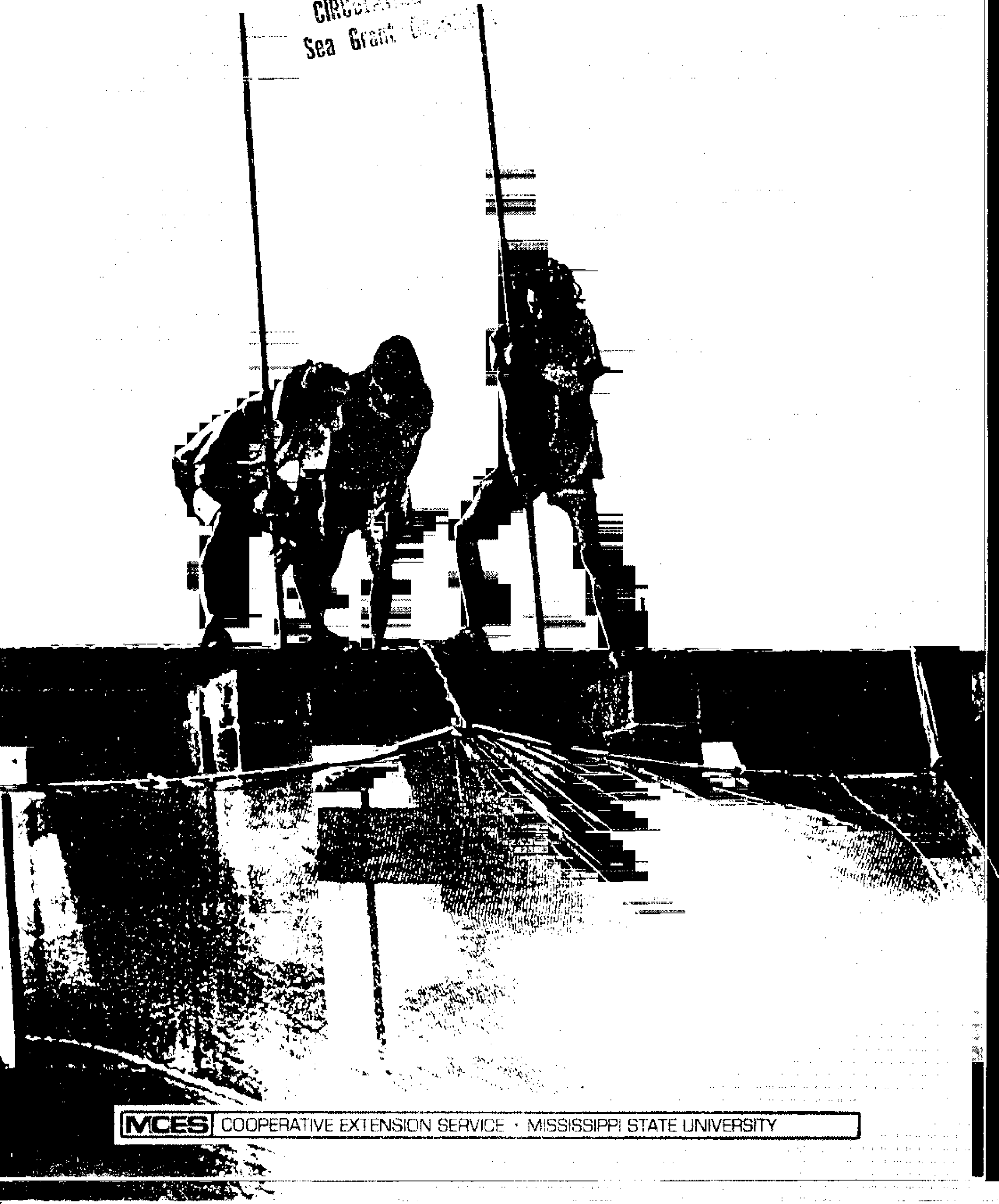
MASGC-H-90-002 C2

PRODUCING FISH AND SHELLFISH IN DREDGED MATERIAL CONTAINMENT AREAS



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Acknowledgements

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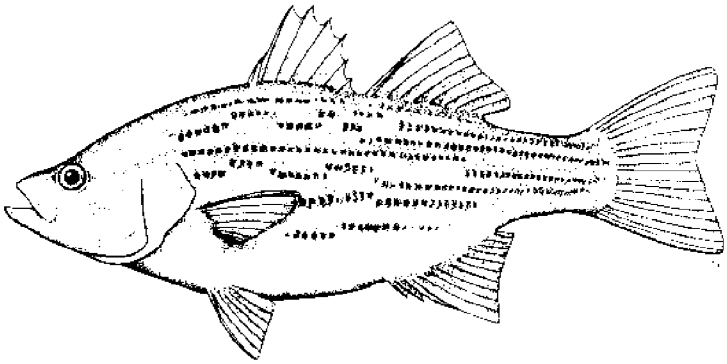


INTRODUCTION

Most people think that aquaculture, the raising of fish, shrimp, or shellfish in fresh or salt water, is one of the newer forms of agriculture. On the contrary, fish farming is an ancient practice. The Romans, Egyptians, Chinese, and even the Mayan Indians farmed fish for food at least 4,000 years ago. Ponds were constructed and fish were raised in much the same way as they are today.

