

# TECHNICAL NOTES

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## EIGHT YEARS OF RECORD ON A MANAGED WARMWATER POND

The attached article "Eight Years of Record on a Managed Warmwater Pond" by D. W. Patterson and I. L. Lines describes the results of a field trial involving the intensive management of a well constructed fishpond in the northern Sacramento Valley in California. It firmly supports SCS recommendations for the management of warmwater ponds for recreational fishing where large-mouthed black bass and bluegill are the primary species. This excellent report on the results that Mel K. Davis has obtained should inspire others wishing to have good fishing to follow our recommended procedures.

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Enclosure

EIGHT YEARS OF RECORD ON A  
MANAGED WARMWATER POND

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INTRODUCTION

Over the past 40 years several thousand small "farmponds" suitable for warm-water fish production have been constructed in California. More often than necessary fishing success has been less than rewarding for pondowners and their guests. Most of these ponds, if properly managed, could produce better fishing. Fishermen and pondowners most often complain about stunted sun-fish populations and heavy stands of aquatic plants that dominate unmanaged ponds.

Soil Conservation Service (S.C.S.) biologists have documented problems and conditions on many farmponds through routine field work, and by formal pond surveys conducted during 1970 on 138 ponds in northern, central, and southern California. The results of our field experience and surveys have shown that few ponds receive the necessary management to produce good fishing. Ponds are often stocked indiscriminately, and there is little followup management or evaluation of fishing results. Little attention is given to pond design or construction to improve conditions for control of aquatic vegetation, improve water quality, or enhance pond productivity.

The Soil Conservation Service does not engage in basic research, but through conservation field trials evaluates management techniques and conservation practices to determine if they are practical for field use. A conservation field trial began in 1969 in California's Northern Sacramento Valley to evaluate pond management and fish population assessment methods. Our ultimate goal was to improve the quality of fishing from small warmwater farmponds stocked primarily with largemouth black bass (Micropterus salmoides) and bluegill (Lepomis macrochirus).

PURPOSE

This field trial was conducted to answer the following basic questions:

Can population assessment and pond management techniques, developed and practiced by the late H. S. Swingle and others in the Southeastern United States, be used in California?

Can fertilizer be used in California farmponds to control submersed aquatic vegetation?

What pond management methods will produce good fishing on a sustained basis in California?

## BACKGROUND

The pond chosen for the field trial study is located in California's Northern Sacramento Valley. The Mediterranean climate is characterized by a 230-day frost free growing season. The average annual rainfall is 25 inches (63.5 cm), 80 to 90 percent of which falls between October and May. Winters are mild, temperatures seldom fall below 25°F (-4°C). Summers are dry and hot, with many days exceeding 100°F (30°C). Elevation at the field trial pond is approximately 1,215 feet (370 m) above sea level.

Approximately 3,000 farmponds exist in the Northern Sacramento Valley. These ponds typically contain between 1 and 5 surface acres (0.4 to 2.0 ha). Most of the ponds were built primarily to provide drinking water for livestock or irrigation water storage. Typically the ponds are constructed by building earthen dams across intermittent drainages and filled by winter and spring runoff. Few receive additional water from April to October. By late summer evaporation lowers the level of most ponds 5 to 8 feet (1.5 to 2.4 m) and the ponds become both thermally and chemically stratified. By mid-summer most ponds become heavily infested with submersed aquatic plants and filamentous algae.

## HISTORY

The pond for the field trial was selected primarily due to the interest of the owner in improving the fishing in his pond, and his willingness to maintain management and catch records. The 5 surface acre (2.02 ha) pond is owned by Mel K. Davis of Igo, California. It is located 12 miles southwest of Redding, California. The pond is fed by a small spring. Typical annual loss of surface area due to evaporation and seepage is normally 5 feet (1.5 m). Due to supplemental water supplied to the trial pond, annual loss of surface area is less than typical but in all other aspects the trial pond is typical.

The Davis pond was enlarged by raising the elevation of the old dam during the fall of 1967. As a result, the surface area of the pond was increased during the winter of 1967-68 from 1.5 surface acres (0.6 ha) and approximately 990 feet (302 m) of shoreline to 5 surface acres (2.0 ha) and approximately 1,980 feet (605 m) of shoreline. After enlargement, the average depth was 8.4 feet (2.6 m) deep and 19 feet (5.8 m) deep at the deepest point. The pond was much shallower prior to enlargement and annually produced a heavy stand of sago pondweed (Potamogeton pectinatus) and muskgrass (Chara sp.).

