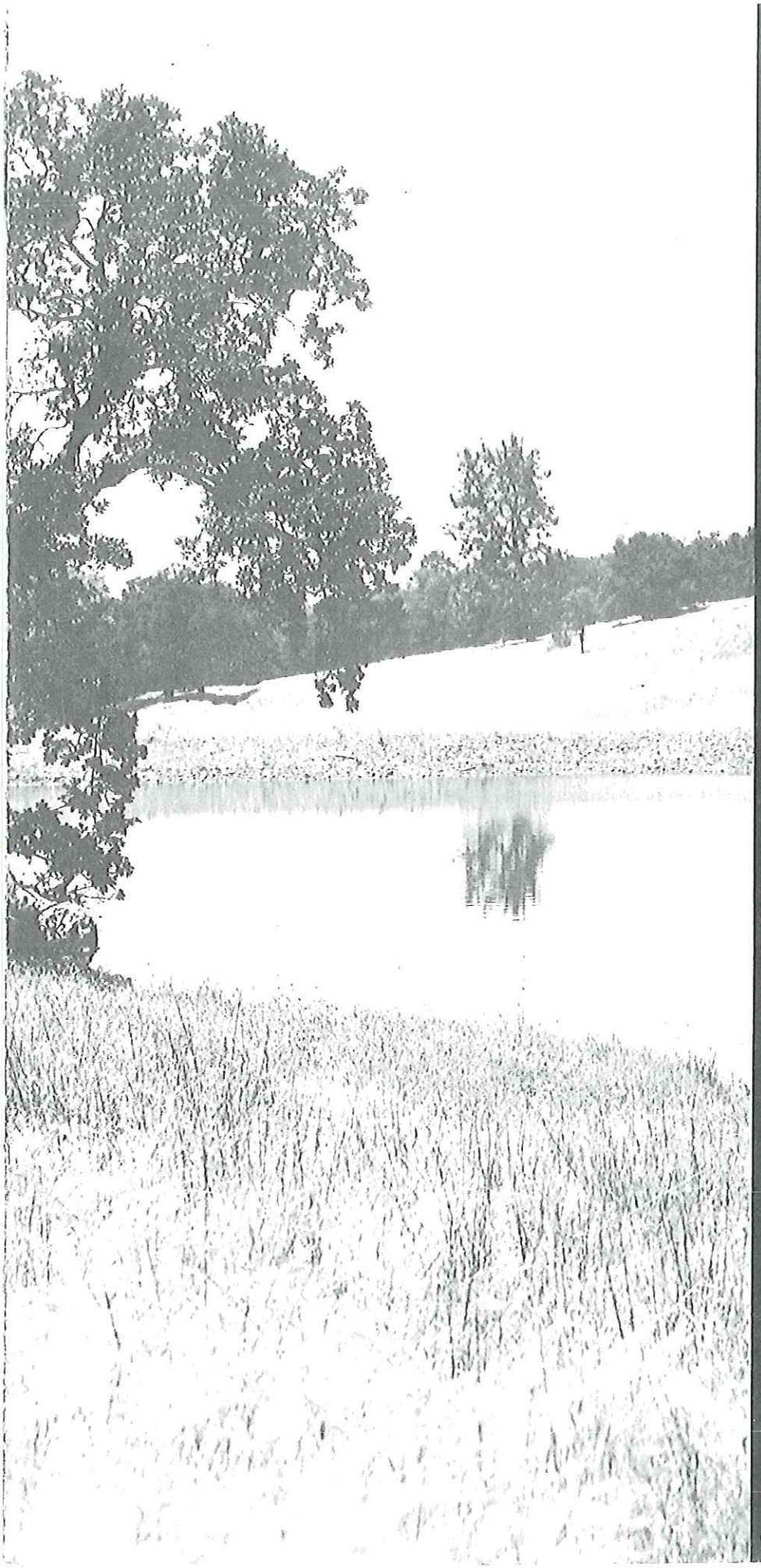

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WARMWATER FISH POND MANAGEMENT IN CALIFORNIA

1973

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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F O R E W O R D

We have written this booklet so that it may be of use to anyone interested in managing warm-water ponds for recreational fishing in California. We do not intend it as a replacement for Farmers Bulletin No. 2250 (Warm-Water Ponds for Fishing) but rather as a supplement that deals specifically with California warm-water ponds.

The Soil Conservation Service has long encouraged the utilization of privately-owned ponds for fish production for recreational or commercial purposes. However, investigations on pond management in California have lagged behind those in other parts of the country, especially the South and the Midwest. But in recent years, interest in private ponds has grown as a result of increasing demand for suitable fishing waters. SCS field trials, as well as research by colleges and universities are now yielding information which will form a basis for better management of California's warm-water ponds.

The term "warm-water" fishpond is intended here to apply to those ponds that are generally too warm for trout--i.e. consistently above 70°F during the summer. Trout can survive in water warmer than 70°F, but their production is usually limited by the higher temperatures and inadequate dissolved oxygen levels. Conversely, warm-water species, such as bass, bluegill and catfish, can live in waters where the temperature does not exceed 70°F but growth is poor and bluegill will usually fail to reproduce. Most ponds in California below an elevation of 3500 feet are suited to warm-water fish production, unless they are fed by a cold spring or well.

Many individuals assisted in the preparation of this booklet. Appreciation is expressed to the following: L. Dean Marriage, David Patterson, Ivan Lines, and Ron Schultze of the U.S. Soil Conservation Service; Almo Cordone, California Department of Fish and Game; and Dr. Richard Yeo, University of California at Davis.

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THE IMPORTANCE OF FISHPONDS

The demand by the American public for suitable fishing waters is increasing each year. In a report presented to the Outdoor Recreation Resources Review Commission, the U.S. Bureau of Sport Fisheries and Wildlife reported that the number of anglers in the United States is increasing at a greater rate than the total population. The California Department of Fish and Game has predicted a substantial increase in the number of fishermen in this state. However, many waters are no longer as productive of fish as they were in the past. Pollution, urban development, and other man-related activities have degraded aquatic habitats. Thus, meeting increasing angling demands is a major challenge to state and federal conservation agencies. Two ways in which new demands can be met are 1) the creation of new waters, and 2) better management of existing waters.

Warm-water fishponds will play an important role in absorbing increasing fishing pressure. Their relatively small size per unit makes them suitable for intensive management, and, acre for acre, they are more productive than larger lakes or reservoirs. Although an individual pond is capable of providing only a limited amount of fishing, the large number of these ponds (approximately 2 million in the U.S.) makes them an important fishery resource. According to the 1970 National Survey of Hunting and Fishing, 7,732,000 fishermen spent 805,105,000 recreation days fishing in small ponds that year. The California Department of Fish and Game urges maximum utilization of private ponds for fishing in order to absorb the anticipated increase in demand.

In California more than 21,000 private ponds and small reservoirs have been constructed during the past 30 years with assistance from the U.S. Department of Agriculture. Some, such as stock water ponds and small, short-term irrigation reservoirs do not hold water all year and are not suitable for fish production. However, the majority are suitable and most have been stocked with fish.

The aquatic environment, even in small ponds, is a complex of interacting systems. While the general principles on which these systems operate are known, they are not commonly understood by pond owners. Many are not familiar with microscopic plants and animals that exist in a drop of pond water, nor how these organisms relate to each other and to the production of fish or the growth of aquatic weeds. The information in this booklet provides pond owners with a fundamental background of management proceedures to more fully realize the fishing potential of their ponds without going into the complexities of pond ecology. As field trials and research continue, present recommendations may be replaced with newer ones.

