in eradication of emergent aquatic plants. The material is relatively harmless to humans and animals, however, is extremely toxic to all broadleaf plants (crops, ornamentals, trees). Precautions to avoid drift of the materials were exercised. The material requires special equipment for treatment, and several retreatments were usually necessary. Results are of short duration unless followed by preventative measures. The material is especially desirable due to its availability, low price and broad application to many plant species.

Copper Sulphate

Copper sulphate (snow and/or crystal) was found to be the most effective and economical chemical for the elimination of cold water, filamentous algae. Treatments of 1 ppm. quickly eliminated both underwater growths and floating mats of *Spirogyria, Chara, Oedegonium, Rhizoclonium,* and *Cladophora.*

Upon application of $CuSO_4$, the algae quickly lost its green color and sank to the bottom where it decomposed. In all treatments, rapid decomposition of thick algae mats was realized in a very short period. In most instances a thorough treatment resulted in elimination of the algae for the remainder of the season. Exceptions were noticed in ponds dependent upon a deep well water supply. Apparently the introduction of large volumes of cold water altered water temperatures enough to promote the growth of these cold water species late into the summer. In these instances it was necessary to either fill more frequently, thus avoiding drastic temperature alteration, or to treat (lightly) with $CuSO_4$ during filling operations to discourage continued algal growth.

Copper sulphate applications were made by one of the following methods depending upon the location (surface or sub-surface) of the plants being treated. For the treatment of surface algal mats, either $CuSO_4$ snow was evenly hand broadcast upon the mats at the rate of approximately 1½ to 3 pounds per acre or the mats were sprayed wtih a mixture of 2 pounds $CuSO_4$ in 5 gallons of water. Very light initial treatments were made on surface mats. and were repeated if complete elimination was not accomplished. In treating underwater growths (especially *Chara*), $CuSO_4$ crystals were dragged through the algae beds. It was necessary to treat only the infested areas, and the heaviest treatment made consisted of 3 pounds of copper sulphate per acre foot of water. Waters of high total hardness were found to require proportionately higher concentrations of $CuSO_4$. This was of minor importance as most ponds treated were in the range of 50 ppm. (Dahl-Goetz) total hardness and below.

Treatments with $CuSO_4$ were very inexpensive even when entire pond areas were considered. The cost was less when elimination of surface mats was the objective. On the average, about 2.5 pounds of $CuSO_4$ were used per acre foot of water treated resulting in an average cost of $3.00 per acre, based on a standard price of 30 cents per pound.

Copper sulphate is cheap, easily obtainable and very effective in algae elimination. Detrimental effects to fish food production were assumed negligible when compared with benefits obtained from algae control, and have been shown to be of minor importance even in prolonged $CuSO_4$ treatments.

The chemical was found corrosive to metal and equipment required thorough cleaning after use.

EVALUATION OF THE NEWER AQUATIC WEEDICIDES

The unsuccessful control of many aquatic plants, the short duration of effects from successful treatments and certain undesirable features of some of the presently used aquatic herbicides have stimulated the search for more versatile and effective chemicals. Many chemicals which appear promising in aquatic weed control have resulted from this search. *Dowpon* (2,2 Dichloropropionic acid, sodium salt), *Kuron* ((2-(2,4-5- Trichlorophenoxy) propionic acid, propylene glycol ($C_3H_6OToC_9H_{18}O_3$) butyl ether ester)), *Novon* ((2- (2,4,5-Trichlorophenoxy) ethyl 2,2- Dichloropropionate)), *Chem Pels 2,4-D* (pelletized iso-octyl ester of 2,4- Dichlorophenoxy acetic acid), *Chlorea* ((sodium chlorate 40%, sodium metaborate 57%, 3-(p-chlorophenyl)-1, 1 Dimethylurea 1%)), *Telvar* ((3-(p-chloro-phenyl)-1, 1-dimethylurea and 3-(3-4 dichlorophenyl) 1, 1-dimethylurea)), and *Delrad* (abiethylamine acetate) were used experimentally.