Sample seining at the beginning of the field trial revealed a fish population consisting of largemouth black bass, black crappie (Pomoxis nigramaculatus), bluegill, green sunfish (Lepomis cyanellus), and brown bullhead (Ictalurus nebulosus). Although catch records were not maintained by Mr. Davis until the 1969 season, he recalls that 3 to 5 pound (1.4 to 2.3 kg) largemouth black bass were taken regularly. However, bluegill and green sunfish caught

from the pond were stunted--from 3 to 5 inches (7.6 to 12.7 cm) in length and unusable. Brown bullhead ranging from 12 to 18 inches (30.5 to 45.7 cm) in length were taken regularly.

While the elevation of the old dam was raised, care was taken to retain all of the original fish stock in the old pond. During the winter of 1967-68 runoff filled the pond to its present elevation, offering greatly expanded habitat for the resident fish population. From 1969 to 1977 the pond was managed using 'second level' fish cultural practices described by Swingle, (1962). Second level fish cultural practices include pond fertilization and the utilization of desirable fish species for stocking.

## METHODS

### Pond Stocking

Fish present in the pond before enlarging the old dam became the parent stock for the present fish population. Neither the exact number of each species present, nor the exact ratios between predator and forage fish were known at the start of the trial. The fish species present at the start of the trial were typical for other California farmponds.

In 1971 approximately 3,000 6 to 8 inch (15 to 20 cm) channel catfish (Ictalurus punctatus) fingerlings were added to the pond to augment the diminishing bullhead catches. A few white catfish (I. catus) were mixed with the channel catfish fingerlings and inadvertently stocked at the same time.

### Pond Fertilization

A 3 x 4 foot (0.9 x 1.2 m) platform with 6 inch (15.2 cm) sides was installed in the pond the spring of 1969 at an accessible location. The top of the platform base was set approximately 6 inches (15.2 cm) below the average elevation of the pond. At this elevation fertilizer nutrients would be dissolved into surface waters for utilization by planktonic algae. A commonly available inorganic nitrogen-phosphorus (ammonium phosphate sulfate) fertilizer (16-20-0) was added periodically to the pond during each growing season. Fertilizer application started in late April or early May when the afternoon surface temperatures of the pond approached 60°F (15°C).

Fertilizer was applied as needed throughout the summer to maintain an 18 inch (45.7 cm) depth of visibility based on Secchi disk readings. Each spring the initial applications were generally 100 pounds per surface acre (112 kg/ha). Additional applications made later in the season were reduced to 50 pounds per surface acre (56 kg/ha) or less. Fertilization was discontinued each year when the surface waters started cooling in late August or early September. In addition to fertilizing the pond for weed control, 7 or 8 domestic geese and 10 to 20 semidomestic ducks were maintained on the pond throughout the study for esthetic purposes and to help control submersed aquatic vegetation.

## Pond Analysis

Each year the pond was sample seined using the method developed by Swingle and others in the Southeastern United States. A 4 x 15 foot (1.2 x 4.6 m) minnow seine as well as a 10 x 50 foot (3.1 x 15.2 m) beach seine with 1/4 inch (0.6 cm) bar mesh were used. Seining was done at intervals around the pond by anchoring one end at the bank, pulling the seine straight from the bank to its full length, and then sweeping in an arc to the bank. In this manner a quadrant area was seined and quantitative estimates made.

At the start of the field trial the pond was thoroughly sample seined to determine the fish species present. Each year sample seining was conducted during early summer after bass and bluegill had reproduced. The degree of success of bass and bluegill reproduction and the abundance of 3 to 5 inch (7.6 to 12.7 cm) bluegills were studied to determine the status of the population balance as described by Swingle (1956).

The pond was also sample seined in early fall to determine the relative number of bluegills that survived the summer to provide forage for bass during winter and early spring. Early spring sample seining was used to determine the relative number and sizes of the bluegill from the previous summer that escaped predation during the winter.

Seining results were compared with catch records to determine the relative balance between the population of bass and bluegill, and the distribution of size classes for each fish species in the pond.

## Catch and Management Records

Either the pondowner or fishermen recorded the number and total pounds of each species caught daily from the trial pond. The pondowner recorded applied management such as dates and amounts of fertilizer applied. S.C.S. biologists compiled catch records yearly. The total number caught, their weight, and the average weight of each species, as well as the pounds of fish caught per surface acre were computed each year. These data are presented on TABLE 1 for 1969 through 1976.

## Fishing

The owner restricted fishing to family and friends. Fish removed occasionally by poachers were not recorded. The number of mandays of fishing the pond received was estimated between 40 to 60 mandays per surface acre per year. In our opinion the pond was lightly fished.