REQUIREMENTS FOR A SUCCESSFUL POND

There are 3 basic requirements that must be met if pond management is to be successful.

1. Pond Construction: Proper construction is of fundamental importance to successful fish production. An improperly constructed pond with excessive shallow areas (less than 3 feet deep) can rapidly become a weed-choked marsh with no potential for fishing. If possible, an outlet pipe through the dam should be included so the water level can be lowered or the pond drained. Stumps and any other obstructions that might interfere with seining or swimming should be removed before impounding water. If a pond's water level will not be maintained by a supplemental water source such as irrigation drainage or well water, the pond should be deep enough to withstand evaporation and last through the dry California summer. Details of pond construction and location are beyond the scope of this booklet; the necessary information can be found in Agricultural Handbook No. 387, "Ponds for Water Supply and Recreation", and Farmers Bulletin No. 2250, "Warm-Water Fishponds", both prepared by the U.S. Soil Conservation Service, and available at any SCS Office, and in Circular 467, "Small Earth Dams", prepared by the California Agricultural Experiment Station Extension Service.

2. Stocking: The pond should be stocked with suitable fish species that will provide satisfactory angling, utilize the pond's natural foods, and successfully reproduce, so that sustained sport fishing yields will result. Details of stocking will be discussed in the next section.

3. Owner Interest: Unless the owner is willing to treat the pond as a "water pasture" and is prepared to manage it, the pond is unlikely to provide successful fishing. Numerous surveys of farm ponds in California and other states have indicated that the majority of pond owners do not take the time to properly manage their ponds, resulting in less than optimum fish production.

Warm-water ponds have considerable potential as a recreational resource. The factor limiting maximum realization of the pond fishery resource is not lack of technical know-how, but the tendency of pond owners to neglect the necessary management techniques. Even though fishing is not usually the primary concern of most California pond owners, fish production can be compatible with such uses as irrigation and stock watering; many successful ponds in the state attest to this fact.

S T O C K I N G T H E P O N D

HOW AND WHERE TO PROCURE FISH

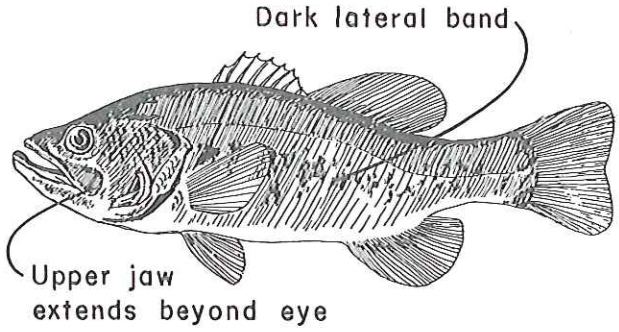
Before a pond is to be stocked with fish, it is necessary to obtain a stocking permit from the Department of Fish and Game (DFG). If the pond owner wishes to sell fish or fishing rights, he must purchase a Domesticated Fish Breeders License. The fish stocked may be obtained only from other licensed domesticated breeders. Licenses, as well as a list of licensed breeders, are available at the nearest DFG regional office. For further information, consult Inland Fisheries Information Leaflet No. 8, "Regulations Governing Domesticated Fish Breeders License", available from the DFG.

If a pond is to be used for noncommercial fishing only, the owner must obtain a Private Stocking Permit, at no charge, from the nearest regional office of the DFG. Fish may be purchased from any licensed domesticated fish breeder, or, if the pond is less than 25 surface acres, the owner may request fish from Central Valley's Hatchery at Elk Grove, through the DFG regional office. Limited numbers of largemouth bass and bluegill or redear sunfish are provided free of charge when they are available. Although these are technically "state-owned" fish, the owner is not obligated to allow public fishing in the pond. However, state of California fishing regulations must be observed. See Inland Fisheries Informational Leaflet No. 6, "Regulations Governing Private Stocking of Fish (noncommercial)" for details. Fish may also be obtained from any private pond owner who is willing to donate them; however, a permit to transport live fish as well as a Private Stocking Permit must be obtained from the DFG.

SPECIES TO STOCK

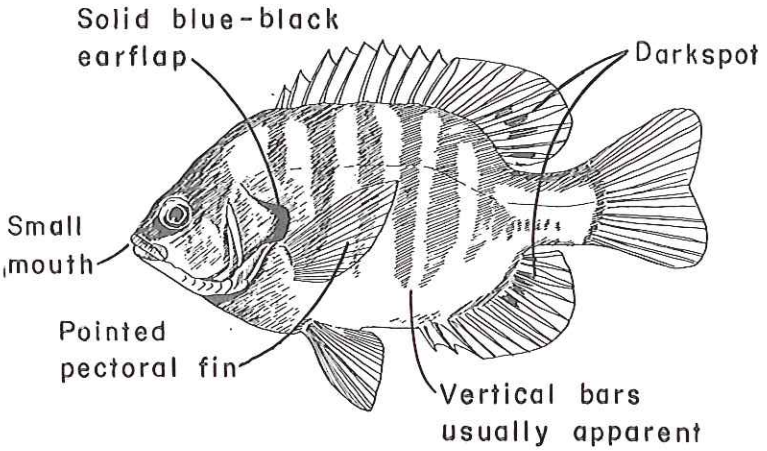
Although many species of warm-water fish can survive and reproduce in California warm-water ponds, only a few can be depended upon to provide good angling year after year.

The largemouth bass, a member of the sunfish family, and one of the most prized warm-water game fish in the country, thrives in the California warm-water pond environment. It is a very predatory fish, and is at the top of the aquatic food chain. Its presence is necessary to control numbers of other species that may be present, such as the bluegill or the



LARGEMOUTH BASS

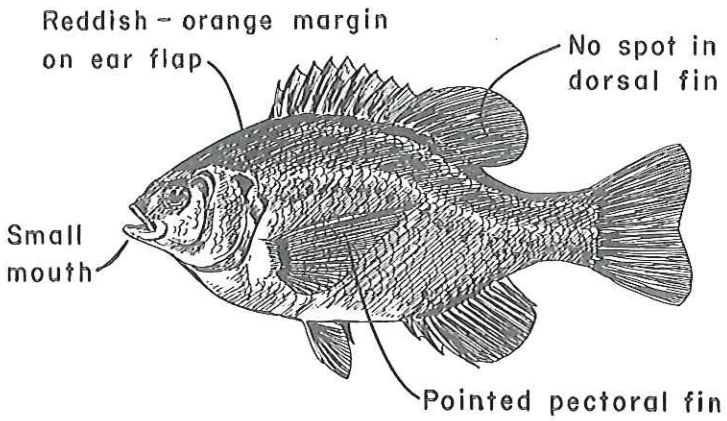
redear sunfish. Bass also feed on crayfish, tadpoles, dragonflies, and other insects. These sources of food may not be sufficient to sustain a large population of bass without a forage species such as bluegill. Bass usually spawn in April or May when the water temperatures reach the mid-60's. Their circular nests are usually observed in water from 2 to 6 feet deep. In California ponds, young bass generally reach an average length of around 5 inches by the end of their first year. They commonly reach 10 inches by the end of their second year, 14 inches by their third year, and 16 inches by their fourth. Like any fish, their growth rate is variable, and influenced by many factors, including population density, food supply, and water temperature. In highly fertile or newly-stocked ponds, they may grow much more rapidly, reaching 10 inches (1/2-lb. or more) by the end of the first year. In established populations bass will generally spawn for the first time during their third year of life if sufficient food has been available. In newly stocked ponds, bass may spawn during their second year of life. Fishing for bass is usually most successful during spring and fall when their natural foods are not so abundant.