Extremely low water levels in ponds due to prolonged drought conditions in Georgia resulted in the encroachment of Manna Grass *(Glyceria Sp.)*, a generally marginal, grassy species, into the normally deep water pond areas. With slowly rising water levels in ensuing years, this plant perisisted and was often found growing in as much as 8 feet of water. In attempting to eradicate this resistant species a number of non-selective herbicides were used experimentally. Chlorea, a dry powder, was broadcast at the rate of 1 pound per 100 square feet on dewatered infestations. Amate was mixed with a wetting agent (Tide detergent) at the rate of 1 pound per 4 gallons of water and sprayed on the foliage. Telvar, a dry chemical, was broadcast on the water surface at the rate of 2 pounds per 100 square feet. These treatments had little apparent effect on Manna Grass and resulted in only temporarily browning the foliage, which after a short period of time, regained its green color and continued growing. These negative results could have resulted from the application methods. However, with the exception of the initial browning effect there was no indication that they would be effective in eradicating this grass species and their use was discontinued.

Dowpon

Dowpon produced excellent results in elimination of Manna Grass and was the only herbicide used which materially damaged this species. Spraying the normally exposed foliage resulted in a good initial kill, however, considerable regrowth followed. A second treatment made some 4 to 6 weeks after the first resulted in a high percentage of control, indicating that two or three treatments with Dowpon would be necessary for the control of Manna Grass with no alteration of the water level. In one instance when water levels were dropped some three to four feet and that additional exposed foliage treated, an estimated 98% control was achieved in an eleven acre pond. The pond was refilled and fertilized heavily about one month after treatment. Although some broadleaf plants reappeared, very little Manna Grass regrowth was encountered. It is felt that Dowpon used at the rate of 10 to 15 pounds per acre would prove effective in the control of resistant, narrow leafed emergent grasses.

Delrad

Delrad was found effective in control of cold water algae (for the species listed previously) in 52 farm ponds. The float method, utilizing the paste form, and spraying of the liquid Delrad were equally effective and comparable in results. Duration of treatment varied from several weeks to complete eradication of cold water algae. In most cases 2 to 5 treatments were necessary for complete control or until warmer temperatures inhibited growth. Chemical control with Delrad was rapid, usually the algal mat was eliminated in a few days. A treatment concentration of 0.3 ppm. or 1 pound per acre (based on average depth of 5 feet) was effective for control. Concentrations of 0.5 ppm. in 4 ponds where the algal mat was extremely heavy eradicated *Spirogyra* and *Oedogonium* without killing fish. For the most part, however, 0.5 ppm. was the maximum dosage that could be used without killing fish, and some fish kills were encountered at this concentration.

Delrad was generally unsatisfactory in control of branched algae *Pithophora*, in treatment methods described above. Temporary control was generally achieved but regrowth rapidly took over again. Experiments in 2 ponds infested with Pithophora, treated at cooler temperatures in the spring before the mats were prevalent, appeared to prolong the control. Growth did appear later in both ponds, but was approximately one month later than untreated Pithophora areas. Overall cost treatments with Delrad were about $7.50 per acre per treatment. The temporary problem of winter algae plus an extremely high cost per acre and necessity of retreatments has virtually eliminated Delrad as an algacide in Georgia farm ponds.

The versatility of 2,4-D and 2,4,5-T and their derivatives has made this group of herbicides one of the most important in aquatic weed control. Newer formulation of these chemicals applicable for use in the control of underwater aquatic weeds have produced materials which show promise of greatly enhancing and simplifying the control of aquatic weeds. Of these new formulations, Chem Pels 2.4-D, Kuron and Novon were used experimentally.