In 1975 it appeared desirable to increase bluegill recruitment from the low static level observed. But due to the light fishing pressure the pond received it was impossible to greatly increase the take of bluegill to re-establish an expanding bluegill population that had been present in the

earlier years of the trial. For this reason we decided to drastically reduce the take of bluegill to study the effects on reproduction rate during 1975 and 1976. Fishermen were asked not to fish for bluegills. If any were caught they were returned to the pond. Only 6 known bluegills were removed from the pond in 1975.

## RESULTS

### Pond Stocking

The species used to stock the pond were known. However, the exact numbers of each species and ratios of predator fish to forage fish were not known. Based on population assessments and catch records, the establishment of a stunted sunfish population was prevented and the bass-bluegill population has essentially been in a balanced condition since 1971. Swingle (1956), said that "In normally balanced ponds, most bluegills caught are above the 6-inch group in size. The average bass caught is from 1 to 2 pounds, but smaller and possibly larger ones are also taken. They (bluegills) are found on beds several times during the spring and summer." In 1971 the fish population in the trial pond closely followed Swingle's description of a balanced bass-bluegill population. The weight of an average trial pond bass was lighter than 1 pound (0.5 kg) from 1974 on, but in all other aspects the bass and bluegill closely followed Swingle's description. The trial pond does contain larger bass weighing 6 pounds (2.7 kg) or heavier. The large number of bass lighter than 1 pound (0.5 kg) present in the pond since 1974 indicates that the bass population has tended to be overcrowded from 1974 to 1976.

The number and ratio of 100 bass and 1,000 bluegill fingerlings per acre as prescribed for initially stocking fertilized ponds were not used; however, post stocking management has prevented establishment of a stunted bluegill population. For this reason we cannot attest to the need to stock precise numbers and ratios of bass and bluegills in managed farmponds. This was substantiated by studies on 20 Oregon farmponds by Isaac and Bond (1963) who stated that, "The effect of stocking on the population balance of bass-bluegill ponds was not evident in the ponds studies".

The advantage of stocking channel catfish on a put-and-take basis in a fertilized pond was well documented. The 3,000 channel catfish stocked in 1971 as 6 to 8 inch (15 to 20 cm) fingerlings, were not fished for 2 seasons until the pondowner allowed them to be taken, starting in 1973. Channel catfish taken from the pond appear on TABLE 1. The number taken and average weight ranged from 19 fish averaging 1.9 pounds (0.9 kg) each in 1973 to 45 fish averaging 3.3 pounds (1.5 kg) each in 1976.

### Pond Fertilization

A water hardness of 34 parts per million (ppm), total alkalinity ranging from 50 to 70 ppm,<sup>9</sup> and warm surface water quickly produced the desired

infusion of phyto and zooplankton after pond fertilization was started each season. One hundred pounds (45.4 kg) of potash (0-0-32) was added to the pond in 1969 to accelerate establishment of a satisfactory plankton bloom. The addition of potash may not have been necessary as the potash was no longer used and apparently not needed after 1969. The depth of visibility was readily judged by use of the hand-held Secchi disk. The plankton bloom was considered satisfactory when the Secchi disk was obscured at a depth of 18 inches (45.7 cm) below the pond surface.

Sago pondweed and muskgrass were controlled from 1969 through 1976. Pond fertilization is continuing in 1977. During the summer few, if any, submersed aquatic plants could be found in water deeper than 3 feet (0.9 m). The plankton bloom effectively limited the photic zone to that depth. The waterfowl, especially domestic geese, have controlled submersed aquatic vegetation where the pond is less than 3 feet (0.9 m) deep and the plankton layer is too thin to shade out aquatic plants.

The effect of pond fertilization on pond productivity cannot be judged, as we have no records on comparable unfertilized ponds. However, it has been well documented by Ball and Tanner (1951) and others, that fertilization can greatly increase the productivity of ponds. We believe our trial pond has responded in a similar manner and the standing crop and pounds of catchable fish have likewise been raised above the production of typical unfertilized ponds.

#### Pond Analysis

Each year the status and trend of the bass-bluegill population was determined for the trial pond. Judgements made about the status of the bass-bluegill population based on sample seining were verified when compared to each year's catch record. Fish population assessment by sample seining was a rapid process requiring a minimum of manpower and equipment. The number and sizes of fish taken in seine hauls varied widely depending on the season in which hauls were made or the state of reproductive potential which existed and was expressed by the bass and bluegill populations. Prior to 1971 typical early summer sample seine hauls contained literally thousands of bluegills and from 25 to 50 bass fry from .5 to 3 inches (1.3 to 7.6 cm) in length. Three to 6 inch (7.3 to 15.2 cm) bass and 3 to 5 inch (7.6 to 12.7 cm) bluegill were also taken regularly. After 1971 typical early summer sample seine hauls contained only 10 to 100 bluegill 3 inches (7.6 cm) or smaller and only 3 to 5 bass of this length. Three to 5 bluegills larger than 5 inches (12.7 cm) and the same number of .5 pound (0.23 kg) bass were also taken in most of these sample seine hauls.