BLUEGILL

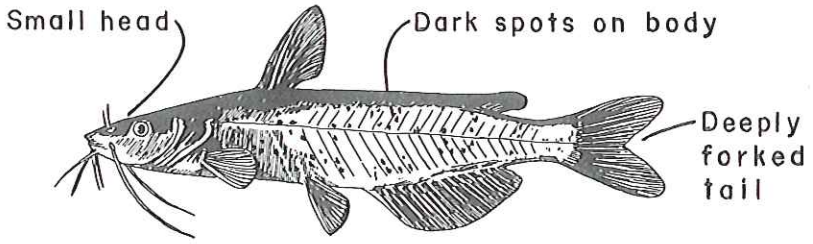
Bluegill, often incorrectly called "perch", have traditionally been stocked with bass. If the pond is properly designed and not too weedy, the bluegill provide excellent angling as well as forage for the bass. They feed on aquatic insects and microcrustaceans. Bluegill begin spawning in June when the water temperature reaches the mid-seventies and continue into August. Bluegill nests consist of well-defined circular depressions. They usually can be seen in groups in 1 to 2 feet of water near shore, with males over the nests to guard the eggs. Young bluegill spawned in early summer may reach a length of around 3 inches by late fall, while those spawned in August may not reach more than 1 inch by this time. If the population is not crowded and food supply is adequate, bluegills may reach 5 inches by the end of their second year and 7 inches by the end of their third. Bluegill can be taken readily on worms or flies throughout most of the year. The population can withstand heavy fishing pressure.

The redear sunfish (or "shell-cracker", as it is called in the southeastern United States), a close relative of the bluegill, is frequently stocked instead of, or along with, the bluegill in bass ponds. The redear does not spawn as intensively as the bluegill and thus does not have the tendency to overpopulate and stunt, even in weedy ponds. In well constructed, intensively-managed, ponds, the redear may not provide the bass with as much forage as the bluegill. Redear feed mainly on aquatic insects, snails, and microcrustaceans. Male redear often can be seen on spawning beds throughout the summer in water less than 1 foot deep near shoreline. Redear grow faster than bluegill, and commonly weigh over one pound. They are harder to catch than bluegill. Worms are the best bait for redear.



RED-EAR SUNFISH

The channel catfish has been gaining popularity as an addition to the bass-bluegill or redear combination, or in ponds by itself. Channel catfish are available in various sizes from several private breeders in the state. They consume a wide variety of foods including insects, snails, worms, and fish. They will also take commercially prepared pellets. They grow rapidly if food is plentiful, reaching 1 1/2 pounds by the end of the second growing season. Channel catfish usually do not reproduce successfully in bass and bluegill ponds, and consequently must be restocked periodically. In catfish-only ponds, they will reproduce successfully if provided with tunnel-like containers (such as milk cans) in which they can spawn. For information on catfish breeding and catfish farming, consult Farmer's Bulletin 2244, "Catfish Farming - A New Farm Crop", which is available from the Soil

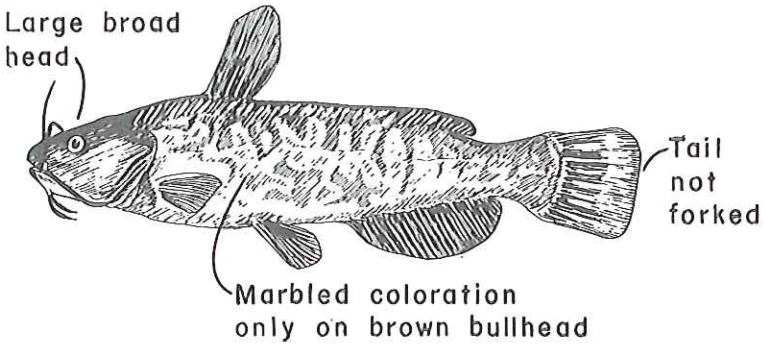


CHANNEL CATFISH

Conservation Service. Channel catfish may be stocked at a rate of 100 to 200 fingerlings per surface acre along with bass and bluegill or redear fingerlings. They can be stocked at the rate of 400 to 2,000 per acre when stocked alone, depending on whether or not supplemental feed is supplied. In ponds with established bass populations, catfish at least 8 inches in length should be stocked, as bass will feed upon smaller catfish.

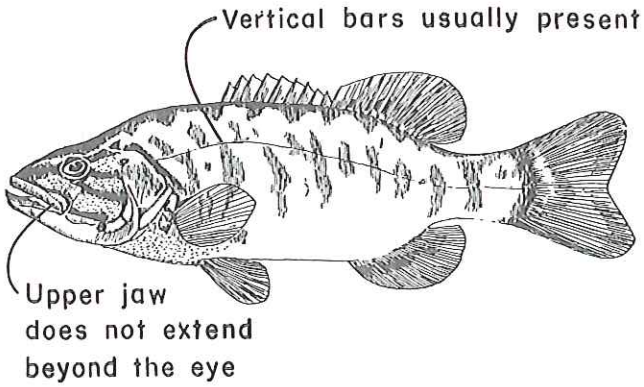
The white catfish, which looks similar to the channel catfish except that it lacks the black spots, can be used in warm-water fishponds. It is more apt to reproduce successfully in ponds than the channel catfish and it can be stocked at similar rates. It does not grow as large and is not as available commercially as the channel catfish.

Bullheads (yellow, brown and black) closely related to the channel and white catfish, are well-suited to most California ponds. They do not grow as large as the channel catfish, but they will normally reproduce in ponds. However, under conditions of heavy bass predation, they have been known to disappear. When not subjected to some bass predation they tend to over-populate. They can be caught with a variety of baits.



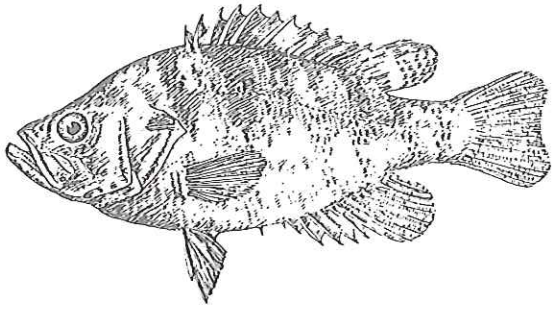
BROWN BULLHEAD

This smaller relative of the largemouth bass is typically found in clear, warm streams and rivers, but it does occur in a few ponds in the state. Smallmouth bass are most likely to be successful in a pond if they are the only species present, the pond is clear with a rocky bottom, and vegetation is not excessive.



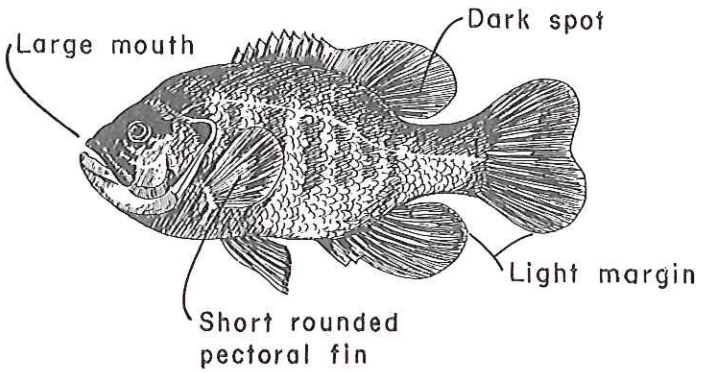
SMALLMOUTH BASS

The Sacramento perch, California's only native member of the sunfish family, is no longer as abundant as it once was. It is a good pan-fish and grows to large sizes-frequently over 10 inches in length. Attempts by the DFG to restore its range and abundance in California so far have met with varied results. It appears to be most successful in waters where other fishes, especially sunfish, are not abundant. It is more tolerant of highly alkaline water than the other sunfishes.



