Spiny Lobster Mariculture in the State of Florida

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SPINY LOBSTER MARICULTURE
IN THE
STATE OF FLORIDA

by

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presented on
5/19/72

MASTER OF MARINE AFFAIRS
UNIV. OF RHODE ISLAND
PREFACE

It is not the purpose of this paper to reiterate the broad interrelationships of mariculture and society. There are some texts on that subject already such as *Mariculture (Sea Farming)* by Robert Landis. Surveying the status of aquaculture throughout the world is not the purpose either.

Nor is the purpose of this paper to go to the other extreme by creating a hypothetical private venture into spiny lobster mariculture and presenting the costs of equipment, personnel, etc. balanced against huge returns. The success or failure of a spiny lobster mariculture business will depend on the knowledge, hardwork, and ingenuity of its founder and some luck. But, an excellent list of considerations to be made before going into business copied from American Fish Farmer has been included in Appendix B.

The purpose of this paper is to introduce the reader to the Florida spiny lobster, *Panulirus argus*; to show the economic potential for the mariculture of this species by exposing value and size of the U. S. spiny lobster market; to present Florida's legal provisions for mariculture and how spiny lobster farming would be acceptable; to indicate the biological considerations for the rearing
of spiny lobster larva and postlarva; and to introduce a general plan for the mariculture of spiny lobster, applicable to the present and providing for the future, that considers the legal provisions of leasing wetlands in Florida and incorporates the biological considerations of spiny lobster.

Good statement of purpose!
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INTRODUCTION

"Though man has farmed land for ages, at sea he has merely hunted for food, catching what he can until the waters offer no more. By now over-fishing has taken a heavy toll, from which the sea may not be able to recover. Pollution of estuaries and filling-in of shorelines have further curtailed nature's bountiful supply of marine life. In general, man has depleted rather than enhanced the production of sea life. But we are now entering a new era - the era of mariculture - the saltwater farming of marine species from spawning to harvesting after being cultivated large enough to be marketable as food. Though still in its infancy, mariculture is under careful study today by scientists throughout the world. With a few exceptions, not enough is known yet about the complex life cycles and reproductive habits of most marine species to make widespread the commercial practice of mariculture. In due time, enough knowledge will certainly be acquired by the scientific community, but it will occur much more rapidly if a commercially successful example of sea farming paves the way."

Such was part of the keynote address to the first meeting of the World Mariculture Society in February, 1970 by Paul Bente, president of Marifarms, Inc. Several
months later, Marifarms harvested its first crop of shrimp, and their second crop the following year. This initial success of a commercial mariculture endeavor in Florida may be the stimulus that has been needed to initiate a more rapid development of commercial mariculture in the United States. Still questionable whether they'll be successful!

Florida's large shoreline, second only to Alaska, its warm and relatively constant climate, its seabed and water column leasing policies, and its clean and enriched Gulf and Gulf Stream waters make Florida an ideal state for mariculture. Furthermore, two excellent marine research facilities are located in Florida: the state Marine Research Laboratory in St. Petersburg and the Rosenstiel School of Marine and Atmospheric Science in Miami.

Of the many species of vertebrate and invertebrate animals that could be farmed in Florida's marine waters, the spiny lobster may have the best potential for future mariculture. Before examining the potential and problems of spiny lobster farming in Florida, one should briefly look at its biology.
BIOLOGY OF THE SPINY LOBSTER

The Florida spiny lobster, *Panulirus argus*, (Fig. 1A) belongs to the family, Palinuridae, that contains about 30 other species of lobster. About one-half of these species are of commercial value. Those found on the U.S. market besides *P. argus* are *P. interrupta* (Pacific coast of the U.S.), *P. laevicanda* (Brazil), and *Jasus islandicus islandicus* (South Africa, Australia, New Zealand) (Chace and Dumont, 1949; Burtis et al., 1957).

Mature spiny lobsters are nocturnal, seeking shelter during the day beneath coral, rocks, sponges, or other objects offering protection. When escaping enemies spiny lobsters swim very rapidly, but when not endangered they generally walk. Trains of migrating spiny lobsters have been observed (Herrnkind and Cummings, 1964).