#### Fish Population Trend

Based on population assessment by sample seining and catch records analysis, several trends were well demonstrated by the fish population in the field trial pond:

1. Bass Population.

Prior to enlarging the old pond in 1968 before pond records were kept, the pond was, in the words of the owner, "A consistent producer of 3 to 5 pound bass". However, after catch records were maintained no bass 3 pounds (1.4 kg) or heavier were taken until 1974 when bass ranging from 3 to 6 pounds (1.4 to 2.7 kg) were taken. A few bass 3 pounds (1.4 kg) or heavier and as heavy as 6.8 pounds (3.1 kg) were taken in 1975 and 1976 (TABLE 1).

Swingle (1946) predicted that bass and bluegill ponds that are fertilized and devoid of submersed aquatic vegetation will normally produce large desirable-size bluegill but will not produce the best possible bass fishing (if good bass fishing is defined as, 'catching a large number of heavy bass'). Both the bass and bluegill populations of the trial pond have closely followed Swingle's prediction.

Over the 8 years of the field trial the weight of the average bass taken tended to become lighter each year while the weight of the average bluegill taken increased from 1969 to 1971 and then stabilized, as shown in FIGURE 1. However, the pondowner is satisfied with catches of large bluegills and an occasional bass weighing 3 pounds (1.4 kg) or more.

Based on population assessment by sample seining, the bass have reproduced successfully and consistently each year. The large number of intermediate size bass and each year's crop of young of the year (y/y) bass have maintained severe pressure on the pond's supply of forage fish.

2. Bluegill.

Since 1969 the average weight of harvested bluegill has more than doubled (TABLE 2). However, since 1970 the rate of growth has slowed markedly (FIGURE 1). An average bluegill has weighed just over 0.5 pounds (0.23 kg) since 1973. The average weight of bluegill for 1975 in TABLE 2 is subject to question due to a small sample size of only 6 fish.

Bluegill weighing from .50 to .75 pounds (0.23 to 0.34 kg) were taken regularly each year of the field trial. The first bluegill weighing 1 pound (0.5 kg) or more was taken from the pond in 1971. That year 23 bluegills weighing 1 pound (0.5 kg) or more were taken from the pond. The heaviest bluegill taken from the pond during the trial was a 1.5 pound (0.7 kg) fish of unknown sex taken during April of 1975.

Based on catch records, the weight of the average bluegill, and no doubt the weight of the standing crop of bluegills, reached a peak in 1971. Based on population assessment by sample seining the recruitment rate of the bluegill population started to decline after 1971. This substantiates a prediction by Swingle (1956) that,

"Heavy reproduction by bluegills is taken to indicate rapid growth of the brood fish, light reproduction to indicate slow growth, and no reproduction to indicate no growth or loss of weight by the brood fish".

A reduction of 0.11 pounds (.05 kg) in weight of an average bluegill was observed from 1971 to 1972. Discounting the average weight for 1975 due to small sample size, the weight of the average bluegill essentially stabilized from 1973 through 1976 (FIGURE 2). A total absence of bluegill reproduction was not observed any year of the trial.

Sample seining from 1969 through 1971 showed evidence of heavy reproduction by both bass and bluegill and large numbers of y/y for both species, depending on the time of the year the pond was seined. However, from 1972 to 1976 each quadrant seined produced evidence that the reproductive rate of bluegill had been markedly reduced. In those years sample seining during late summer typically produced 10 or less y/y bluegills and only occasionally up to 100 y/y per quadrant.

### 3. Bass/bluegill Interaction.

The bass and bluegill population from 1969 through 1971 can best be described as an expanding population. Wood (1951) defined an expanding population as an, "assemblage of fishes rapidly expanding in numbers, average size and weight". Swingle (1956) stated the following regarding expanding populations: "During the expansion large numbers of small fishes are available. This is an ideal condition for production of a high poundage of piscivorous fishes; bass, crappie, walleye, and others. In fact, for a short period the expanding population usually produces a higher poundage of piscivorous fishes than a balanced population, because the latter maintains a high percentage of its total weight in large forage fish" (i.e. that are too large to be eaten by bass).