Commercial production and marketing of fish has been economically successful in many parts of the United States. Photos of ponds packed with fish, news reports of successful aquaculture operations, and television shows on the "blue revolution" have sparked the interest of many people. Fish, shrimp, crawfish, and shellfish (clams, oysters) are excellent animals to raise. Fish and shrimp convert feed to body tissues more efficiently than farm animals; clams, oysters and crawfish don't have to be fed at all. Fish can be intensively cultured in ponds and offer a new, profitable alternative crop to farmers, landowners, and investors.

Before jumping into the business, however, consider your decision objectively. Like most other types of farming, fish farming (or shrimp or clam farming for that matter) is a risky business that requires special knowledge, facilities, and considerations. As a start, let's look at some of the ideas people have about aquaculture.

Fiction: Any marine or aquatic animal can be raised economically.
Fact: Most can't be. Lack of control over reproduction and nutrition makes it impractical to raise many valuable species.

Fiction: Fish farming is relatively easy.
Fact: Fish farming is farming, and requires hard work, close management, special skills, and the ability to tolerate risk.

Fiction: Fish farming is very profitable.
Fact: No, it's not a gold mine. The profits are like those in other types of farming.

Fiction: Fish farming is a good retirement activity.
Fact: Running even a hobby farm requires hard physical work and long hours; any risky business can be stressful.

Fiction: Fishing is a good background for getting into fish farming.
Fact: Farming is the best background. Basic farming skills such as equipment repair, welding, and farm management are needed.

Fiction: I can easily find a site for a fish pond on my property.
Fact: Most sites are not suitable for pond construction because of inadequate water, poor soils, presence of wetlands, irregular terrain, or other factors.

The Corps of Engineers and Aquaculture

The lack of suitable sites often creates a problem for the aquaculturist. This is where the Corps of Engineers (CE) can play a part. Working with the CE, it may be possible to build ponds that can be used by an aquaculturist for raising fish, crawfish, or other species as well as for the placement of dredged material.

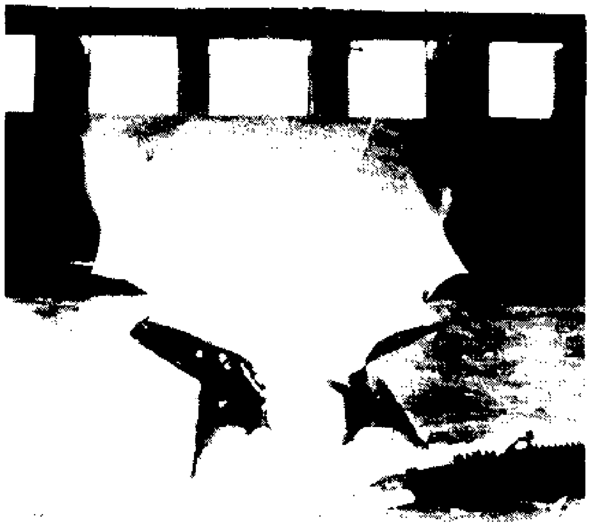
The CE is responsible for managing the dredging projects needed to maintain the nation's waterways. A large portion of the dredged material is placed in confined dredged material containment areas or DMCA. Although a DMCA may have a life of up to 50 years, more than 7,000 acres are needed every year for new DMCA. So local dredging sponsors, such as Port Authorities and Navigation Districts, are looking for new ways to acquire land on which to build diked disposal areas. One way is to build ponds that can be used for both aquaculture and dredging.

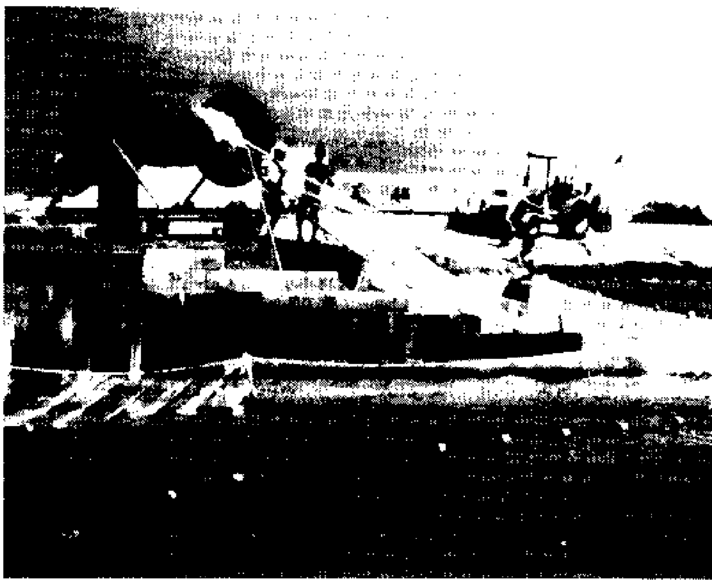
Diked disposal areas share many features with aquaculture ponds: level sites, good foundation soils, water-holding capability, and a water-control structure. Both also have similar discharge and construction permit requirements.

