University of California, Davis Department of Animal Science

CALIFORNIA AQUACULTURE

FISH STOCKING STRATEGIES FOR LARGEMOUTH BASS IN RECREATIONAL PONDS AND LAKES

Introduction

Recreational fishing in lakes, ponds, stock tanks and even irrigation ponds is highly valued in California, and well stocked and managed lakes and ponds add to quality of life and land value. Building a new pond or renovating an older water impoundment can bring long lasting satisfaction to pond owners, but pre-stocking choices and decisions are essential for long-term enjoyment.

Stocking a new pond with fish, or restocking an older pond, requires some knowledge of suitable species for the environment and the number of fish to be stocked to establish a good fishing environment. Species selection depends on factors including water temperature and size of the impoundment. One of the first steps in determining what species of fish will do well in water impoundments is to evaluate the seasonal water temperature profile of the system and then match this information with the biological requirements of the available fish. Information on how to select fish species for ponds and lakes may be found in Species Selection for Recreational Fishing in Small Ponds and Lakes (Conte, Waldvogel and Vaught, 2000).

Predator/Forage Fish Relationship: All of the fish discussed in this publication are predators and are also cannibalistic. Large fish eat smaller fish; and the smallest fish consume eggs, larvae, insects, crustaceans and any other animal small enough to be consumed. The largemouth bass is a highly developed predator, and larger bass are usually located at the top of food chain when they are present in the western states' cool and warm water environments (between 70° and 90° F in the summer).

This publication concentrates on stocking strategies for a largemouth bass recreational fishing pond that uses other species of fish as a food (forage) fish for the bass. Table 1 presents a list of the common and scientific names for the largemouth bass and forage fish such as bluegill and red-ear sunfish that are addressed in this publication. The edible forage fish are also referred to as pan fish.

The largemouth bass is a predator, and it requires the presence of forage fish under natural conditions. Bass can be raised in tanks using artificial feed, but they depend on natural food when stocked in a pond or lake. Once stocked in a more natural environment, bass raised on rations may no longer accept artificial food. Most success in feeding bass (or a bass/pan fish complex) has been observed in smaller ponds where bass and bluegill can be trained on floating feed with regular feedings.

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Table 1. Common and scientific names for largemouth bass and forage fish.	
Largemouth Bass	*Micropterus salmoides*
Bluegill	*Lepomis macrochirus*
Red-ear	*Lepomis microlophus*
Channel Catfish	*Ictalurus punctatus*
Fathead Minnow	*Pimephales promelas*
Golden Shiner	*Notemigonus crysoleucas*
Mosquitofish	*Gambusia affinis*
Black Crappie	*Pomoxis nigromaculatus*
White Crappie	*Pomoxis annularis*

The choices of forage fish available to bass will be based on physical resources present in the pond or lake, the size of the water impoundment, and local regulations. This publication emphasizes smaller water impoundments (¼ to <5 surface acres) and small lakes (5 to 10 surface acres). For convenience, the term "pond" will be used to describe all of these bodies of water.

Stocking Permits and Movement of Fish

Whenever aquatic species are moved between bodies of water, primary consideration is given to protecting the natural resources of the area and providing legal protection for the pond owner. California has resource regulations designed to accomplish the first objective, and these regulations must be followed to accomplish both objectives.

Aquatic species should never be moved and reintroduced into new environments unless the movement and introduction are sanctioned by the California Department of Fish and Game, Title 14 regulations. Title 14 regulations apply to all aquatic species, even those located on private property. Fish in privately owned pond systems have escaped into area watersheds because of levee breaks, excessive rainfall and flooding. Title 14 regulations are designed to consider these natural occurrences and restrict specific species to specific area watersheds.

In reality, the regulatory process for stocking farm ponds is not excessive or difficult. A summary of the regulatory protocol for stocking ponds is presented under Resource Agency and Stocking Regulations appearing on page 9 of this publication. This section includes contacts for regulatory information, fliers, and necessary pond stocking protocol.

Prestocking Considerations

New Pond: Addressing these prestocking considerations can often save a pond owner time, money, labor, and/or prevent potential legal problems.