Results of the field trial again substantiated this prediction by Swingle. In 1972 and 1973 the number of larval and fry bluegills observed dropped off sharply. This observed trend of sharply reduced bluegill production continued through 1976. In 1972 a reversal or leveling off was also noted in the previous trend during 1969 through 1971 of annual increase in the weight of the average bluegill. A reversal was noted for bass when the weight of the average bass peaked but then started a trend of gradual decline from 1972 through 1975 and may have stabilized in 1976 (FIGURE 1).

Based on these observations both the bass and bluegill populations changed during 1972 from expanding to balanced populations as predicted by Swingle. Swingle (1956) also stated, "The fact that an expanding population within a given environment cannot continue to expand for more than 1 or 2 years, limits good fishing for bass and other predatory species to the second and part of the third year

after expansion begins". Population expansion took 3 years in the field trial pond since the pond was completely filled and simultaneously stocked the winter of 1967-68, and both the bass and bluegill reached their heaviest average weight recorded in 1971. Some large bass were present in the old pond before enlargement, so the exact nature of the bass population expansion may have been masked. However, the best bass fishing, based on average bass weights and total pounds of bass caught, occurred in 1971, 3 years after the start of expansion, closely following Swingle's predictions.

The results of reducing the take of bluegills to 6 fish in 1975 was closely observed in 1975 and 1976. Seining results in 1975 and 1976 showed a continued reduction in the reproductive rate of bluegills expressed as larval and fry bluegills taken in sample quadrants. It was evident that during the same time period the reproductive rate of bass remained high and this, in addition to the presence of many bass in the 8 to 10 inch (20 to 25 cm) groups maintained severe pressure on bluegill forage fish. The substantial population of large channel catfish present in the pond from 1973 to 1976 placed even more pressure on bluegill forage fish.

#### 4. Brown Bullhead.

In 1969, 221 bullhead, averaging 1.01 pounds (0.46 kg) were taken from the pond. In 1970, after the aquatic weeds were controlled, following fertilization of the pond for only 1 year, the bullhead take dropped dramatically to 27 fish. The trend toward a vast reduction in bullhead numbers continued until only 4 were taken in 1974 and 8 in 1975. No bullhead were taken during 1976. We assume that fishing pressure for bullheads remained approximately constant for these years. A very small number of bullhead probably remain in the pond. We believe the absence of cover previously provided by the aquatic vegetation allowed heavy predation by bass and large channel catfish and eliminated any bullhead recruitment. No y/y or fingerling bullheads were ever taken in sample seined quadrants during the field trial. On several occasions the pondowner observed large bass feeding voraciously in "balled up" schools of bullhead fry.

While diminishing in number the average weight of bullhead increased from just over 1 pound (0.5 kg) in 1969 to around 2.25 pounds (1.02 kg) in 1974 and 1975. Swingle and others in the southeast predict that bullheads and other catfish cannot be self sustaining with bass in ponds where aquatic vegetation is controlled. Extensive cover composed of aquatic vegetation or submerged brush is necessary for the protection and survival of bullhead reproduction to catchable size in managed ponds.

#### 5. Channel Catfish.

Approximately 3,000 6 to 8 inch (15 to 20 cm) fingerlings averaging 4 ounces (.11 kg) each were stocked in 1971. No supplemental feed

was provided for the fish other than the increased pond productivity due to pond fertilization. In 1973, after 2 growing seasons, the harvested channel catfish averaged 1.89 pounds (0.86 kg) each and by 1976 averaged 3.27 pounds (1.48 kg) each. No y/y or fingerling channel catfish were taken in any sample seined quadrants or by hook and line fishing. Again, no reproduction was observed. The pondowner and fishermen have been delighted with the growth of the channel catfish.

The small number of white catfish stocked with the channel catfish in 1971 have shown up as a few nice catchable fish of 2 to 3 pounds (0.9 to 1.4 kg) each. No y/y or fingerling white catfish were taken by sample seining or by hook and line fishing during the field trial.

6. Green Sunfish.

Based on sample seining at the start of the field trial there were only a few green sunfish in the pond in 1969, compared to the number of bluegills. The exact reason green sunfish did not survive in the pond is not known. Since 1970 no green sunfish have been taken in sample seined quadrants or by hook and line fishing. We feel that the green sunfish is not prolific enough to survive in a bass-bluegill pond without heavy cover.