Chem Pels 2,4-D

Chem Pels 2,4-D a clay type pellet impregnated with the iso-octyl ester of 2,4-D broadcast over weed infested areas was effective in the control of Parrot's Feather, Watershield, and Waterlilies. The first treatments were made at the rate of 1 pound per 100 square feet, however, it was found that application rates of 100 to 150 pounds per acre were adequate for effective control of these plants. As with most translocated chemicals, visible effects from treatments with this material were quite slow and were somewhat proportional to the vigor of plant growth at the time of treatment. Spring and early summer treatments were most effective. Some 3 to 4 weeks after application, plants in the treated areas underwent typical accelerated growth, died and began decomposing. Decomposition of dead plants was very slow, indicating the possibility of elimination of heavy plant infestations with little fear of oxygen depletion. Also, this chemical showed tendencies of giving prolonged residual control especially on Myriophyllum, an observation reported by other workers.

All treatments with Chem Pels 2,4-D were made by hand broadcasting the pellets as evenly as possible over the weed infestations. More even distribution could have been attained by using a cyclone type seeder or some type of power driven fertilizer spreader. Spot treatments were very effective as were a number of treatments made in ponds with larger amounts of water passing through them. It was not necessary to exclude livestock from treated areas as the chemical is non-toxic to warm blooded animals, and there was no problem of wind drift on to desirable terrestial plants.

From these results, there is every indication that this and other new formulations of growth regulating compounds hold great promise in future aquatic weed control work. Surely, more information concerning them is necessary and more comprehensive experimentation with them is certainly desirable.

Kuron

Kuron, a liquid emulsion of 2,4,5-TP introduced into the water at the rate of 2 ppm. was found to effectively control Parrot's Feather, the visible results from this material were, on the whole, slow, and somewhat proportional to plant growth. Some 1 to 4 weeks after treatments, plants in treated areas showed accelerated growth, died, turned black and began decomposing and breaking loose from the bottom. Slow decomposition indicated the possibility of elimination of heavy weed infestation without fear of oxygen depletion.

In treating, Kuron was pre-emulsified with 5 times its volume of water and sprayed over the surface of the water. In several areas where the nozzle was placed in the water for sub-surface introduction, a quicker and apparently more efficient kill was achieved. This could possibly have resulted from a slight increased concentration in these areas, but indicated the possibility of even, sub-surface introduction being the more effective method of application.

As with pelletized 2,4-D, Kuron was found to be a very promising new aquatic herbicide for controlling submerged vegetation. The material is effective on a wide variety of aquatic plants and is non-toxic to warm-blooded animals. Desirable characteristics of Kuron and other of the newer materials may well serve as a basis for their replacing some of the more-dangerous-to-use aquatic herbicides.

Novon

Novon, mixed at the rate of 1 gallon chemical in 4 gallons of water and sprayed over exposed vegetation, was effective in control of Manna Grass and Waterlilies in one experimental application. There was every indication that this material would have effected a kill on these two species in more dilute concentration, but since only one experiment was completed this remains supposition. Novon appears promising in aquatic weed control and further experimentation would be desirable.

DISCUSSION

The effective economical control of aquatic weeds in farm fish ponds was the objective of this study in Georgia. In all instances, spring and early summer treatments produced best results. Also, reinvestation of treated areas was very rapid unless adequate fertilization practices were initiated following treatments.

Sodium arsenite has been for some years and is now the most widely used chemical for controlling underwater vegetation. The overall results from this material were good. Also, it was felt that the benefits obtained in ponds requiring one or possibly two treatments for control of aquatic vegetation overshadowed the temporary detrimental effects of destruction of fish food organisms and slight buildup of As_2O_3 in the bottom soils. On the other hand, its toxicity to animals and humans make it extremely dangerous to handle. This coupled with the short duration of the results from sodium arsenite treatments make desirable the replacement of this material with some of the newer, harmless herbicides suitable for use in underwater situations, which offer residual control.