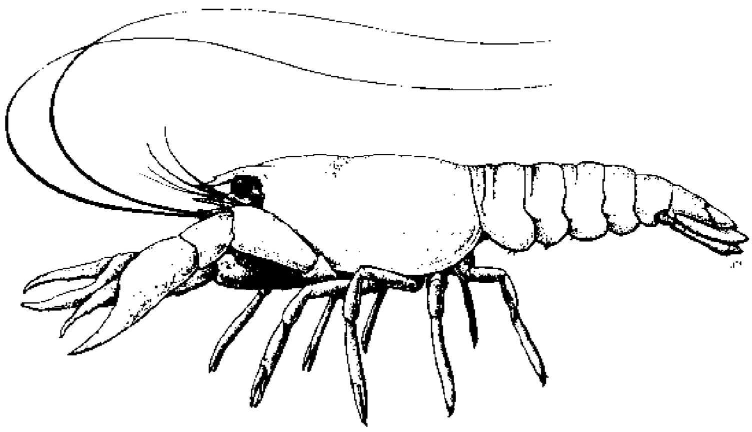
The use of dredged material containment areas for both disposal and aquaculture has many benefits. Aquaculturists gain access to good sites and benefit from reduced costs for pond design, engineering, permits, construction, and other site improvements. Land owners benefit from improvements to their property and higher lease fees, and the dredging sponsor obtains the land needed for new DMCA construction.

On the other hand, there may be added costs for aquaculturists. A more expensive design may be needed to accommodate both activities. Production may be periodically interrupted or operations modified to allow disposal activities. Pond structures may also need to be rebuilt after large amounts of dredged material have accumulated in the ponds.

The actual savings and benefits realized by the aquaculturist will depend on the outcome of negotiations with the CE and the dredging sponsor.







The Decision

Your first point of contact in planning any DMCA aquaculture venture is the Corps of Engineers District Office in your area. To be successful, a DMCA aquaculture project requires a CE dredging project in the area, a need for additional land for DMCA, CE interest in the project, and that the aquaculture operation be compatible with the dredging project's disposal needs.

There are some important points to keep in mind when considering aquaculture in a confined disposal area. Although most dredging operations involve clean sediments, it is important to check the quality of material to be placed on a site. Remember, the CE and the dredging sponsor will be interested only if they, too, can benefit from the project. The CE demonstrated the feasibility of commercial aquaculture in DMCA as an incentive for landowners to make additional sites available for the construction of new disposal areas. There is little interest in the CE for refitting existing DMCA for aquaculture without additional sites becoming available for new disposal areas.

Once the feasibility of a DMCA aquaculture venture is established, you must make some serious planning decisions. Detailed planning is essential before you make any large capital investment. Planning includes a detailed evaluation of the biological, economic, and legal feasibility of raising a particular species.

To help you determine if DMCA aquaculture is possible in your particular situation, a checklist of important points to consider is provided below. It doesn't cover **all** of the possibilities, but it does cover most of the important considerations. Answering "yes" to most of the questions does not necessarily mean success, just as answering "no" does not mean failure. Although the questions refer to "fish," the term includes shrimp, crawfish, and shellfish (clams and oysters) as well.

Checklist

Management

- ☐ Do you have a suitable pond site?
- ☐ Do you know which agencies regulate aquaculture in your area?
- ☐ Do you have the necessary permits to develop the site (construction, water intake and discharge, exotic species, etc.)?
- ☐ Do you know what equipment you will need (tractors, pumps, storage building, etc.)?
- ☐ Do you have the necessary financial resources (for catfish, for example, about $3,000/acre investment and $2,500/acre annual production cost)?
- ☐ Do you have a business plan suitable for a lender?
- ☐ Do you know the prices of equipment, supplies, and the operating costs for your farm?
- ☐ Have you made an estimate of investment costs and annual cost and return?
- ☐ Have you estimated the impact of changes in fish prices and feed costs on projected income?
- ☐ Will current interest rates and interest costs on investment and operating capital permit a reasonable profit?
- ☐ Will the expected profit provide an adequate return for your labor, management, and risk?
- ☐ Can you afford to forego income until you sell your first crop (usually 12-24 months after starting)?
- ☐ Have you looked at record systems available and picked one best suited to your situation?
- ☐ Can you afford to absorb occasional losses?
- ☐ Are you willing to devote the time, money, labor, and effort required?

Marketing

- ☐ Do you know of an established market for your fish?
- ☐ Is there a market for your fish at the time of year you plan to sell them?
- ☐ Will you have harvesting and transport equipment, or do you have a suitable arrangement for harvesting your fish?
- ☐ Will you be able to harvest fish year round?
- ☐ Do you have an alternative marketing strategy?

Physical Factors

- ☐ Is the site suitable for construction of a confined disposal area?
- ☐ Will the soil hold water?
- ☐ Is the topography of the land suitable for pond construction?
- ☐ Is there adequate water close to the site?
- ☐ Is the water quality suitable for fish farming?
- ☐ Will it work in this climate?
- ☐ Is the pond area protected from flooding?
- ☐ Will discharge water be separated from intake water?
- ☐ Will the pond bottom be sloped to drain completely and rapidly?
- ☐ Can you prevent wild fish from entering the pond?
- ☐ Is there daily access to the ponds, regardless of weather, for feeding, treating, and harvesting?
- ☐ Is the pond bottom suitable for the planned harvesting method?
- ☐ Will someone live close enough to the pond to allow frequent observation and necessary management?
- ☐ Are the sediments "clean"?