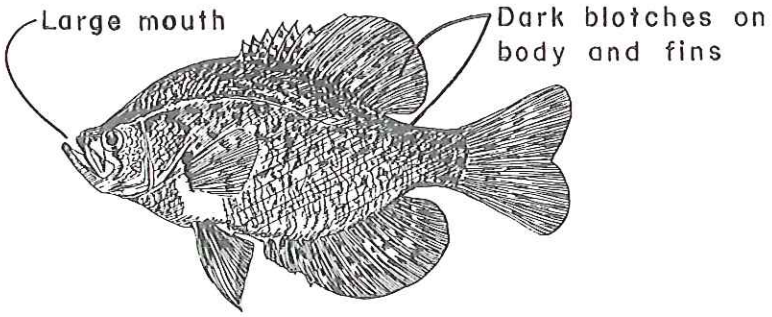
SACRAMENTO PERCH

The green sunfish is not recommended because of its tendency to overpopulate and because it spawns at nearly the same time as bass. They are competitors for food with the young bass.



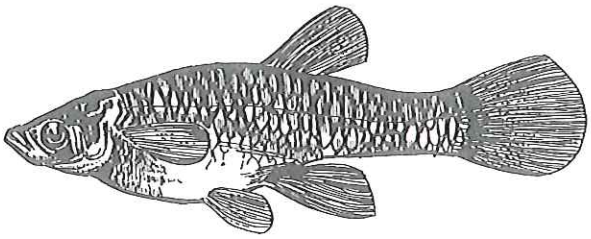
GREEN SUNFISH

Black and white crappies, while excellent pan-fish in larger lakes and reservoirs, are difficult to manage in small ponds. They tend to overpopulate and compete with bass and other sunfish, throwing this combination out of balance.



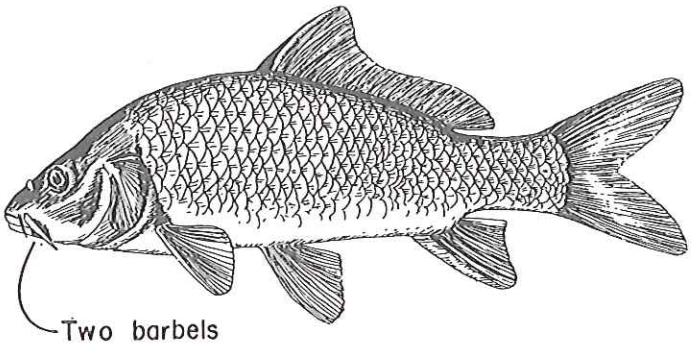
BLACK CRAPPIE

The mosquitofish, a small fish which produces its young alive, is found in most ponds in the state. It is stocked in new waters by mosquito abatement personnel to control mosquito larvae. It probably serves only to a small degree as bass forage, thus, its main value is in mosquito control in shallow areas of the pond.



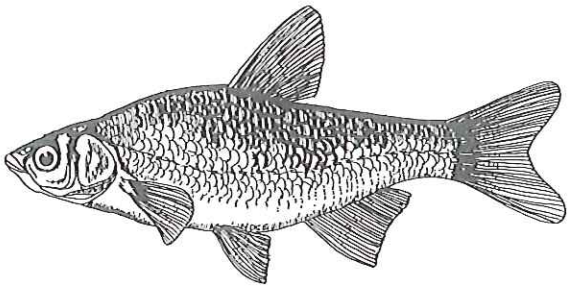
MOSQUITOFISH

Several fish species occasionally found in California ponds should be avoided. The carp is a nuisance fish because it roils the bottom and may compete for food and space with other game fish in the pond. Under certain conditions it can be used to control submerged weeds. The common goldfish, a relative of the carp, should also be avoided.



CARP

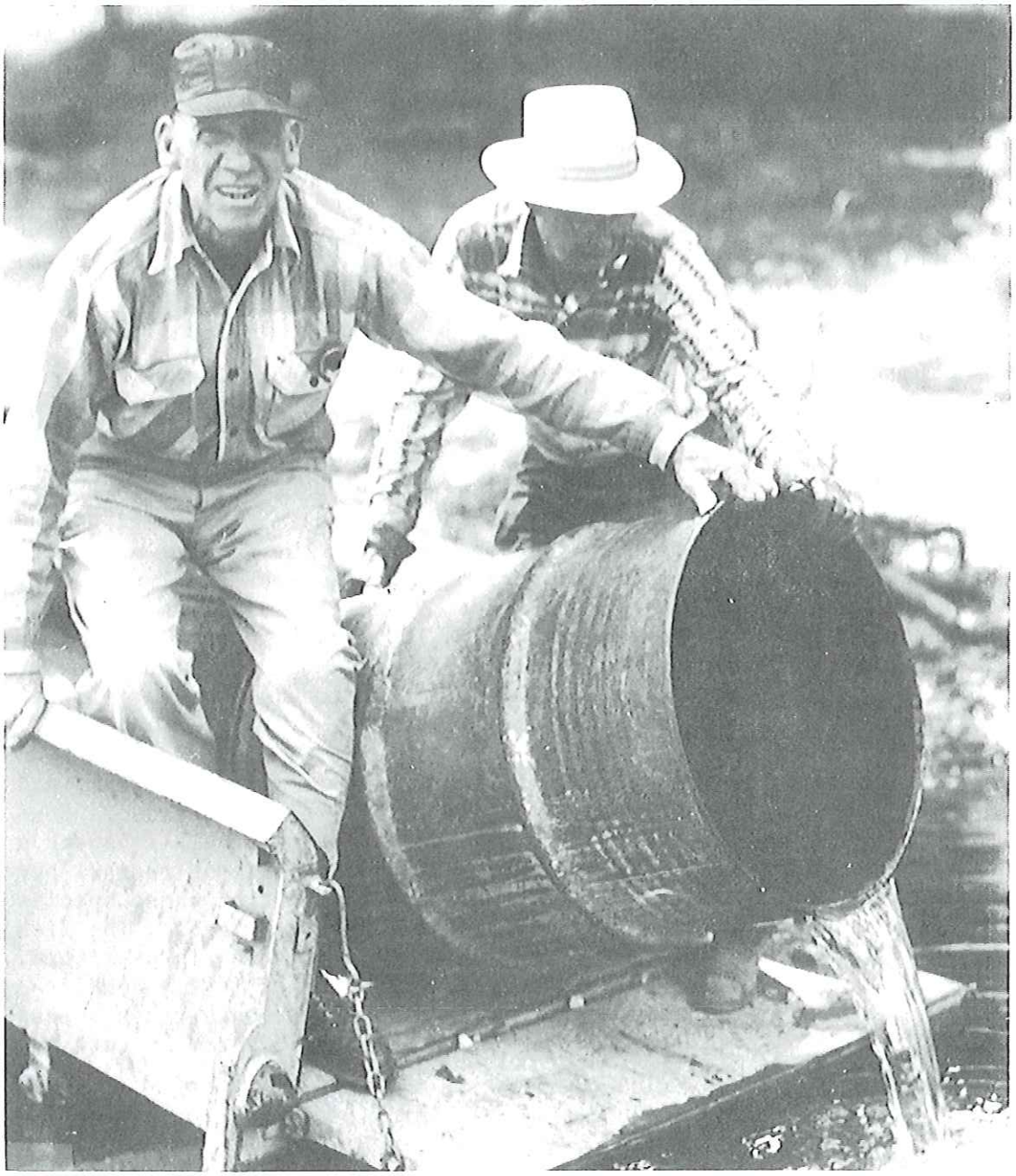
The golden shiner, which is the common bait minnow in California, is of questionable value in warm-water ponds. While it may provide the bass with good forage, it is usually too small for hook and line fishing. In weedy ponds it has a tendency to overpopulate and become a nuisance.