- Before a pond is to be stocked with fish, always check with the Regional Office of the California Department of Fish and Game (CDFG) to determine if a stocking permit is required in the county in which the pond is located. Because of different watershed configurations, some counties require a stocking permit where others might not.

- Plant appropriate vegetation on all levees and in the immediate watershed to prevent erosion and limit muddy water resulting from erosion activities. Excessive turbid water can stress fish and interfere with feeding activities of many species. The USDA Soil Conservation Service (SCS) can provide recommendations for vegetation types that are suitable for seeding in your area. The SCS is listed in local telephone directories under Federal Government, United States Department of Agriculture.

- Be sure the pond is adequately sealed before introducing fish. Pond leaking and excessive seepage can be corrected, but this is more easily accomplished before an investment in fish is made. The SCS can provide excellent information on sealing water impoundments.

- Obtain a list of local and regional fish suppliers to compare the types of service provided and pricing. A list can be obtained from the California Aquaculture Association (CAA) by contacting CAA, 3700 Chaney Court, Carmichael, CA 95608, PH: (916) 944-7315.

- Be sure to consider the size versus price of the fish. Some fish combinations may take longer to establish a sustainable fishery when measured from the initial stocking to the recommended start-of-harvest. Smaller fish are cheaper initially, but the rate of survival to first spawn or to a harvest size is reduced compared to stocking larger fish. Larger fish cost more, and some species are more expensive than others.

- When interviewing potential fish suppliers, be sure to discuss the least expensive method for delivering the fish, and ask if an on-site consultation will be offered when the fish are delivered. Delivery options can include delivery

by the dealer, by FedEx for small fish, or fish pickup by the pond owner. If delivery is arranged through FedEx, the agreement should include guarantee of live delivery. The dealer should recommend supplies and methods for safe transport of the fish for pond owners who plan to pick up and transport fish themselves. If the latter option is chosen, the dealer's liability for the fish ends when the pond owner takes possession of the fish.

Older Ponds: In addition to the prestocking considerations discussed above, older ponds often have unique, additional problems that should be addressed prior to making an investment in new fish stocks.

- Consider aquatic weed control before stocking older ponds. Older ponds often have weed control problems that inhibit water circulation and periodically initiate oxygen depletion. Excessive aquatic vegetation also leads to overpopulation of fish and stunted fish growth. If there is an aquatic weed problem, it should be corrected before fish are stocked. Aquatic vegetation is necessary for a healthy ecosystem, but excessive vegetation becomes a weed problem. For assistance with aquatic weed control, please refer to the publication Aquatic weed control: obtaining assistance (Conte, 2000). The publication can be found in Adobe (.pdf file) format on the California Aquaculture web site (http://aqua.ucdavis.edu).

- Older ponds often contain an undesirable fish population that may have been introduced by natural means or by unauthorized stocking. Elimination of these fish as part of the pond rehabilitation program should be addressed before an investment is made in introducing new fish. If practical, the pond should be drained and dried to remove the fish. Excessive vegetation can also be removed at this time. If the pond cannot be drained completely, partial draining will expose the shallower shelf area, thus allowing weed treatment. This practice can also concentrate an overabundance of smaller fish in the pond's basin and allow the bass to feed on the excess fish. If chemical destruction of fish is planned, prior approval by the CDFG is required. The decision to grant a permit for this procedure is usually the responsibility of the CDFG regional office.

Recreational and Management Objectives for Ponds

Who fishes the pond? To assure maximum enjoyment of a recreational bass fishing pond, recreational and management objectives should be defined early in the planning stage. Recreational objectives should consider who will fish the pond. If children are to be included, the pond's species mix might contain forage fish such as red-ear, bluegill, sunfish and channel catfish. These are easy to catch and can enhance the early experience for children who are being taught recreational fishing values. Pan fish and channel catfish can provide excellent fishing for adults, including seniors who love fishing, but who may not choose to stalk or attract the more elusive bass.