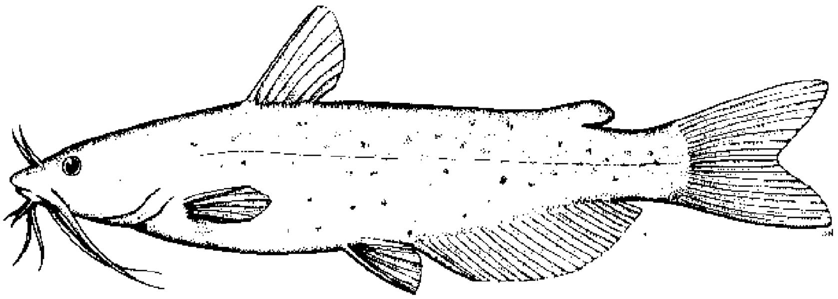
Production

- ☐ Is there electrical power available to the site?
- ☐ Are good quality feeds available locally at competitive prices?
- ☐ Is there a source of supply for drugs and chemicals?
- ☐ Are fingerlings/seed stock available at competitive prices?
- ☐ Can you make or purchase needed aeration equipment?
- ☐ Is dependable labor available?
- ☐ Do you have adequate storage facilities for feed?
- ☐ Is there an Extension Service or Sea Grant Aquaculture Specialist in your area?
- ☐ Are you aware of the government agencies that can provide you with educational and technical assistance?

Risks

Are you prepared to handle these problems?

- ☐ Periodic interruption of production operations for disposal and drying of dredged material
- ☐ Poor water quality
- ☐ Diseases
- ☐ Risk of hurricane damage, floods, oil spills, or other catas-
- ☐ Contamination by agricultural chemicals
- ☐ Poachers and vandals
- ☐ Bird predation
- ☐ Low fish prices and high feed costs
- ☐ Personal stress resulting from financial loss



THE INVESTMENT

Your first step should be evaluating the economic feasibility of the project. The economic success of a DMCA aquaculture venture will depend, in part, on the species cultured, on the site selected, and on how dredging operations will affect production. Equally important, are the operators' skills in administration, farm management, and marketing.

The amount of investment required will vary with the species, the management and production systems selected, and other factors. Develop possible production plans to help you decide on species and production system choices.

The agreements negotiated with the dredging sponsor and the CE will also affect the amount of investment needed for design and construction, and may affect the revenue as well.

The following is a list of costs common to most fish, crawfish, and shrimp farms. Use this list to get familiar with the type of costs you will incur and to determine the approximate costs for your situation.

Capital and Fixed Costs

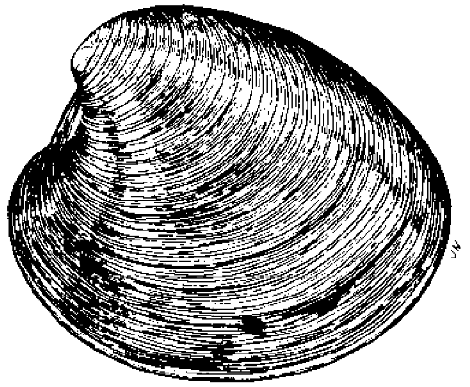
- Soil testing
- Your share of pond construction*, other earth work, gravel, vegetation
- Your share of drains* (pipe, valve, fittings)
- Water supply (surface or well)
- Building (storage and service)
- Aeration equipment (paddlewheel, relift pumps, etc.)
- Boat and motor
- Trucks
- Fish hauling tanks and agitators
- Feeding equipment, feed storage bins
- Tractors
- Mowers
- Oxygen testing equipment
- Other water quality testing equipment
- Seines, storage reels, crane
- Dip nets
- Waders and boots
- Miscellaneous equipment
- Lease
- Taxes and insurance
- Interest

Operating Costs

- Feed (cost varies with type and feed conversion)
- Fingerlings/seed stock
- Electricity
- Fuel (diesel and gasoline)
- Maintenance and repairs (including any needed site modifications after dredging)
- Harvest labor
- Transportation
- Daily labor
- Chemicals and drugs
- Telephone
- Miscellaneous/administrative
- Interest on operating capital
- Cost to remobilize after a dredging operation

** Negotiate cost with CE and dredging sponsor*

Financing for aquaculture is difficult to obtain outside of major catfish and crawfish producing areas. The most successful way to get financing is to use personal funds to operate a pilot project for several years. Then you can use the financial records from your operation as the foundation for a business plan and loan proposal to a bank. Information on how to produce an agriculture business plan is available from the Extension Service in your area. Your local banks are the contacts for Small Business Administration (SBA), Farmers Home Administration (FmHA), and other agricultural loan programs.



Site and Selection Planning

Selecting a site is the next critical decision. Many aquaculture operations have failed because of poor location. Selecting a site for a dual use DMCA is especially critical because it must be suitable for both material placement and aquaculture.

Site selection for DMCA aquaculture is a four-step process. First, you must assess **feasibility**. The project will be feasible only in locations where there are active dredging projects, where new DMCA are needed, and where there is a support for the project at the CE District Office and by the local sponsor.