GOLDEN SHINER

NUMBERS AND SIZES TO STOCK

The number of bass and bluegill or redear to stock per surface acre in new and unstocked ponds is not universally agreed upon by fishery biologists. Some biologists feel that the exact numbers of fish stocked are not especially critical, particularly if stocking is done with adult or sub-adult fish which will spawn at the first opportunity.



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In California, investigations on this aspect of pond management have not been completed. Field experience in northern California in recent years indicates that the stocking rate of 1,000 to 1,500 bluegill fingerlings and 100 to 150 bass fingerlings per surface acre will produce excellent results in fertilized ponds. In unfertilized ponds, one-half this number of each fish species should be used. If a pond-owner is unable to purchase fingerlings from a licensed breeder, but still wishes to use this approach to initially stock the pond, an attempt should be made to procure fish from a neighbor's pond. In the fall of the year, there are usually large numbers of bluegill fingerlings along the edge of ponds. Large numbers can be caught readily with a minnow seine[1/] and used to stock new ponds. By the following summer these small fish are large enough to spawn and supply fry for young bass. Fingerling bass are most readily available in late spring or early summer when they concentrate along the shore or in shallow areas and can be seined easily. Later on they move out into deep water and are difficult to capture. Thus, for stocking a new pond, the ideal time to stock bluegills is in the fall, followed by the stocking of bass in the spring.

This procedure may present a dilemma for the pond owner whose new pond does not fill until the winter rains and who does not wish to wait until the following fall to start the stocking program. A substitute or alternate program is to stock the pond in June with fingerling bass at the recommended rate and at that time also stock bluegill that are large enough to spawn (around 5-6 inches). The stocking rate for bluegill can be reduced to compensate for the natural mortality that normally would occur if fingerlings were stocked 9 months earlier. We suggest stocking at least 25 adult bluegills (5 or more inches in length) per surface acre, or 100 to 300 intermediate-sized bluegills (3 to 5 inches) per surface acre. Red-ear sunfish can be substituted for bluegill, or included in the stocking rate at a ratio of approximately 1 red-ear per 2 bluegills.

If a pond owner cannot obtain large numbers of fingerlings, and is not concerned with obtaining maximum yield from a balanced pond in the shortest possible time, it may be more practical to stock a dozen or so adults of each species (bass and bluegill or redear) per surface acre. This will usually assure establishment of these species in the pond and provide angling within a couple of years. The fish should be allowed to spawn at least once before fishing is permitted. Stocking of this type is likely to be successful if it is done from late fall to early spring. Larger fish will experience less stress from a move during this period due to the colder water temperatures.

1/ It is necessary to obtain permission from DFG to use any collecting gear other than hook and line, such as seines or traps, unless you have a Domesticated Fish Breeder's License.

Other recommendations on stocking are: 1) Eliminate fish present in the pond before stocking. These "wild" fish may include undesirable species that would compete with the fish being stocked. 2) Be sure that no fish are accidentally introduced into the pond. 3) Do not permit live fish that might contaminate the pond to be used for bait.

AQUATIC WEED CONTROL

Probably the most troublesome management problem of California farm ponds is aquatic vegetation. While sparse to moderate growths of vegetation may be desirable because they may provide habitat for aquatic insects and other pond life, excessive growths are undesirable because 1) they make young fish, particularly bluegill, invulnerable to bass predation, leading to an overpopulation of bluegills; 2) they discourage angling and subsequently contribute to overpopulation of bluegills and other forage fish; 3) they can cause oxygen depletion when they die and decay; 4) they use up nutrients; and 5) they decrease the lifespan of the pond by the build-up and accumulation of organic matter (eutrophication).

There are 4 main categories of vegetation in ponds: 1) ALGAE, which includes a) planktonic algae (phytoplankton), tiny microscopic plants which give the water a greenish cloudiness or "bloom"; b) filamentous algae, long thin, thread-like strands often forming unsightly surface scums (see figure at left); and c) more highly developed forms such as Chara, which grow up from the bottom; 2) SUBMERSED PLANTS, which are rooted in the bottom and occasionally reach the surface of the water--they include Elodea, sego pondweed, coontail, milfoil, and water lillies; 3) EMERSED PLANTS, rooted in the pond bottom or along shorelines, extending well above the water surface--examples are cattails, bulrushes (tules), and arrowheads; 4) FLOATING PLANTS, such as duckweed and water hyacinth, float on the water's surface and are not rooted in the bottom.

FILAMENTOUS ALGAE

A properly constructed pond with moderately steep slopes and adequate depth is not likely to have serious weed problems; a poorly constructed pond with extensive shallow areas (less than 3 feet deep)

represents excellent habitat for a variety of aquatic plants. As long as suitable habitat for aquatic weeds exists, any control method will be temporary. The best remedy for a weedy pond is renovation involving draining, deepening, and steepening the sides. All overhanging vegetation around the pond's edge should be removed. When vegetation, such as leaves, falls into the water and decays, it stimulates undesirable growths of filamentous algae.

If modifying the pond bottom is not feasible, the pond owner should consider the alternative approaches to weed control discussed below. These five methods are: 1) mechanical control, 2) fall drawdown, 3) chemical control, 4) fertilization and 5) biological control.

MECHANICAL CONTROL--This involves cutting or pulling the weeds. If the weeds are removed a few at a time as they appear, and before they become well established, the work will be minimal. For established weed beds, submersed weeds can be removed by dragging a steel cable or a heavy chain across the pond bottom. For larger ponds, mechanical cutting devices that are mounted on boats are commercially available but are quite expensive.

FALL DRAWDOWN--A proven way to control rooted vegetation in ponds that have depths of more than 10 feet is the fall drawdown, where the water level can be substantially lowered in September--down to about 40 percent of the pond's capacity. This drawdown exposes the shallow areas of the pond where rooted vegetation will be exposed to the bright autumn sun. The vegetation is soon killed and dried out. It is also advisable to disc, rake, or better yet, scrape the exposed pond bottom at this time. The pond will be rapidly refilled by the winter rains which usually arrive in November. This annual treatment effectively prevents the establishment of submergent vegetation and helps control emersed weeds as well.

CHEMICAL CONTROL--In recent years, much attention has been given to the chemical control of aquatic vegetation. Several aquatic herbicides are on the market. The main advantages of chemical control are that application is fast, requires minimum labor, and produces quick results. Its disadvantages are that it can be expensive, repeated applications are usually necessary, and extreme caution is needed during application. State regulations require that a permit be obtained from the nearest Regional Office of the Department of Fish and Game prior to the use of any chemical that is toxic to fish in waters of the state. The USDA has issued the following precautionary statement on the use of pesticides which applies to the use of aquatic herbicides:

Pesticides Precaution Statement

Pesticides used improperly can be injurious to man, domestic animals, beneficial insects, plants, fish, and wildlife. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers--out of reach of children and pets--and away from foodstuff.

Apply pesticides selectively and carefully. Do not apply a pesticide when there is danger of drift to other areas. Avoid prolonged inhalation of a pesticide spray or dust. When applying a pesticide it is advisable that you be fully clothed.

After handling a pesticide, do not eat, drink or smoke until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If the pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Empty pesticide containers are dangerous. Contact the County Agriculture Commissioner for instructions for legal method of disposal.