Spiny lobsters are scavengers but prefer live food such as fish, worms, mollusks, and other crustaceans. When food is scarce or when their diet lacks calcium carbonate, they become cannibalistic (Dees, 1963; Crawford and DeSmit, 1922).

The growth rate of *P. argus* has long been a matter of speculation and study. Studies have shown that growth depends upon the frequency of molting, and consequently varies with age, abundance of food, and water temperature.
The young generally increase in length more rapidly than the adults. Spiny lobsters are believed to take 3 to 5 years to reach maturity or 9 inches in total length, at which time they weigh approximately one pound.

The primary feature that distinguishes the sexes is that the fifth pair of legs of the female have small pincers which are lacking in the male. Furthermore, there is sexual dimorphism in their weight vs. length relationship (Creaser, 1952). Females are thought to spawn every year and some of them may breed twice in one season. The female may produce anywhere from 50,000 to 2,500,000 eggs depending on her size (Creaser, 1950; Dees, 1963).

In approximately three weeks, the eggs hatch into nearly transparent phyllosoma larva (Fig. 1B). The larva pass through 11 molts in 6 to 7 months (Lewis, 1951; Sims and Ingle, 1967). As larva they make up part of the pelagic zooplankton. After their eleventh molt, they settle to the bottom as post-larval or juvenile lobsters. Lengths of larval and post-larval stages are shown in Figure 2. Juvenile spiny lobsters have been observed to have a possible symbiotic relationship with sponges (Khandker, 1964) and spiny sea urchins (Davis, 1971).

Most P. argus phyllosoma larva are lost to the elements or are eaten by plankton feeders. Juveniles are eaten by fish and other crustaceans; adults by larger fish and man.
ECONOMIC POTENTIAL FOR SPINY LOBSTER MARICULTURE

The economic criteria for evaluating the potential of a species for mariculture are its market volume and price. For the success of a mariculture venture in the United States, the product must not only have a relatively high volume; but more important, it must be in the high price or so-called luxury category. Spiny lobster easily fulfills both requirements.

Spiny lobster is near the top of the luxury seafood price list. Its price per pound exceeds that for shrimp, northern lobster, and sea scallops. The average wholesale price for a pound of spiny lobster tail has risen from $1.07 in 1960 to $2.12 in 1970 - doubling its value in 10 years. In November 1970, a record peak of $3.16 per pound was reached (Surdi and Whitaker, 1970).

Also, the market volume of spiny lobster has risen. Apparent consumption of spiny lobster tails was a record 35.7 million pounds during 1970 - 14 percent above the 1965 - 69 average (Surdi and Whitaker, 1970).

Total market value, the product of the market volume and price, is a useful measure for viewing these two criteria together. In this light, spiny lobster exceeds

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1. Spiny lobster in this discussion refers to the total of all species on the U. S. market unless otherwise indicated.
2. Warm water species.
all other fishery markets except shrimp (Table 1.)

A substantial percent of many seafoods on the U. S.
market is imported. At the top of the list is spiny
lobster. Approximately 95 percent of this lobster, eaten
in the United States from 1959 to 1970, was imported
(Table 2.). Concern over the large importation of South
African spiny lobsters was expressed over 20 years ago
(Kahn, 1949). Today, these imports also come from Brazil,
Australia, and New Zealand. In recent years, the import
of spiny lobster represents a drain of well over 50 million
dollars per annum.

Like other seafood markets, that of the spiny lobster
could be expanded by use of sales promotions, advertising,
and merchandising (Haberichter, 1968). Not only spiny
lobster, but all aquaculture products have two beneficial
influences on their own marketability. Freshness is very
important in seafoods. With aquaculture, the time between
catching and processing is reduced, thereby producing a
very fresh product. Such products last longer and get
higher market values. Secondly, aquaculture can be used
to produce a relatively constant year-round supply of a
product. With such a supply, larger food merchandising
firms can distribute and market the product. For spiny
lobster, the most successful areas for household market
development appears to be the central and Pacific states. (Table 3.).