7. Crappie

A very limited number of black crappie were present in the pond in 1969. If the crappie reproduced during the field trial no reproduction was evident in sample seined quadrants. Two crappie weighing 1.5 pounds (0.68 kg) each were taken in 1972 and a crappie weighing 2 pounds (0.91 kg) was taken in 1975. The exact reason why the crappie did not become established is not known.

### Fishing

Fishing pressure on the pond was light. The fishermen, with the exception of some children, were experienced. The majority of fishermen used bobbers with either minnows or worms for bait. The owner and several others fished for large bass with artificial lures. None of the fishermen with access to the pond were believed to be highly skilled bass fishermen.

Swingle recommended that to maintain a desirable balance between predator and prey species, fishermen should strive to harvest bluegill and bass in a ratio, by weight, of 4:1 (4 pounds (1.8 kg) of bluegills for each pound (0.5 kg) of bass. The best ratio achieved by fishermen on the pond was 1.79 pounds (0.81 kg) of bluegills for every pound (1.5 kg) of bass caught in 1969. The worst ratio was 0.06 pound (0.03 kg) of bluegill for every pound (0.5 kg) of bass when a restriction was placed on taking bluegill from pond in 1975. These ratios are very low when compared to the recommended ratio.

## DISCUSSION AND CONCLUSIONS

Deepening ponds to reduce the growth of submersed aquatic plants and use of post stocking management such as pond fertilization, record keeping, and population assessment are extremely important. These management methods should be stressed as much as, or more than stocking desirable species of predatory and forage fishes in exact numbers and ratios. Our Soil Conservation Service publication entitled, "Warmwater Fish Pond Management in California", designed for use in California; and USDA Farmers Bulletin No. 2250, "Warm-water Fishponds", both stress importance of pond design and management.

Pond fertilization with inorganic nitrogen and phosphate fertilizer can be used in California's adapted warmwater ponds to control the growth of submersed aquatic plants. Where used in well designed ponds, the ultimate production of catchable fish will be above the production of most unfertilized and otherwise unmanage farmponds. Stunted sunfish populations typical of most unmanaged ponds will also be prevented. The addition of potash to farmponds may or may not be necessary to establish a satisfactory plankton bloom.

Swingle's rapid fish population assessment method based on sample seining pond quadrants is a valuable pond management tool. The combination of sample seining and pond records provide the necessary information to help pondowners and managers make farmponds produce more pounds of usable fish on a sustained basis. Although useful on a short term basis, sample seining observations can best be used when data are collected for two or more years and analyzed. The value of the rapid fish population assessment method based on sample seining of pond quadrants has been repeatedly substantiated during this field trial, other field work, and pond surveys. Most of Swingle's findings in ponds in the southeastern States held true for ponds we examined in California:

Fishing pressure on the trial pond was light throughout the field trial and will, no doubt, continue to be less than necessary to fully exploit the productivity of the pond. The owner of the pond is more than content with the fish taken from the pond and does not desire more fishermen to increase the take. For this reason, the present production of the pond could be defined as optimum yield (OY), as defined by Stroud (1977), as opposed to maximum yield. The sustained yield of 62 pounds per surface acre (69 kg/ha) of bass, bluegill, and catfish harvested from the field trial pond annually for 8 years is well above an average of 22.6 pounds per acre (25.3 kg/ha) of fish taken from 121 large reservoirs throughout the United States (Jenkins, 1968). In addition, the average annual catch-take from the field trial pond is considerably above the 3 to 8 pounds per surface acre (3.4 to 9.0 kg/ha) taken on several large California reservoirs as reported by vonGeldern (1972).

Information gained from the 8 year field trial strongly supports the use, in California's warmwater ponds, of pond management and fish population assessment methods developed and practiced by the late H. S. Swingle and others in the Southeastern United States.

Stroud (1977), speaking of inland waters of the United States south of Alaska, stated "...that predator (game) fish components are probably already sufficiently exploited." The associated preyfish components (panfish, etc.) can evidently support several times greater utilization in most waters." As the future outlook for so many of our resources are being predicted nowadays Stroud sees severe limitations on the availability of angling opportunity in the near future unless present management regimes used for warmwater fisheries are changed. We feel that this is the case, at least in California.

Many more studies and much more work and effort should be exerted by natural resource agencies and schools teaching fishery science to make the precious water in our warmwater ponds in California, and elsewhere, more productive.

#### ACKNOWLEDGMENTS

We wish to express appreciation to Mel Davis for allowing us to "play" with his pond for several years, for fertilizing the pond and faithfully maintaining pond records; but most of all for providing a lot of excellent fishing for "Bull Bream". We also wish to thank Richard Call, Wendell Miller, and Vern Davison (ret.) for starting this field trial.