Second, the **compatibility** of the planned aquaculture operations with disposal requirements must be established. You will need information on the dredging project from the CE District office for this. Most important will be frequency and duration of use, sediment type, the presence of any undesirable substances in the sediments, and depth of material placed each time.

Remember to consider the entire period the site will be closed to aquaculture for preparation, disposal, and drying, usually about 6 months.

Once feasibility and compatibility are established, you can proceed with the actual site evaluation and selection. First, the site must be suitable for the construction and use of DMCA for dredged material placement. The CE District Office will determine this. Only then can the site be evaluated for aquaculture. Much of the engineering information needed for evaluation and planning for aquaculture will be available from the CE District Office.

The species selected and the management choice will affect site selection. Look for these characteristics in a potential site during the preliminary survey:

- Site must be needed for DMCA.
- Site is close to dredging project.
- CE and dredging sponsor are interested.
- Site meets design requirements for DMCA construction.
- No legal and social obstacles to development exist.
- Site is accessible.
- Soil can hold water and support earth works.
- Land is flat.
- Lands classed as "wetlands" have limited potential for development. Check with the CE District.
- Site is sufficiently elevated to drain in the required time.
- Land is not subject to flooding.
- Pesticide or other residues are not present in the sediments.
- Adequate water is available to fill pond within the required time.
- Water is not polluted.
- If surface water is used, the source is adequate for filling pond during normal rainfall.
- In coastal areas, filling and draining can take place regardless of tidal level.

Pond Design and Construction

Pond size, shape, number, levee designs, and other features will vary greatly, depending upon disposal requirements and on the species and management approach you choose. You can negotiate pond features with the CE to arrive at a design suitable for both material disposal and aquaculture. It is important to remember that the ponds will be slowly filled with dredged material. This may require reworking water control structures, drainage, and levees at some later date.

Designs for food fish, bait fish, crawfish, and shrimp production are fairly well established. While shellfish (clams and oysters) can be grown in ponds, no preferred pond designs have been developed. The best sources for pond design and engineering information are production manuals, some of which are listed in the "Production" reference section. Pond design assistance is also available from the local offices of the Soil Conservation Service. Cooperative Extension Service or Sea Grant Aquaculture Specialists are available for help as well.

The following are some design features to consider in pond construction. These are based on accepted fish farm designs and may apply, with a few changes, in many situations.

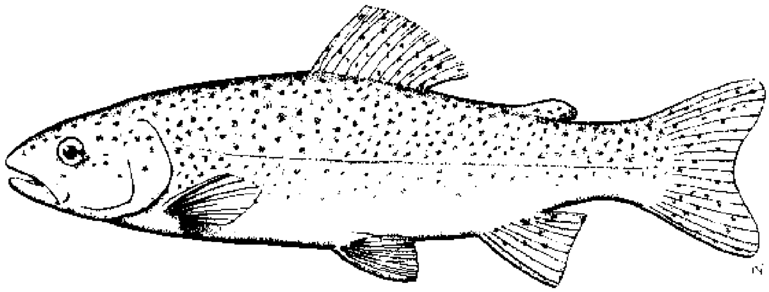
- A common size for fish ponds is 17.5 water acres on 20 land acres. Large ponds are more difficult to manage, and smaller ponds are more expensive to construct. The proportion of water to land will increase with increasing pond size.
- The bottom should slope to drain by gravity flow (0.1 - 2 ft. per 100 ft.)
- The type and size of drain will vary, depending on the size of the pond, harvest method, and time needed to drain.
- Drain outlet must be at least 2 feet above surface of water in drainage ditch to prevent wild fish from entering pond.
- Levee widths should be at least 16 feet and, ideally, topped with gravel to accommodate traffic. In some cases, levees may be narrower (crawfish, baitfish ponds).
- Side slopes should be 3:1 with proper compaction. Slopes greater than this are common in large ponds (over 20 acres).
- Freeboard (the height of the levee above the water level) should not exceed 2 feet nor be less than 1 foot.
- For fish ponds, depth should be at least 3 feet at the toe of slope at shallow end and should not exceed 6 feet at toe of slope at the deep end. Crawfish ponds are shallower.
- The shape of the pond will be determined by topography, land ownership, and dredging needs. As a guide, a square 20-acre pond requires 1,867 feet of levee. A rectangular 20-acre pond that is 660 x 1,320 feet requires 1,980 feet of levee, a difference of 113 feet.

Table 1. Time in hours required to pump different volumes of water in acre feet at four different pumping rates.

Pumping Rate	Volume in Acre Feet* 1	5	10	70**
		Hours		
100 gal/min	54.3	271.5	543.1	3802
500 gal/min	10.9	54.3	108.6	760
1,000 gal/min	5.4	27.0	54.3	380
2,000 gal/min	2.7	13.5	27.2	190
3,000 gal/min	1.8	9.0	18.1	127

* 1 acre foot = 325,850 gallons = 1 surface acre that is 1 foot deep.

** The number of acre feet of water in a pond with 17.5 surface acres with an average depth of 4 feet.



Production

When you get into the production phase of raising fish, crawfish, shrimp, or shellfish, there are many important things you will have to know and remember. This section covers the major species cultured in the United States. Selected references on how to grow these species are included as well.