It is difficult to remove all traces of a herbicide (weed killer) from equipment. Therefore, to prevent injury to desirable plants do not use the same equipment for insecticides and fungicides that you use for a herbicide.

NOTE: Registrations of pesticides are under constant review by the Federal Environmental Protection Agency. Use only pesticides that bear the Federal registration number and carry directions for home and garden use.

Copper sulphate pentahydrate (bluestone), which has been cleared for use in fish culture by the USDA, effectively eliminates both filamentous and planktonic algae. The recommended rate is from 2-4 lbs. per acre-foot of water; the effectiveness of copper sulphate is reduced in hard water. Copper sulphate crystals may be broadcast directly on floating algae masses, or it may be sprayed as a mixture of 1 pound copper sulphate crystals with 3 gallons of water. It may also be applied by dragging crystals in a burlap bag behind a boat. Doses greater than the recommended rate may kill fish.

Such herbicides as endothal, Diquat, 2,4-D, and dalapon have been effective in controlling various types of submersed, emersed, and floating weeds. No one herbicide has been developed that will safely and effectively kill all weeds--the weeds first must be identified and then the appropriate herbicide selected. Most available herbicides have not yet been cleared by the USDA for use with food fish. When these herbicides are used in ponds, the treated water cannot be used for irrigation or domestic purposes for some time after application. Certain herbicides should not be applied to waters used for human consumption or watering livestock. For details on the use and application of chemical herbicides, consult Non-crop Farm, Industrial, and Aquatic Weed Control Recommendations (1972), published by the California Agricultural Experiment Station Extension Service at the University of California, Davis.

If the pond owner is considering chemical control, some points to remember are:

1. Chemical herbicides are potentially dangerous; the manufacturers' directions on the label should be carefully read and closely followed.

2. Aquatic weeds are more effectively controlled with chemicals while they are young and growing rapidly--not when they are old and well-established.

3. If the weed infestation is heavy, treat only a part of the pond at one time to avoid a fishkill by oxygen depletion due to decaying vegetation.

FERTILIZATION--Submersed weeds require sunlight in order to germinate and grow. Thus, it is possible to prevent or discourage the growth of submersed weeds in most properly constructed ponds by adding fertilizer which stimulates the growth of phytoplankton (microscopic algae). This in turn acts as a light filter and shades out the weeds. The addition of fertilizer will usually increase the production of fish. The phytoplankton provides the "green grass" upon which the zooplankton (microscopic animals) graze and is the beginning of the food chain in a fishpond.

If weeds are to be controlled, an adequate amount of basic plant nutrients--nitrogen, phosphorus, and potash--must be in solution and available to the phytoplankton during the normal summer growing season. These nutrients are provided by a complete inorganic fertilizer which should have a basic nitrogen-phosphate-potash ratio of 4-4-1. The recommended formulation is 8-8-2 (8% nitrogen, 8% phosphorus, and

2% potash). Other formulations can be substituted as long as the nitrogen and phosphorus ratio remains essentially equal. If "triple-ten" or "triple-fourteen" (10-10-10 or 14-14-14) is readily available, either can be used if the poundage applied is adjusted according to the strength of the mixture. The extra potash wasted is not critical and is not an expensive ingredient in the formula. The popular 16-20-0 formulation can be used if potash is added at the approximate rate of 6 pounds of 50% potash (0-0-50) per 80 pound bag of 16-20-0.

The fertilizer program should begin in the spring when the afternoon surface temperature of the pond regularly reaches 60°F or higher. Phytoplankton blooms will usually not occur until the surface temperature reaches at least 70°F.

Apply the fertilizer at the rate of 100 pounds of 8-8-2 per surface acre (i.e. 8 pounds of elemental nitrogen per acre) by pouring onto a gravel or sand bottom in shallow water--less than 36 inches deep--or by placing it on a submerged platform. As the algae absorb the nutrients from the water, more fertilizer must be added. To determine when to add additional fertilizer, it is necessary to measure the density of the phytoplankton. If a white object such as a Secchi disc disappears from sight when submerged to a depth of about 18 inches, the pond has adequate fertility. If the disc can be seen at approximately 24 inches or more, additional fertilizer is needed. When fertilizer is added, the density of the phytoplankton usually increases rapidly, and care must be exercised to avoid over-fertilization. If a white object disappears at a depth of less than about 14 inches, too much fertilizer has been added. Such a condition is not usually critical and is only temporary, but indicates a waste of materials.

SECCHI DISC AND HOMEMADE SUBSTITUTE

SCS PHOTO

The pond owner can easily learn to adjust the application rate according to the needs of the individual pond. In some cases several applications may be required the first summer to maintain a satisfactory bloom; it usually requires fewer applications in subsequent years.

Occasionally, highly fertile or over-fertilized ponds can develop a "pea-soup" condition that is objectionable and potentially dangerous. Under such a condition, the dissolved oxygen in the pond is concentrated near the surface (in the upper foot or so of water) where photosynthetic action is intense. Below this level phytoplankton is shaded excessively and dies. These microscopic plants decompose rapidly and use up the dissolved oxygen in deeper water. As a result, fish life is confined to the oxygenated surface layer. Under these conditions, a sudden change in weather resulting in overcast skies could produce a serious fishkill. Excessive plankton blooms and the possible oxygen deficiency that often occurs as a consequence can be corrected by adding fresh oxygenated water, or inducing circulation with aeration equipment, or by the use of a recirculating pump well in advance of oxygen deficiencies.

It is much easier to prevent submersed weeds from developing in a new pond with fertilization than it is to control a heavy infestation after it has developed. In the latter case, it may be desirable to use mechanical control methods in conjunction with a fertilization program to attain control, or to use chemical treatments to obtain initial control and prevent the weeds from coming back with a fertilizer program. Fertilizer is not effective in shallow areas along the shoreline where the water is less than 3 feet deep. Supplemental chemical or mechanical control methods may be needed in these areas.

If excess water is to be discharged from a fertilized pond, the pond should be equipped with a bottom-water outlet. This structure drains water from near the pond's bottom, rather than from the surface (See Farmers Bulletin No. 2250). Water flowing over a conventional outlet at the surface--such as a trickle tube, spillway, etc.--carries away needed fertility and high quality water while a bottom overflow conserves the surface water and evacuates the poorer quality water from the bottom. The water from the bottom is usually deficient in dissolved oxygen and may contain toxic amounts of ammonia and hydrogen sulphide.

Obviously, the effective use of fertilizer in pond management requires close attention. A single application, without the proper follow-up applications, is useless and a waste of time and materials. Pond fertilization should not be attempted if more than 10 percent of the surface is less than 3 feet deep. However, a well-planned and

properly-executed fertilizer program, in most cases, will control submersed weeds, cost less than conventional chemical control, and increase fish production.

BIOLOGICAL CONTROL--There is much interest in biological controls, although their use has not proven to be a panacea for pond owners. Crayfish have been used effectively in some trout lakes in Arizona to control submersed weeds. Carp can control sego pondweed, but create very turbid water in doing so. Tilapia, which have become established in the drain ditches in Imperial Valley, have been used in Hawaii for aquatic weed control, but cannot tolerate cold water (less than 55°F). Field trials will be necessary to see if they can be used successfully in small ponds in southern California. Other weed-eating fish are being experimented with for aquatic weed control. Their long-range ecological impact on California waters has not yet been determined and this will take several years.

C L E A R I N G M U D D Y P O N D S

Muddy water is undesirable in a pond because it shades out sunlight needed by microscopic plants, hinders feeding by the fish, makes fish harder to catch, and makes the pond unattractive. Muddiness may be due to poor watershed management, resulting in excessive silt in the runoff water which enters the pond. It can also be caused by cattle wading in the pond, or by the presence of muskrats and carp.