#### ABSTRACT

An 8 year field trial was conducted in California's Northern Sacramento Valley on a typical warmwater farmpond. The pond was stocked with large-mouth black bass (Micropterus salmoides), bluegill (Lepomis macrochirus), channel catfish (Ictalurus punctatus) and other species. The field trial was conducted to determine if population assessment and other pond management techniques developed and practiced by the late H. S. Swingle in the Southeastern United States could be used in California. Pond fertilization was also evaluated for control of submersed aquatic vegetation. A stunted bluegill population, typical of unmanaged ponds, was also avoided. The field trial pond produced an average annual catch of 62 pounds per surface acre which is considerably more than the catch reported for larger warm-water impoundments throughout California and the United States.

TABLE 1. Davis pond catch record summary

| Fish            | Number<br>of Fish | Total<br>Pounds | Weight<br>Kilograms | Average<br>Pounds | Weight<br>Kilograms | Wt. Per Unit of Area   |                       |
|-----------------|-------------------|-----------------|---------------------|-------------------|---------------------|------------------------|-----------------------|
|                 |                   |                 |                     |                   |                     | lbs./Sur-<br>face-Acre | Kilograms/<br>Hectare |
| <u>1969</u>     |                   |                 |                     |                   |                     |                        |                       |
| Largemouth Bass | 38                | 52.2            | 23.7                | 1.4               | .63                 | 10.5                   | 1.9                   |
| Bluegill        | 359               | 93.2            | 42.3                | 0.3               | .14                 | 18.7                   | 3.4                   |
| Brown Bullhead  | <u>221</u>        | <u>225.2</u>    | <u>102.2</u>        | 1.0               | .45                 | <u>45.0</u>            | <u>8.3</u>            |
| Total           | 618               | 370.6           | 168.2               |                   |                     | 74.2                   | 15.6                  |
| <u>1970</u>     |                   |                 |                     |                   |                     |                        |                       |
| Largemouth Bass | 94                | 115.5           | 52.4                | 1.2               | .54                 | 23.1                   | 4.2                   |
| Bluegill        | 133               | 88.5            | 40.2                | 0.7               | .32                 | 17.6                   | 3.2                   |
| Brown Bullhead  | <u>27</u>         | <u>38.2</u>     | <u>17.3</u>         | 1.4               | .63                 | <u>7.6</u>             | <u>1.4</u>            |
| Total           | 254               | 242.2           | 109.9               |                   |                     | 48.3                   | 8.8                   |

TABLE 1. Davis pond catch record summary

| Fish            | Number<br>of Fish | Total Weight |           | Average Weight |           | Wt. Per Unit of Area  |                       |
|-----------------|-------------------|--------------|-----------|----------------|-----------|-----------------------|-----------------------|
|                 |                   | Pounds       | Kilograms | Pounds         | Kilograms | lbs/Sur-<br>face-Acre | Kilograms/<br>Hectare |
| <u>1971</u>     |                   |              |           |                |           |                       |                       |
| Largemouth Bass | 171               | 240.0        | 109.0     | 1.4            | .64       | 48.0                  | 8.8                   |
| Bluegill        | 165               | 126.0        | 57.2      | 0.8            | .36       | 25.2                  | 4.6                   |
| Brown Bullhead  | 15                | 20.0         | 9.1       | 1.5            | .68       | 4.0                   | 0.7                   |
| Total           | 349               | 386.0        | 175.3     |                |           | 77.2                  | 14.1                  |
| <u>1972</u>     |                   |              |           |                |           |                       |                       |
| Largemouth Bass | 73                | 73.0         | 33.1      | 1.0            | .45       | 14.6                  | 2.7                   |
| Bluegill        | 194               | 115.0        | 52.2      | 0.6            | .27       | 23.0                  | 4.2                   |
| Brown Bullhead  | 45                | 43.0         | 19.5      | 0.9            | .41       | 8.6                   | 1.6                   |
| Total           | 312               | 231.0        | 104.8     |                |           | 46.2                  | 8.5                   |