Pond culture involves stocking fish in ponds filled with water. It is a well proven and reliable means of fish production when properly managed. Essentially all species suitable for aquaculture can be grown in standing-water ponds. Ponds have generally proven to be the most economical means of producing fish and the way to get the most fish production per unit of available water.

What To Produce?

There are many types of fish and aquatic animals that offer good potential for culture. The discussion that follows is designed to allow you to consider some different species while pointing out the advantages and disadvantages of each. Some of these are included because they appear promising. Other species with poor potential are included only because many people are interested in them.

Bait Fish

Golden shiners, fathead minnows, and goldfish are among the most popular bait species and can be produced reliably in ponds. Mud or bull minnows are popular marine bait fish that reproduce naturally and grow well on inexpensive feeds. A series of small flat-bottomed ponds that can be drained, seined, and refilled are needed so buyers can be supplied on a regular basis.

If you are considering bait fish production, you need to be aware that you will be competing with large producers. These producers have low production costs and will probably offer their fish at cheap prices if you attempt to compete with them directly.

Guidice, J. J., D. L. Gray and M. M. Martin. 1981. Manual for bait fish culture in the south. University of Arkansas Cooperative Extension Service, Little Rock, AR.

Strawn, K., P. W. Persbacher, R. Nailon and G. Chamberlain. 1986. Raising mudminnows. Texas A & M Sea Grant Publication 86-506. College Station, TX.

Channel Catfish

As the most important aquaculture industry in the United States, catfish farming contributes significantly to the economies of many southern states. The channel catfish is preferred over other species of catfish because of its tolerance for handling, good feed conversion, high dress-out percentage, and ease of spawning. Flat-bottomed ponds filled by well water are the ideal situation for catfish production.

Jensen, G. L. 1988. Commercial production of farm-raised catfish. Louisiana State University Agricultural Center, Baton Rouge, LA.

Lee, J. S. 1981. Commercial catfish farming. Interstate Printers and Publishers, Danville, IL.

Wellborn, T. L. 1989a. Catfish farmer's handbook. Mississippi Cooperative Extension Service, Mississippi State, MS.

Crawfish

Production of crawfish has been economical in Louisiana and Texas, and interest has spread to other states. Large crawfish are prized as a gourmet food item while smaller ones are in demand as bait. Red swamp crawfish are the traditional species to culture.

Requirements include relatively flat land with good water holding capacity and enough water to maintain 1 1/2 to 2 feet of water depth. Much labor is needed to harvest and reset traps each day for 4 to 7 months out of the year.

Australian crawfish, advertised as "marron" or "freshwater lobster," have been available for several years in this country. A permit to culture this species is needed in most states. To the best of our knowledge, no commercially successful production has been achieved in the U.S. These exotic crawfish are likely to be susceptible to the widespread crawfish fungus plague, to which our native species is resistant.

LaCaze, C. 1976. Crawfish farming. Fisheries Bulletin No. 7, Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA.

Louisiana Crawfish Farmers' Association. Proceedings of the 13th Annual Meeting, September 10, 1983, Baton Rouge, LA.

Hybrid Striped Bass

Demand for hybrid striped bass is high, especially on the east coast where the wild catch is declining and pollution problems worry consumers. The cross between white and striped bass has proven to be an excellent fish for pond culture in either fresh or brackish water. There is great interest in pond production of this species.

Hodson, R. G., and J. Jarvis. 1990. Raising hybrid striped bass in ponds. UNC Sea Grant Publication 90-05. North Carolina Sea State University, Raleigh, NC.

Redfish

Redfish can be grown in fresh or salt water. Production was moving to the commercial stage after a series of successful trials. However, market prices are not as attractive as they were several years ago, and the industry has been set back by the apparent susceptibility of redfish to extreme low temperatures.

Chamberlain, G. W., R. J. Miget and M. G. Haby, editors. 1990. Red drum aquaculture. Texas A & M Sea Grant Publication 90-603, Galveston, TX.

Shrimp

Marine penaeid shrimp are a luxury food for which Americans seem to have an ever growing hunger. To help satisfy this hunger, major corporations and private investors have built large shrimp farms in Central America, South America, and Asia where the tropical climate is favorable. In the continental U.S., South Carolina and Texas have commercial marine shrimp farms.

A species of freshwater shrimp, *Macrobrachium rosenbergii*, grows well at temperatures above 68 °F and salinities of up to eight parts per thousand. Heads are much larger than on marine shrimp and the flesh may be softer than marine shrimp, leading to some marketing difficulties. Because death occurs at temperatures below 50 °F, commercial potential for this species is limited, at best, to the southern states.

Chamberlain, G. W., M. G. Haby and R. J. Miget, editors. 1985. Texas shrimp farming manual. Texas Agricultural Extension Service Research and Extension Center, Corpus Christi, TX.

New, M. B., and S. Sigholka. 1982. Freshwater prawn farming. FAO Fisheries Technical Paper (225). Food and Agriculture Organization of the United Nations, Rome, Italy.

Sport Fish, Forage Fish Fingerlings, and Tilapia

Production of bass, bluegill, hybrid bluegill, and other fingerlings for stocking in private fishing ponds is a proven form of aquaculture that has been practiced for decades. Additional species that can be produced as forage for bass include shad and minnows. Production of these species involves natural spawning of brood stock in ponds, removal of brooders, and rearing of fingerlings in place. Because the production of fingerlings requires much care and skill, it is not recommended for those who have no experience in producing food fish.