Many small ponds have been stocked with a bass/bluegill/catfish/minnows mix with excellent results. Past recommendations discouraged a bass/forage fish complex for ponds smaller than 1 surface acre. As pond size diminishes, there are fewer resources available to sustain a forage population for the bass. However, ponds as small as ¼ surface acre have supported the bass/forage fish complex when hand feeding has been successfully initiated or where supplementary forage fish, such as fathead minnows, are periodically added to the pond. Hand feeding can be accomplished using automatic feeders that promote feed acceptance by the fish through a consistent delivery of feed. The fish supplier you select should have information on available fish rations. It is often more expensive to operate a smaller pond, especially when electrical power is needed to operate automatic feeders or provide supplementary aeration.

What level of pond management? Management objectives should address the level of involvement the pond owner wants to have in maintaining a balanced, vibrant fishery. Bass/forage fish combinations that include red-ear and bluegill require more time and effort to balance the fish population and avoid overpopulation and stunting of fish. To keep the fish population balanced and healthy, it is recommended that these species be fished moderately to heavily, removing about 3 pounds of pan fish for every pound of bass caught. Older ponds often have a stunted bass population. In this situation, bass caught under 8 inches in length should be removed from the pond. Good pond management of the red-ear bluegill combination includes examination of the catch and annual mid-summer seining in shallow areas of the

pond to record the condition and number of fish present.

Balancing the pond: In a well managed, balanced pond, the catch will consist of bluegill and red-ear averaging 6 inches in length and bass averaging about 1.0 to 2.0 pounds. An overabundance of pan fish is indicated by numerous 3- to 5-inch fish and few bass that average about 2.0 pounds or larger. Bass averaging less than 1.0 pound and large pan fish averaging 0.5 pounds and above indicates an overabundance of bass. In a balanced pond, mid-summer seining of shallow areas will demonstrate the presence of young bass, bluegill and red-ear, but the overabundance of intermediate-sized 3- to 5-inch pan fish is an indication of pond imbalance. Unmanaged ponds more often result in a large number of small bass.

A lower level of management: Many pond owners prefer to avoid management aspects of bass/pan fish complexes. An alternative approach is to provide the bass with forage fish such as fathead minnows or golden shiners. These forage fish require minimum management, overpopulation and stunting are not an issue, and forage fish are supplied to the bass by natural reproduction or by additional stocking. This is a popular choice made by pond owners who want a lower level of pond management, whose systems support natural reproduction of minnows, or who can afford the additional expense of stocking forage fish on a more frequent basis.

Pond owners who have a land conformation that allows several ponds or multiple level ponds have additional options. Many western recreational ponds are based on an upper pond that supports fathead minnow or golden shiner production, and a lower bass pond that is supplied with the forage fish through periodic release into the bass pond from the upper pond. Another option is to net off a section of the bass pond in which habitat and substrate necessary for minnow production are present. As minnows reproduce, the young fish swim through the mesh of the net, but the smaller sized mesh holds back the breeding population. Minnows can also be produced in a separate pond at the same elevation on the property and periodically moved to the bass pond. These options require the establishment of conditions in the minnow pond that meet the requirements for minnow production. Requirements for minnow production can be found in the publication section of the California Aquaculture web site (http://aqua.ucdavis.edu).

Pond Fertility and Stocking Density

Stocking density recommendations are usually based on the estimated fertility of the pond. Other terms used for pond fertility are pond productivity or pond condition. For our purpose we will use the term pond fertility and define it as the amount of resources in a pond available to the living organisms (biomass) in the pond. The greater the fertility, the larger the amount of biomass (fish) the pond can support.

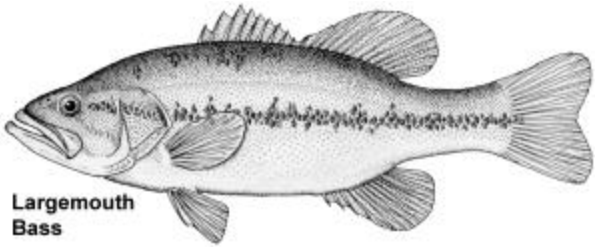
The available resources of a pond include nutrients and other chemicals that support microscopic plants (algae = phytoplankton), which are the base of the food chain that supports all life in the pond. At the top of the food chain is the predator fish, including the pan fish and the bass. Pond resources also include habitat diversity and space, with the latter expressed in surface acres. The larger the pond's surface acreage, the greater the amount of natural food that can be produced and habitat provided for hiding, feeding and nesting. Large surface acre ponds often have larger and more diverse watersheds that direct nutrients into the pond.