The use of 2,4-D and 2,4-D—2,4,5-T combinations to control emergent vegetation has proven especially beneficial for several reasons. The materials are effective in controlling a large variety of plants, are relatively harmless to animals and humans and are readily available and economical to use. In every instance, however, complete control required two to four treatments resulting in considerable cost with regard to labor. More recent formulations of these compounds, Kuron and others, have made them usable in underwater situations and have in general, greatly increased their adaptability for aquatic weed control. The use of these less toxic materials is surely more desirable where human and animal factions are concerned. In addition, pelletized forms can be applied by hand, give residual control and offer effective treatments in areas where excess water inflow or dilution prohibit the use of emulsifiable or liquid materials. Some of these newer herbicides appear very promising for future aquatic weed eradication, and more comprehensive experimentation with them is desirable.

Copper sulphate was found to be the most effective in elimination of cold water algal mats. It was felt, as with Sodium arsenite, that benefits received from algae control exceeded the much publicized detrimental effects of this material. In a number of instances, a plankton bloom was noted within six days after treatment. Also, other workers have reported the absence of detrimental effects in prolonged uses of Copper sulphate.

Delrad produced good results in control of cold water algae, but was ineffective in the control of Pithophora. Cost was generally prohibitive for use of this chemical in ordinary farm pond management.

Dowpon was the only herbicide used which materially damaged Manna Grass. Spraying the normally exposed foliage resulted in good initial kill, however, considerable regrowth followed. In one eleven acre pond an estimated 98% control was realized from treatment following a four foot drawdown. Dowpon used at the rate of 10 to 15 pounds per acre would probably control most resistant, narrowleafed, emergent grasses.

ACKNOWLEDGMENTS

The writers wish to thank the Dow Chemical Company, The Chemical Insecticide Corporation, The Chipman Chemical Company and the Dupont Chemical Company for supplying chemical samples with which to experiment. Also, the many Georgia farm pond owners whose cooperation made the paper possible. Special thanks are due many members of the Georgia Game and Fish Commission who devoted much time and information towards the work reported herein.

EXPERIMENTS ON GROWING FINGERLING CHANNEL CATFISH TO MARKETABLE SIZE IN PONDS

By H. S. SWINGLE
Agricultural Experiment Station
Alabama Polytechnic Institute
Auburn, Alabama

Commercial warmwater fish farming is in its infancy in the United States, but is slowly developing into an established industry. At present, by far the greatest acreage in commercial ponds has been developed in Arkansas, where idle rice fields could be converted readily into aquatic pastures for fish production. In most of the states in the Southeast, a small acreage is now being tried, and interest in commercial fish farming is rapidly increasing. A slow and orderly development is to be desired as there has been to date insufficient research upon which to base this new industry.

The bigmouth buffalo fish (*Ictiobus cyprinella*) is now raised commercially based on information previously published.* Since this fish sells at a low price, search has been continued for other species suitable for commercial pond culture. In preliminary experiments, the channel catfish (*Ictalurus punctatus*) appeared a promising species and production up to 1,242 pounds per acre was reported.† Further experiments at Auburn on growing fingerling channel catfish to marketable size in ponds are reported in this paper.

The fingerling channel catfish for these experiments were made available by the U. S. Fish and Wildlife Service.

Prior to stocking, the fish were examined and treated for control of parasites. They were then stocked into holding ponds and fed. Subsequently, they were removed from the holding ponds as needed for experiments, treated for the control of parasites and disease, and stocked in varied numbers into the commercial production ponds. The ponds were fertilized and the fish fed a mixed dry feed

* Swingle, H. S. Revised procedures for commercial production of bigmouth buffalofish in ponds in the Southeast. Proc. Ann. Conf. S. E. Assn. Game and Fish Comm. 10:162-165. 1956.

† Swingle, H. S. Preliminary results on the commercial production of channel catfish in ponds. *Ibid* 10:160-162. 1956.