Table 2. An informal summary of the aquaculture development potential of selected species in the near and long term.

	Short Term (to 2000)			Long Term (beyond 2000)		
Species	Low	Med	High	Low	Med	High
FRESHWATER FINFISH:						
Tilapia	x				x	
Trout			x			x
Largemouth Bass	x			x		
Striped Bass Hybrid		x				x
Channel Catfish			x			x
Baitfish		x			x	
SHELLFISH:						
Freshwater Prawns	x			x		
Hard Clam Hybrid			x			x
American Oyster	x			x		
Shrimp			x			x
Crawfish			x			x
MARINE FINFISH:						
Redfish	x			x		
Striped Bass Hybrid		x				x

Originally found in Africa and the Near East, many different species of tilapia have been introduced around the world because of their suitability for aquaculture. Tilapia hybrids have an excellent quality flesh that many people compare to crappie. They are tolerant of poor water quality conditions and grow well on low protein feeds. The leading technical problem in culturing tilapia is that they die when temperatures drop to about 50 °F. Because of this, brood stock or fingerlings must be overwintered in heated indoor tanks or small ponds fed by naturally warm well or spring water. Another serious problem is that many states prohibit or regulate this culture of the species.

Dupree, H. K., and J. V. Huner. 1984. Third report to the fish farmers. U.S. Fish and Wildlife Service, Washington, DC.

Trout

Culture of trout is a major form of aquaculture in Idaho, the Appalachians, and in the central U.S. These cold-water fish generally grow best at water temperatures between 55 and 65 °F and die when temperatures approach 70 °F. In warm-water areas, culture of rainbow trout in ponds during the winter months has been demonstrated.

Stevenson, J. P. 1987. Trout farming manual (second edition). Fishing News Books, Ltd. Farnham, Surrey, U.K.

Clams and Oysters

Shellfish are not currently produced in ponds. However, pond culture of shellfish may be successful under some conditions.

Hard clams (East and Gulf coasts) and manila clams (Pacific Northwest) are excellent candidates for aquaculture. Demand for clams is high and prices have increased due to a decline in production from natural stocks in many areas. Aquaculture technology for the hard and manila clams is well established, and profitability appears high.

Oysters are attracting commercial aquaculture attention. Oyster hatcheries are well established and growout operations are found on all coasts. Recently, several shrimp farmers have demonstrated the feasibility of raising oysters as a second crop in shrimp ponds. This approach may apply to salt-water fish ponds as well.

Castagna, M., and J. N. Kraeuter. 1984. Manual for growing the hard clam Mercenaria. Special report in applied marine science and ocean engineering, Virginia Institute of Marine Sciences Sea Grant Program, Gloucester Point, VA.

Magoon, C., and R. Vining. 1980. Introduction to shellfish aquaculture in the Puget Sound region. Washington Department of Natural Resources Handbook, Olympia, WA.

Water Quality

- One key to successful farming is an adequate supply of suitable water. Here are some water sources:
  - Wells are most desirable because of year-round availability and uniform quality; they are also free of fish that can transmit disease. Quantity may be limited.
  - Surface waters can supply large volumes but can act as a source of wild fish, disease, and chemical contamination.
- Be prepared to check water in fish ponds for these situations:
  - Oxygen — daily
  - Ammonia — every 7-10 days
  - pH — when ammonia is present
  - Nitrites — every 2-3 days
  - Chlorides — in fresh water when nitrites are present
  - Total Alkalinity — before stocking and any chemical pond treatment

Stocking

While production techniques differ with the species and the management system you choose, some examples of how to calculate important production variables are illustrated below.

Before stocking the pond, weigh and sample-count the stock so you can determine the number actually being stocked.

To determine number actually stocked, weigh out a sample of fish (1 to 10 lb) and count. Then calculate the total number of fish stocked with this formula:

Number of seed stocked

$$= \frac{\text{number in sample}}{\text{weight in sample}} \times \text{total weight in lb stocked}$$

For example:

Number of fish in sample = 266
Weight of fish sample = 5 lb
Total weight of fish = 85.5 lb

Thus, number stocked

$$= \frac{266 \text{ fish} \times 85.5 \text{ lb}}{5 \text{ lb}} = 4{,}548 \text{ fish}$$

To determine the weight of 1,000 fish, weigh and count sample of fish; then:

Weight of 1,000 fish

$$= \frac{\text{wt. of fish in sample in lb} \times 1{,}000}{\text{number of fish in sample}}$$

Diseases and Treatment

- Observe stock daily to see the first sign of a disease. Signs that fish or shrimp may be getting sick fall into two main categories:
  - Behavior — the way fish act, particularly a reduction in feeding activity, will often indicate the beginning of a disease. Odd behavior may also indicate a water quality problem.
  - Physical appearance — Check any abnormalities to see if a disease is starting.
- Anything that prevents stress will reduce the chance of an infectious disease.
  - Proper Nutrition — feed must contain all essential nutrients; feed the correct amount.
  - Proper handling reduces stress.
  - Prevent toxins, natural or introduced, from entering pond.
  - Maintain good water quality by preventing loss of oxygen or buildup of nitrite, ammonia, etc.