Measures of Pond Fertility: Pond fertility should be considered a relative term because exact physical and biological measurements are seldom available for individual ponds. Levels of pond fertility are often described as average, high or low, and most determinations of fertility are judgment calls. Classification is often based on past fishing experience and observations of past and present phytoplankton blooms, measurements of water hardness, and/or alkalinity. Consistent, but not excessive, phytoplankton blooms are characteristic of fertile ponds. Pond fertility can be increased through pond fertilization applications of inorganic or organic fertilizers that are then affected by water hardness and/or total alkalinity. For information on techniques of pond fertilization and information on the relationship between pond fertility and water chemistry, please refer to the list of suggested readings at the end of this publication. In general, and for our purposes, the level of relative fertility of a pond receiving no supplemental feed can support a given fish biomass as expressed in Table 2. A pond owner’s objective is to maintain a sustainable harvest of fish in a pond that is fished moderately or heavily.

Table 2. General classification of relative pond fertility and carrying capacity of non-fed pond biomass expressed in pounds of fish per surface acre of pond.

POND CONDITION	CARRYING CAPACITY Pounds/Acre
High Fertility	400
Average Fertility	200
Low Fertility	100

Table 2 represents ponds receiving no supplemental feed. Smaller ponds of ¼- to ½-surface acre that receive supplemental feed can support a larger fish biomass of about 25 percent. This requires water exchange and attention to water quality and feeding protocol.



Stocking Density for Bass Complexes

The stocking density tables for largemouth bass used in this publication were developed by fishery biologists and are based primarily on data from the southeastern United States. These basic recommendations were tested and adopted in the western states, but are sometimes modified to fit local conditions such as climate, elevation profiles and activity by wildlife predators. Higher stocking densities are often recommended in the more arid sections of western states with fewer wetland habitats. Under these conditions birds concentrate on available water, and the rate of fish loss due to predation increases. Increased stocking density under these conditions also results in a more rapid establishment of a useable fishery. In all of the following stocking density recommendations, stocking density is based on pond surface acre, not water volume.

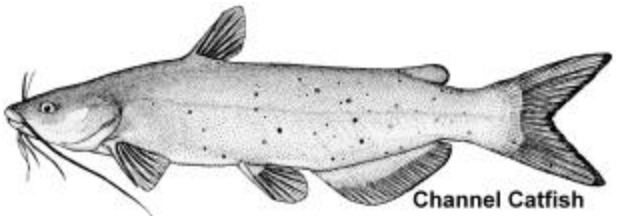
Stocking tables should be considered guidelines and not exact formulas for the "perfect" fishing pond. Every pond is different, and the quality of the harvest will depend on the health and natural productivity of the pond. If you can locate a fish producer with experience in local pond management, the subtle modifications in stocking tables and other tips will be invaluable.

Table 3 provides alternative stocking protocols for largemouth bass with suitable forage fish based on relative pond fertility, and with and without the presence of channel catfish. The inclusion of channel catfish does not alter the density protocols for the bass or pan fish.

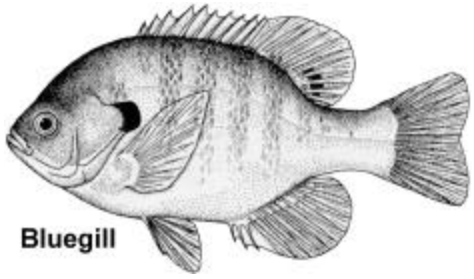
Table 3. Stocking densities for largemouth bass, bluegill and red-ear sunfish in combinations based on relative pond fertility, with and without inclusion of channel catfish, and based on 1.0 surface acre of pond.