A PROPERLY MANAGED FISHPOND CAN SAFELY BE USED FOR SWIMMING.
SCS PHOTO 3-3598-12

Good watershed management, fencing out cattle, and control of muskrats and carp may solve the problem of a muddy pond. In some cases muddiness may persist, even though none of the above-mentioned factors are contributing to the problem. This muddiness is due to minute clay particles which tend to remain in suspension. There are three different treatments which will cause these clay suspensions to settle out and subsequently clear the water, and none will harm the fish. Periodic treatments may be necessary.

1. Spread powdered gypsum over the water at the rate of 12 lbs. per 1,000 cubic feet of water (500 lbs. per acre-foot).

2. Apply 50 lbs. of super phosphate fertilizer and 100 lbs. of cottonseed meal per surface acre. Do not use this treatment during the hot summer months, as it may result in oxygen depletion.

3. Scatter loose green hay or dry straw in the water. Use 7 to 10 bales for each surface acre. Do not use this treatment during the hot summer months, as it may result in oxygen depletion.

FISH PARASITES AND DISEASES

Fish in general harbor a variety of parasites. A fish in nature without some kind of parasite is rare. Numerous kinds of parasites, such as yellow grubs, tapeworms, anchorworms, and nematodes are commonly found in bass and other pond fish.

Generally, parasites do not represent a serious problem in ponds. Since most occur in the viscera of fish, they are discarded when the fish are cleaned. Those that occur in muscle tissue and skin are killed when the fish is cooked and represent no danger to man.

When heavy parasite infestations occur, it is usually because the fish are stressed or weakened from some other cause, such as low concentrations of dissolved oxygen or high water temperature. In fish hatcheries, where fish are confined in relatively small areas, parasites spread rapidly and can be a serious problem. They can be controlled with various chemical treatments. In ponds, the fish are usually not crowded and parasites are less likely to become a problem. Generally, it is not feasible to control them with chemicals in ponds. Certain fish parasites are hosted temporarily by snails before infecting fish. Since redear sunfish feed on snails, they may serve to reduce the incidence of these particular parasites (such as the yellow grub).

Fish diseases are not uncommon in warm-water ponds, but they represent no threat to man and rarely cause serious fishkills. Diseased fish are usually sluggish and may have sores, swelling, or lesions on the body. Fishkills that result from disease outbreaks (such as Columnaris or Ichthyophthirius) are likely to occur when the fish are weakened or stressed such as in early spring after overwintering, or during periods of high water temperature and/or low dissolved oxygen.

If a disease occurs in your pond resulting in death of many fish, you should report it to the nearest DFG biologist. He may wish to examine some of the fish to identify the disease. Unfortunately, fish diseases in ponds are usually difficult to control and you will probably have to let the disease run its course. Although heavy mortality may occur, there will usually be enough surviving fish to reproduce and rapidly return the pond to is carrying capacity.

F I S H P O P U L A T I O N M A N A G E M E N T

HARVESTING THE FISH

Fishing is an important aspect of fishpond management. To be productive, a pond must receive moderate to heavy fishing. As fish are removed, more food is available to those fish remaining. When a pond is underfished (as most ponds are), it will contain large numbers of slow-growing fish. In other words, the pond will contain more fish than it can adequately feed.

SCS PHOTO

These general rules on harvesting fish should be followed:

1. Do not remove fish from a new pond until they have spawned at least once. Under favorable conditions, bluegill spawn during their second year of life, but bass often will not spawn until their third.

In California ponds, bass have usually completed spawning by early June. Bluegill and redear usually begin spawning in June and continue to spawn intermittently throughout the summer.

2. Heavy fishing pressure can deplete a bass population. This may lead to an overpopulation of forage fish. All bass smaller than 10 inches should be returned to the water. If adult or sub-adult bass rather than fingerlings were used in the original stocking, these will be the only fish available to sustain angling until their progeny reach catchable size 2 to 4 years later. Therefore, they should be fished only lightly or not at all. In most ponds, no more than 25 to 30 lbs. of bass per surface acre should be removed each year.

3. Established populations of bluegills and redears should receive heavy fishing pressure. For every pound of bass taken, 3 to 4 lbs. of bluegill or redear should be harvested. No matter how small, no bluegill caught should be returned to the water.

EVALUATING THE CONDITION OF THE FISH POPULATION

The goal of fishpond management is a "balanced" population--which means a fish population capable of producing satisfactory harvests of bass and bluegill or redear year after year. When a population is out of balance, fishing is poor. The most common indication of an "unbalanced" population is overpopulation of bluegills. A dense bluegill population can interfere with bass reproduction through predation on bass eggs and fry. Some factors that frequently lead to bluegill overpopulation are 1) overfishing for bass, 2) underfishing for bluegill, 3) excessive aquatic vegetation. Usually the problem is caused by a combination of these factors. Less frequently, bass may become too numerous, displaying slow growth and eventually failing to reproduce. This often happens when too few bluegills or redear are stocked initially or if these species fail to reproduce successfully.

The pond owner must be aware of the condition of the pond population, so he will know what management measures to take to maintain or return to a balanced pond condition. The late Dr. H. S. Swingle of Auburn University reported 2 different methods of determining the conditions of a pond fish population: 1) Examining the angler's catch--Perhaps the best way to determine the condition of the pond's fish population is to examine the fish that are caught. In a balanced pond, the average bluegill caught are at least 6 inches long, and the bass caught average between 1 to 2 pounds. In a pond overpopulated with bluegill, most bluegills caught average 3 to 5 inches. Also, few bass are caught; those that are taken are 2 pounds or larger. In a pond crowded with bass, the bass caught average less than 1 lb. and are thin; bluegills caught are ½-lb. and larger (too large for the bass to

swallow). 2) Shoreline seining [1/] (see following page)--Collections with a minnow seine along the shoreline during mid-summer can also be used as an index to the pond's conditions. Presence of both young-of-the-year bass and bluegill or redear in the collection indicate a balanced population, since both species are reproducing successfully. Large numbers of intermediate bluegills (3-5 inches) usually mean an overpopulation of this species. A lack of young bass indicates that bass were unsuccessful in spawning the previous spring, while the absence of small bluegill fry indicates a spawning failure. Both conditions foretell an unbalanced condition.

POPULATION CONTROL

When a pond owner has evidence that the fish population is in an unsatisfactory condition, he should select the appropriate method to correct the situation.

Overpopulation of bluegills: When bluegills become overabundant and stunted, their numbers may be controlled by seining the shallow waters or by using traps made with hardware cloth or poultry netting. Fall drawdowns may also be effective where aquatic weeds are a problem. As the water recedes, the small fish are forced into the open water and become easy prey for bass. In extreme situations, bluegills may be thinned by treatment with a fish toxicant such as rotenone or antimycin. If a pond is completely overpopulated with bluegills, with few if any bass present, it is probably best to completely eradicate the population with a fish toxicant, or to drain the pond, and restock it. It is necessary to obtain permission from the California Department of Fish and Game to use any fish toxicant in your pond or to seine and trap fish.

Overpopulation of Bass: A crowded bass population can be thinned by heavy fishing. If forage is scarce, it may be necessary to stock more adult bluegill or redear--larger than the bass can swallow--to produce more small fish in the pond to serve as bass food.

Contamination with undesirable species: It may be possible to thin or control undesirable species such as green sunfish or crappie by seining or trapping, or by spot treatment with chemical toxicants (permit required). However, if they become too abundant, along with such species as carp or golden shiners, it may be necessary to treat the pond completely with a toxicant, or drain it and restock. If the pond received inflow from an irrigation system containing wild fish,

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1/ It is necessary to obtain permission from DFG to use any collecting gear other than hook and line, such as seines or traps, unless you have a Domesticated Fish Breeder's License.