TABLE 1, Davis pond catch record summary

| Fish            | Number of Fish | Total       |             | Average |           | Wt. Per Unit Area |                   |
|-----------------|----------------|-------------|-------------|---------|-----------|-------------------|-------------------|
|                 |                | Pounds      | Kilograms   | Pounds  | Kilograms | lbs./Surface-Acre | Kilograms/Hectare |
| <u>1973</u>     |                |             |             |         |           |                   |                   |
| Largemouth Bass | 127            | 135.5       | 61.5        | 1.1     | .50       | 27.1              | 5.0               |
| Bluegill        | 411            | 214.5       | 97.4        | 0.5     | .23       | 42.9              | 7.9               |
| Channel Catfish | 19             | 36.0        | 16.3        | 1.9     | .86       | 7.2               | 1.3               |
| Brown Bullhead  | <u>14</u>      | <u>13.0</u> | <u>5.9</u>  | 0.9     | .41       | <u>2.6</u>        | <u>.5</u>         |
| Total           | 571            | 399.0       | 181.1       |         |           | 79.8              | 14.7              |
| <u>1974</u>     |                |             |             |         |           |                   |                   |
| Largemouth Bass | 225            | 196.75      | 89.25       | .87     | .40       | 39.35             | 44.18             |
| Bluegill        | 314            | 172.25      | 78.14       | .55     | .25       | 34.45             | 38.68             |
| Channel Catfish | 9              | 25.37       | 11.32       | 2.80    | 1.27      | 5.07              | 5.70              |
| Brown Bullhead  | 4              | 10.50       | 4.62        | 2.62    | 1.19      | 2.10              | 2.29              |
| White Catfish   | <u>1</u>       | <u>3.00</u> | <u>1.36</u> | ---     | ---       | ---               | ---               |
| Total           | 553            | 404.87      | 183.81      |         |           | 80.97             | 90.99             |

TABLE 1. Davis pond catch record summary

| Fish            | Number<br>of Fish | Total<br>Pounds | Weight<br>Kilograms | Average |                     | Wt. Per Unit of Area   |                       |
|-----------------|-------------------|-----------------|---------------------|---------|---------------------|------------------------|-----------------------|
|                 |                   |                 |                     | Pounds  | Weight<br>Kilograms | lbs./Sur-<br>face-Acre | Kilograms/<br>Hectare |
| <u>1975</u>     |                   |                 |                     |         |                     |                        |                       |
| Largemouth Bass | 184               | 98.25           | 44.60               | .53     | .24                 | 19.65                  | 22.08                 |
| Bluegill        | 6                 | 4.50            | 2.04                | .75     | .34                 | .90                    | 1.00                  |
| Channel Catfish | 43                | 141.75          | 64.35               | 3.30    | 1.50                | 28.35                  | 31.86                 |
| Brown Bullhead  | 8                 | 17.00           | 7.72                | 2.10    | .95                 | 5.40                   | 3.82                  |
| Crappies        | <u>1</u>          | <u>2.00</u>     | <u>.91</u>          | -----   | -----               | -----                  | -----                 |
| Totals          | 242               | 263.50          | 119.62              |         |                     | 52.70                  | 59.22                 |
| <u>1976</u>     |                   |                 |                     |         |                     |                        |                       |
| Largemouth Bass | 228               | 135.58          | 61.55               | .59     | .27                 | 27.12                  | 30.47                 |
| Bluegill        | 67                | 39.00           | 17.71               | .58     | .26                 | 7.80                   | 8.77                  |
| Channel Catfish | <u>45</u>         | <u>147.00</u>   | <u>66.74</u>        | 3.30    | 1.50                | <u>29.40</u>           | <u>33.04</u>          |
| Total           | 340               | 321.58          | 146.00              |         |                     | 64.32                  | 72.78                 |

TABLE 2. Average weight, in pounds, and number of fish caught from Davis pond

| Year | Bass   |        | Bluegill           |        | Bullhead |        | Channel Catfish |        |
|------|--------|--------|--------------------|--------|----------|--------|-----------------|--------|
|      | pounds | number | pounds             | number | pounds   | number | pounds          | number |
| 1969 | 1.38   | 38     | 0.26               | 359    | 1.01     | 221    | -----           | -----  |
| 1970 | 1.23   | 94     | 0.66               | 133    | 1.41     | 27     | -----           | -----  |
| 1971 | 1.40   | 171    | 0.76               | 165    | 1.53     | 13     | -----           | -----  |
| 1972 | 1.00   | 73     | 0.59               | 194    | 0.96     | 45     | -----           | -----  |
| 1973 | 1.07   | 127    | 0.52               | 411    | 0.93     | 14     | 1.89            | 19     |
| 1974 | 0.87   | 225    | 0.55               | 314    | 2.26     | 4      | 2.82            | 9      |
| 1975 | 0.53   | 184    | 0.75 <sup>1/</sup> | 6      | 2.12     | 8      | 3.30            | 43     |
| 1976 | 0.59   | 228    | 0.58               | 67     | -----    | -----  | 3.27            | 45     |

<sup>1/</sup> Based on sample size of only 6 fish, due to restriction on catch in 1975

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