Relative Pond Fertility	Bass	Bluegill	Red-ear	Channel Catfish
High	150-200			300*
	150-200	1000	-	100
	150-200	700	300	100
Average	100-125			150*
	100-125	750	-	75
	100-125	525	225	75
Low	75-100			75*
	75-100	500	-	50
	75-100	350	150	50

* Stocking protocols using bass and channel catfish without a suitable pan fish as forage should be supplemented with a forage minnow (see Table 4).

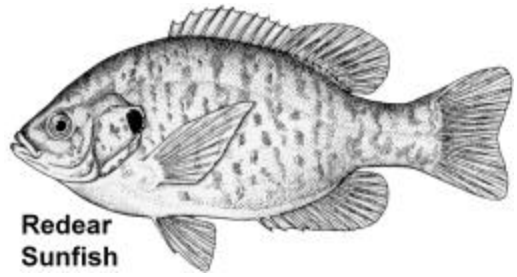


Bass and Channel Catfish: Whenever bass and channel catfish are stocked together without a pan fish (Table 3), a forage species such as a minnow should be provided. Even if the catfish were to spawn in the pond, the offspring rarely provides enough forage to maintain a suitable bass fishery. Use of minnows as forage is recommended and should follow the density protocols listed in Table 4. The catfish can also be fed a suitable fish ration. However, the bass/channel catfish/minnow combination is not a common protocol.



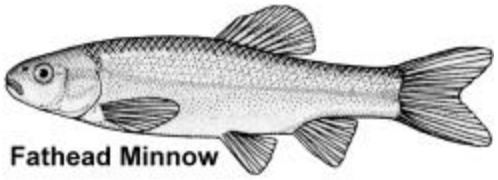
Bass and Bluegill: The traditional largemouth bass/pan fish combination places the bass with the bluegill sunfish as the targeted forage fish (Table 3). Traditional recommendations suggest that bass are stocked in a ratio of 10 bluegill for every single bass stocked. As previously described, under some circumstances a higher ration of bass are often recommended in all categories of high, average and low pond fertility. The higher stocking densities presented in Table 3 are primarily recommended for arid areas that concentrate birds and other fish predators on available wetlands. The cost of stocking fish, however, may be a consideration in favor of the lower recommendation. But, under some circumstances there is a minimum level where low stocking density will not establish or improve a pond fishery.

All of the stocking combinations presented in Table 3 require a significant level of fisheries management to maintain a balanced ratio between bass and bluegill. Fisheries management includes removing 3 pounds of bluegill for every pound of bass caught, along with good aquatic weed control. Bluegills easily overpopulate, especially when aquatic weeds are overabundant. This can lead to an Imbalance of bluegill and bass, stunted growth and poorly conditioned bass.



Bass, Bluegill and Red-ear: The most popular recommendation in western states is largemouth bass with a combination of bluegill and red-ear sunfish (Table 3). Red-ear sunfish produce fewer offspring than bluegill and are stocked at less than half the density recommended for bluegill. Red-ear do not have the tendency to overpopulate and stunt, even in weedy ponds. Combining red-ear with bluegill reduces problems associated with overpopulation and stunting, but the sunfish must still be fished out in a ratio of 3 pounds of pan fish for every pound of bass removed. Red-ear are not recommended as the sole forage fish for bass because their rate of reproduction does not support an active bass population. In addition, red-ear sunfish also feed on snails. They are recommended for snail control in fishing ponds in which people also swim because the snail is the intermediate host for a larval stage of the parasite that causes "swimmers' itch" in humans.

Bass, Bluegill, Red-ear and Channel Catfish: Ponds of ½-surface acre and greater can also support channel catfish in combination with bass and pan fish. The larger pond can support the diverse habitats necessary for each species' reproductive and foraging needs. Because of the relative differences in the species, channel catfish do not impact bass and lesser sunfish beyond the occasional role of predator or prey. Field research has demonstrated that channel catfish may be stocked in ponds in densities unrelated to the stocking rate of the other species, but they should be stocked within the range described for relative pond fertility (Table 3).