SCS PHOTO 3-5743-6

SEINING A FISHPOND TO DETERMINE FISH SPECIES COMPOSITION AND BALANCE

SCS PHOTO 3-5743-16

saran sock filters can be attached to inlet pipes to prevent entry of these fish.

FISHKILLS AND THEIR PREVENTION

The most common cause of fishkills in farm ponds is oxygen depletion. Oxygen deficiencies are most likely to occur during the summer when water temperatures are highest. There are several contributing factors which can lead to a fishkill as a result of high temperatures: 1) water holds decreasing amounts of oxygen as the temperature rises, 2) fish require more oxygen at higher temperatures since their metabolic rate increases with temperature, 3) bacterial decomposition, which also requires oxygen, increases with temperature. Since photosynthesis (which produces oxygen) ceases at night, and respiration (which utilizes oxygen) proceeds at night, oxygen shortage will be most acute at dawn. Fish gasping for air at the surface at this time of day is a sure sign of oxygen shortage in the water. (Note: small, simple to operate, portable water chemistry kits for testing oxygen level in the water are available commercially).

The pond owner can best take measures to prevent fishkills by not permitting conditions to occur which lead to oxygen depletion. Shallow, weed-filled ponds are likely places for oxygen shortages to occur in warm cloudy weather, as are ponds which have inflowing water containing organic pollutants, such as drainage from cattle pastures. When signs of oxygen shortage occur, the oxygen level of the water can be raised by importing fresh water or aerated well water, or by utilizing portable aerators and re-circulating pumps. These are available commercially. The application of 50 to 100 pounds of superphosphate per acre broadcast over the pond surface is also an emergency measure.

Another cause of pond fishkills may be the accidental introduction of pesticides into the pond. Surface runoff from treated fields may cause a fishkill; livestock sprayed with insecticide wading in a pond may also produce a fishkill. Extreme caution must be exercised when using pesticides of any kind near ponds.

KEEPING RECORDS

It is important that records be kept of the pond harvest. The owner should have people who fish the pond record numbers and sizes of the fish they catch, along with the time spent by each person fishing on each trip. This information can be conveniently recorded on a 3x5 card (see example on following page). These data will provide the basis for the owner to evaluate the condition of his pond fish population, as well as a record of the total pond harvest. Records of other pond management activities, such as fertilization, should also be kept.

SAMPLE FARM POND RECORD CARD:

POND_____

Name and Address_____

_____

Type of Fishing Gear Used_____

Length of Time Fished (Draw a line through the hours fished)

AM: 12 Midnight..1..2..3..4..5..6..7..8..9..10..11..12 Noon

PM: 12 Noon..1..2..3..4..5..6..7..8..9..10..11..12 Midnight

LENGTHS OF FISHES CAUGHT

SPECIES	LENGTHS
Bass	
Bluegill	
Redear Sunfish	

NOTE: Circle the lengths of any fish returned to the water.

Such records are your fishpond "bank account" ledger and should prove invaluable. Don't neglect them.

HAPPY FISHING!

APPENDIX

FOR FURTHER READING:

Bayer, D. E., C. L. Elmore, W. A. Harvey, L. S. Jordan, A. H. Lange, W. B. McHenry and R. Yeo. 1972. Non-crop Farm, Industrial, and Aquatic Weed Control Recommendations. California Agricultural Experiment Station Extension Service. 25 p.

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* _____. 1971. Ponds for Water Supply and Recreation. Agricultural Handbook No. 387, USDA. 55 p.

* Available at SCS Field Offices.
** Available at CDFG Regional Offices.

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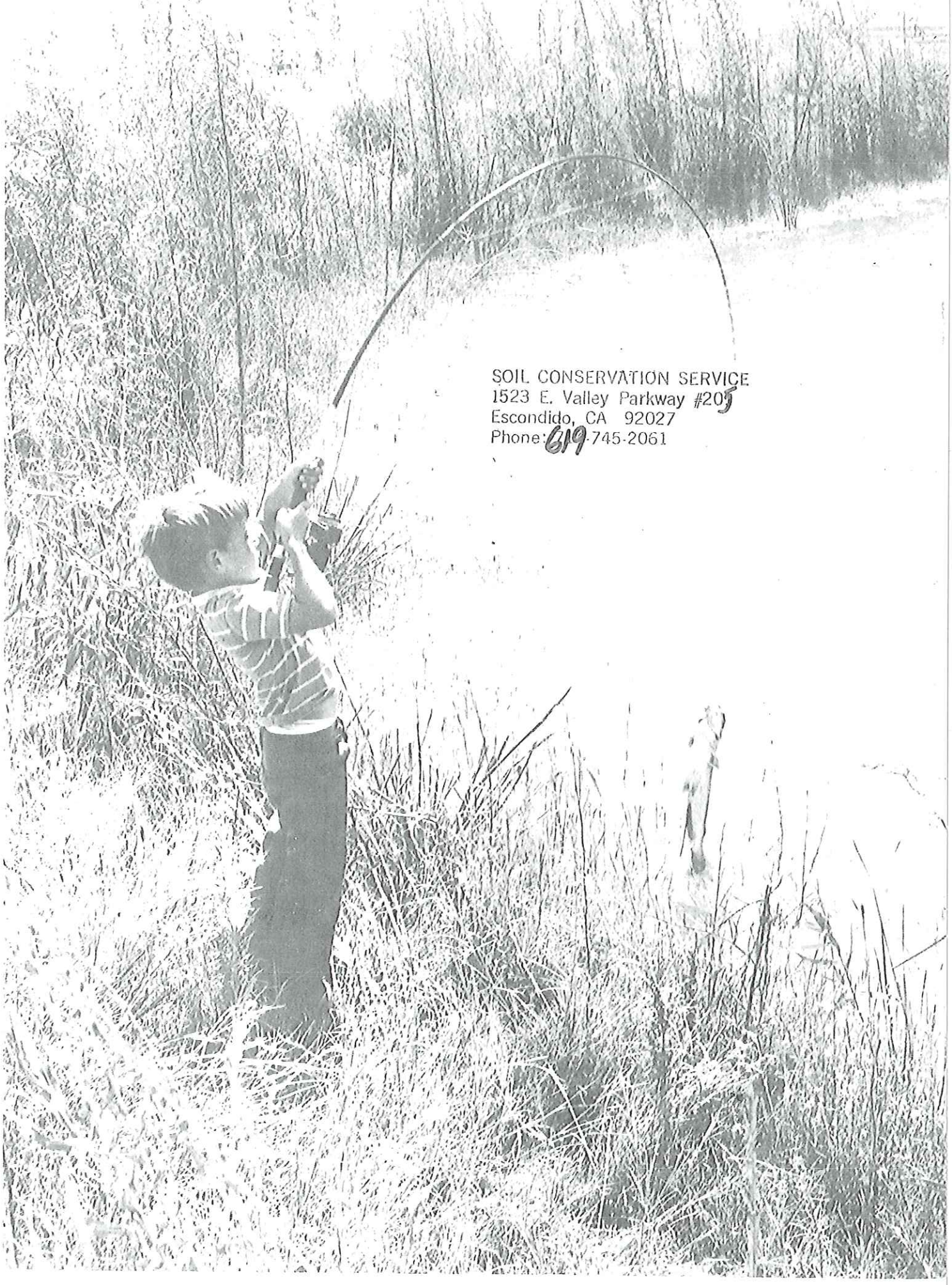

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