Feeding

- Feed size — Match feed size to fish/shrimp size.
- Quality of feed — Use complete feed with vitamins added.
- Feeding rates — There are several factors that control the amount of food that fish or shrimp will eat: temperature, water quality (oxygen, pH, ammonia, etc.), food size, palatability or taste of food, frequency of feeding, method of feeding, location of feeding sites, and whether floating or sinking pellets are used.

Adjust amount fed every two weeks by getting a sample of fish from the pond, weighing the sample, and counting the number in the sample. Then use the following formula to calculate the weight of food to feed per acre daily for the next 2 weeks.

Weight of feed needed daily per acre

$$= \frac{\text{wt. of sample} \times \text{no. stocked/acre}}{\text{number in sample}} \times \%\ \text{to feed}$$

Example:

Weight of sample = 20 lb
Number in sample = 100 fish
Number stocked per acre = 4,500 fish
% to feed daily = 3%

Weight of feed needed daily per acre

$$= \frac{20\ \text{lb} \times 4{,}500\ \text{fish}}{100\ \text{fish}} \times 0.03 = 27\ \text{lb feed needed/acre/day}$$

Recordkeeping is a must for good management. You can develop your own system or use the forms on page 14.

- Before treating fish for disease, there are several things you need to know:
  - What the disease is
  - Prognosis for treatment
  - Feasibility of treating in facility where fish are located
  - Economics of treating
  - Does loss rate warrant treatment?
- Before deciding on what treatment to use, you must know these things:
  - Water quality and how it will affect the treatment
  - Fish and how they will respond to the treatment
  - Chemical and its effectiveness in a particular situation
  - Disease and how it will respond to the treatment selected
  - Remember, types of chemicals and treatment rate will vary with species, size, and whether or not the fish are being raised for food.
- Calculation of Treatment Levels - Contact your Extension Service or Sea Grant Advisory Specialist for advice.

What To Do if Fish Get Sick

Know in advance who can provide a diagnosis. Submit sample of sick fish and water sample to the nearest diagnostic laboratory for a quick and accurate diagnosis. Select and ship samples according to instructions available from the laboratory, your county agent, or the Sea Grant Advisory Service.

Remember, identify who can provide diagnosis and treatment advice before you have a problem. Make sure you can ship the fish for diagnosis before you have a problem. Be prepared.

Control of Undesirable Fish

There are two ways to control undesirable fish in ponds:

- Completely eradicate all fish by one of these methods:
  - Drain and dry ponds
  - Rotenone — Use 3 pounds of 5% rotenone powder or 6 pints of 2.5% emulsifiable rotenone per acre foot of water. Use only when water temperature is above 70 °F (21.1 °C).
- Selectively remove scale fish.

Fintrol (Antimycin A) — Legal to use. Used at 1/5 the recommended rate is satisfactory and economical. Use early in the morning when pH is less than 8.5 to reduce cost of treating.

Aquatic Weed Control

- Avoid problems by proper pond management.
- Have problem weed identified by county agent.
- Calculate pond area and volume to be treated.
- Choose most economical and effective control method.
- Follow label instruction.

DAILY FEEDING RECORD

Week of ______ to ______

Pond #	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Total

WEEKLY POND RECORD

Week of ______ to ______

Pond # ______ Date Stocked ______ Weight of Fingerlings Stocked ______ Number of Fingerlings Stocked ______ Total Weight Stocked ______

Size ______ Acre ______

Estimated Conversion Ratio: ______ Total ______ Total ______

(1) Week Ended	(2) Lb Feed Fed	(3) Lb Gain	(4) Total Fish Wt	(5) Lb Harvested or Loss	(6) Price Rec'd Per lb	(7) Remarks (Treatments, Feed, Etc.)

RECAP & ADJUSTMENT CALCULATIONS FOR FEED FED

1. Beginning Feed Inventory = ______
2. Total Feed Purchased = ______
3. Ending Feed Inventory = ______
4. Feed Used (1 + 2 − 3) = ______
5. Total Feed Fed From Pond Records = ______
6. Correction Factor (4 ÷ 5) = ______

POND CONVERSION RATIO CALCULATIONS

Correction Factor — (C.F.) = ______

Pond #	(1) Est. Lb Feed Fed (Form 103)	(2) Actual Lb Feed Fed (1) × (C.F.)	(3) Total Stocking Wt	(4) Total Lb Harvested (Form 103)	(5) Conversion Ratio 2/(4 - 3)

Additional Information

There are four other volumes in the "Technology Transfer Series: Aquaculture in Dredged Material Containment Areas," published by the Mississippi Cooperative Extension Service and the Mississippi-Alabama Sea Grant Program. One, the "Containment Area Aquaculture Handbook" reviews all of the important aspects to consider when planning a DMCA aquaculture venture. The remaining volumes cover planning, design, and construction of facilities, economics and legal considerations in DMCA aquaculture. Please refer to these publications if you intend to pursue DMCA aquaculture further. There is an extensive library of aquaculture publications that can help you in deciding on species choices, management options and other factors.

Contact your state Cooperative Extension Service or the Sea Grant College Program for assistance in locating these publications. Ask for publications of the USDA Regional Aquaculture Centers in your area.

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