Bass and Minnows: Many western pond owners are interested in recreational bass fishing without the problems associated with pan fish fisheries management. They want to fish for bass and nothing but bass, and/or the pond is of significantly less than one surface acre and will absolutely not support a bass/pan fish combination. An excellent choice for this objective is the combination of largemouth bass and a forage minnow such as fathead minnows or golden shiners. Fathead minnows are the preferred choice of these two species as they spawn all summer and into the fall. Peak spawning occurs in the spring, followed by a secondary smaller peak in the fall. Another popular choice is mosquitofish. Mosquitofish are prolific, have one major spawning peak across the summer months, and provide good summer forage. Golden shiners spawn in the spring but usually provide less forage as the year progresses. The stocking recommendations for a bass/minnow complex are presented in Table 4. The recommendations are

based on the density and size of the bass correlated the recommended number of minnows.

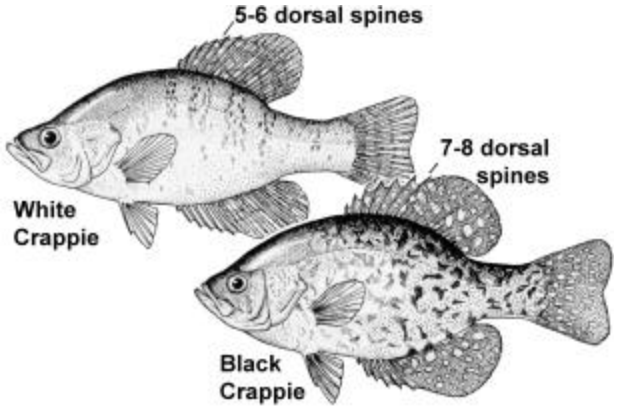
Table 4. Combinations of densities for fingerling and adult largemouth bass stocked with fathead minnows, mosquitofish, or golden shiners based on relative pond fertility, and 1.0 surface acre of pond.

POND FERTILITY	BASS 4" to 6"	BASS 8" to 10"	Minnows**
High*	150	100	2000
	100	50	1500
Average*	100	75	1000
	75	35	750
Low*	75	50	1000
	50	25	750

* Higher recommendations are presented for areas where predation is a factor.
** Fathead minnows, mosquitofish, golden shiners.

This bass/minnow combination requires periodic restocking of minnows as they are depleted by the bass. An alternative to restocking would include establishing pond conditions that promote minnow reproduction and suitable cover for young minnows. The bass will do well if the pond has adequate shelf area for nesting and spawning. They will reproduce and protect the eggs before hatch and the young fry after hatch. However, minnows have different habitat requirements because they deposit their eggs on structures and do not guard their young. Fathead minnows can be encouraged to spawn by providing partially submerged or floating boards on which they can attach their eggs. River rock placed on the edge of the pond also provides good egg attachment substrate. Golden shiners will attach eggs to filamentous materials such as artificial moss. The young of both species require weedy areas in which to hide as they grow. If resources are available, a successful, innovative approach as described on page 4 is to produce the minnows in a separate pond and supply the forage to the bass pond.

Minnows are not universally accepted as forage fish throughout the West. The recommendation for minnows as forage fish must be compatible with resource objectives of the area watershed, and the pond owner should consult with the regional office of the CDFG.



Bass and Black or White Crappie: Crappies are the largest of the pan fish and are considered an excellent sport fish. Neither black nor white crappie does well in higher elevation ponds or transports well. In addition, crappies are seldom available from commercial producers in the West. The largemouth bass and crappie combination is only recommended for lower elevation water impoundments greater than 5.0 surface acres. Crappies are aggressive, spawn at similar water temperatures as the black bass and use the same nesting habitats. Unless the water impoundment has extensive shoreline and shelf area to accommodate both species, the inevitable competition is detrimental to the continued success of the fishery.

Because of the larger water impoundment used in bass/crappie combinations, the system can accommodate additional species that will become established in the available habitats. Additional introductions are to be expected in larger impoundments. The water will attract wildlife, which will transport the eggs of other aquatic animals to the system, including fish. Table 5 provides initial stocking recommendations for the bass/crappie combination. Once established, the pond owner can add other appropriate species as desired.

Table 5. Stocking densities for combinations of fingerling and adult largemouth bass and black crappie based on average pond fertility and per 1.0 surface acre of pond.

POND FERTILITY	BASS	CRAPPIE
Average	100 (4" to 6")	200 Fingerlings
Average	50 (8" to 10")	25 Adults

Seasonal Stocking Sequences for Bass Complexes

Establishing a bass/forage fish recreational fishing pond is a multi-year process. To create a sustainable fishery, reproducing populations of the fish have to become established in the pond, and the fish have to grow to a reasonable size.

Bass Growth and Spawning: In California, fertile warm water fishponds usually promote fairly rapid growth of fish populations. Small fingerling bass (about 2 inches) grow to an average of about 5 inches by the end of their first year and often average 10 inches by the end of the second year. Under good conditions, some bass may reach 14 and 16 inches by the end of their third and fourth years, respectively. Growth rate is variable and depends on water temperature, density and food supply.

If conditions are suitable in new ponds, some bass may spawn in their second year. Bass in older ponds with established fish populations will usually spawn during their third year. Largemouth bass begin spawning in the spring when water temperatures reach 60° F and above.

Bluegill and Red-ear Growth and Spawning: Progeny of the early summer spawn of bluegill grow to about 3 inches in length by late fall, 5 inches by the end of the second summer and 7 inches by the end of their third year. Bluegill from the late August spawn can grow to about 1 inch by late fall. Red-ear grow faster than bluegill, and adult fish frequently weigh over one pound in well-managed ponds. Bluegill spawn from about mid-June through August in a single peak. Spawning begins when water temperatures reach the mid-70s. Red-ear spawn in the spring and then again in the fall when the water temperature is about 75° F.

Stocking strategies are designed to ensure that an appropriate forage fish is available to the bass when they are stocked into the pond. For combinations using pan fish for forage, this usually involves first stocking the forage fish and allowing them to spawn, then having the small offspring of the forage fish available when the young bass are stocked. Bluegill feed primarily on worms, insects and micro-crustaceans. Red-ear consume the same organisms plus snails. The bass is a top predator and feeds on anything it finds palatable and is capable of consuming.

Stocking Strategy for Bass, Bluegill, Red-ear, Channel Catfish Complex: Traditional stocking strategy involves stocking the bluegill and red-ear in the late summer or fall and the bass the following year in the early spring. This allows the forage fish to become established and spawn in the spring and summer. The more recently stocked bass feed on insects and other small organisms until they are ready to feed on the pan fish offspring. Channel catfish can be stocked at any time; however, the early spring is preferable, before the onset of fall and cooler water temperatures. In California, channel catfish availability peaks in late spring and early summer (Table 6).

Table 6. Traditional stocking strategy for a bass, bluegill, red-ear combination, with and without channel catfish.

FISH	STOCKING PERIOD
Bluegill & Red-ear	Spring through mid-November
Largemouth Bass	Spring of the following year
Channel Catfish	Anytime, preferably early spring

California fish producers have reported success when stocking all fish at once in the spring if minnows are included in the mix. Natural food, such as insects, is available, and the supplementary minnows serve as forage and sustain the bass throughout the summer. The preferred method is to stock minnows in the early spring, let them establish in the pond, and stock the bass, catfish and lesser sunfish one month later (Table 7).

Table 7. Western stocking strategy for a bass, bluegill, red-ear combination, with and without channel catfish.

FISH	STOCKING PERIOD
Minnows	Early Spring
Bluegill & Red-ear	One month after stocking minnows
Largemouth Bass	One month following minnows
Channel Catfish	One month following minnows, or before fall

Bass and Minnows: The bass/minnow complex is a simple stocking strategy. The bass and minnows are stocked during the same period. To assure available forage every year, many pond owners restock the pond in the early spring with about 1000 minnows per surface acre (Table 8).

Table 8. Largemouth bass and minnow stocking strategy.

FISH	STOCKING PERIOD
Largemouth Bass	Spring, at the recommended stocking rate (Table 4)
Minnows	Spring, at the recommended stocking rate (Table 4)

Bass and Black or White Crappie: Crappie are seldom available in many parts of the West, but when they are, they provide excellent fishing. The stocking strategies for bass and crappie are relatively simple, providing the smaller animals of approximately the same age and size can be found (Table 9).

Table 9. Stocking densities for combination of fingerling and adult largemouth bass and black crappie.

FISH	ALTERNATE STOCKING DENSITY AND PERIOD
Bass/ Crappie	100, 4" to 6" fingerlings, May through September 200, 4" to 5" fingerlings, May through September
Bass/ Crappie	50, 8" to 10" juveniles, May through September 25 adults, May through September

Resource Agency and Stocking Regulations

California does not require a private stocking permit in every county within the state. Approximately 37 counties or portions of these counties are exempt. California law does requires a pond owner to obtain a private stocking permit to stock a pond or lake if that pond or lake is located in designated "resource sensitive" counties or portions of these designated counties. A permit is also required in any area where the plant or animal does not appear as a listed species for that area. The stated purpose of a California private stocking permit is "… to prevent the introduction or spread of undesirable kinds of plants and animals and diseases or parasitized plants and animals which might prove harmful to aquaculture and the State's aquatic resources."

The source of information identifying the specific counties and other essential information may be found in the CDFG regulation and application publication and form:

> *Regulations governing private stocking of aquatic plants and animals (Noncommercial)* (Anon., 1993a). (Information Flier)
>
> *Application for private stocking permits, Form FG 749* (Anon., 1993b). (Permit Form)

Both the information flier and permit form may be obtained from CDFG regional offices. Your regional CDFG office is listed in the phone book under State Government, or on the CDFG web site (http://www.dfg.ca.gov/). CDFG may sometimes require an inspection of waters to be stocked before issuing a permit although this is not always mandatory. The forms also may be viewed in the Publication section of the California Aquaculture web site (http://aqua.ucdavis.edu).

Large mouth bass, bluegill, red-ear and crappie may be stocked in private waters only in drainages where they are already present. They are excluded from private waters within the watersheds of salmon and steelhead streams, in mountain trout areas, or in public waters. There are also stipulations about where minnows may be stocked as forage fish for bass or used as bait to catch bass. Stocking intentions should always be discussed with CDFG regional personnel.

Fish for private stocking may be purchased from the State's registered aquaculturists, and a list of these suppliers may be obtained from the CDFG regional office. Please note that fish may not be legally stocked after capture under the provisions of a sport-fishing license. In addition, fishing seasons, bag limits, license requirements, and other California angling regulations apply to all waters on private lands within the state, except when fishing in ponds belonging to registered aquaculturists.

Illustrations: Illustrations taken from Freshwater Fishes of California by Samuel McGinnis (1984), with permission of University of California Press.

References and Suggested Readings

Anon. 1993a. Regulations governing private stocking of aquatic plants and animals (Noncommercial). Calif. Dept. Fish Game, Inland Fisheries Branch, Information Leaflet No. 6. 7 pp.

Anon. 1993b. Application for private stocking permit. Form FG 749. Calif. Dept. Fish Game. 1 pp.

Boyd, C.E. 1990. Water quality in ponds for aquaculture. Alabama Agri. Exp. Stat., Auburn Univ., Birmingham Publishing Co. Alabama. 482 pp.

Calhoun, A. (Editor) 1966. Inland fisheries management. State of California, The Resource Agency, Department of Fish and Game. 546 pp.

Conte, F.S. 2000. Aquatic weed control: obtaining assistance. Univ. of Calif., Davis, Department of Animal Science, ASAQ-C01. 6 pp.

Conte, F.S., J.B. Waldvogel and T. S. Vaught. 2000. Species selection for recreational fishing in small ponds and lakes. Univ. of Calif., Davis, Department of Animal Science, ASAQ-C13. 8 pp.

McGinnis, S.M. 1984. Freshwater fishes of California. Illustrations by Doris Alcorn. University of California Press. Berkeley, Los Angeles, London. 316 pp.

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