Aside from human consumption, there is another market for spiny lobster, the bait industry. Years ago, Crawford (1922) estimated that one-half of all spiny lobsters caught were used for bait. He goes on to say that a dollar's worth (dozen) of spiny lobsters, that had died before the fisherman could market them, could usually net the fisherman $10 worth of fish. This market possibly still exists, if not, it could be recreated.

In summary, it is obvious that there is a very valuable market available to spiny lobster mariculture. Almost all of this market is supplied by imports. Therefore, a spiny lobster mariculture industry in the United States would help correct the U. S. balance of payments.
FLORIDA'S LEGAL PROVISIONS FOR MARICULTURE

Mariculture of any species using public waters requires laws to facilitate its peaceful introduction into our society. Requiring some degree of exclusive use of water areas, mariculture will naturally conflict with other interests such as navigation, sport and commercial fishing, recreation, and water quality. Therefore, new laws may be necessary for the existence of mariculture (Kane, 1970).

Leasing public waters and/or their bottoms for mariculture is practically impossible under the present laws of many coastal states. Florida is an exception. Since 1881, Florida has been leasing bay bottoms for oyster and clam culture (Shields, 1970) and believes that the future of her oyster industry lies in the ownership and cultivation of private oyster leases (Ingle, 1962). Furthermore, Florida was the first coastal state to adopt legislation authorizing the use of the water column for aquaculture. A copy of this bill and its associated lease guidelines can be found in Appendix A.

Cowan (1971) advanced inadequacies of the law in dealing with conflicting interests and said that unless amended, the law and guidelines would be an inviting target for legal attack. The first attack was made soon after
Florida leased 2,500 acres of wetland to Marifarms, Inc. The Organized Fisherman of Florida, a commercial fishermen's association, filed suit against the State of Florida and Marifarms, charging that the leasing was contrary to the public interest (Cowan, 1971). On December 22, 1971, the Circuit Court of Leon County, Florida ruled in favor of the leasing (Gross, 1972). Therefore, the court upheld Florida's aquaculture law and its associated lease guidelines.

Although spiny lobster mariculture would necessitate more restrictions on the public use of leased areas than does oyster farming, it could require less restrictions than does shrimp farming. The plan for spiny lobster farming, proposed later in this paper, would only require the prohibition of SCUBA diving, anchoring, trawling, and of course the dumping of wastes. The method proposed would enable the public to have continued use of the area for navigation, sport fishing (fishermen would have a greater chance of losing their tackle), and other activities not involving use of the bottom and a few feet of the water column above the bottom. Therefore, wetland leases for spiny lobster mariculture should be easier to obtain than leases for the raising of animals, such as
shrimp, that would require more restrictions on the public use of the wetlands.

Also, Dr. Robert Ingle of the Florida Department of Natural Resources hopes that they will be able to revise the law so that some of the existing procedural difficulties for aquaculture leasing can be overcome (Hull, 1972).
BIOLOGICAL CONSIDERATIONS IN SPINY LOBSTER MARICULTURE

Any plan to cultivate a marine species must take into account needs of the organism that are rigidly established by its physiological apparatus. Facilities and techniques consonant with its unique life history features must also be provided. For example, temperature requirements for optimum growth, spawning, and survival are programmed in basic biochemistry and if other temperatures are experienced, vital physiological mechanisms may be deleteriously affected. Also, if some peculiar need of a species is not satisfied during a part of its life cycle, optimum development may be interfered with or death may ensue (Ingle and Witham, 1969).

In traditional artificial cultivation activities certain individuals are permitted to reproduce or are stimulated to do so. The resulting eggs and immature stages are then protected from pathogenic organisms, food is provided, and isolation is provided against predators. All of this is carried out in a milieu of compatible physical and chemical conditions. In due time the animals are harvested, having reached a desired growth and condition through the indulgent care and protection they have received (Ingle and Witham, 1969).

Those who would attempt to employ this program with
spiny lobsters would quickly encounter enormous difficulties. The distinguishing and in many ways the most dominant feature of spiny lobster biology is its long larval life. Their requirements are sufficiently exquisite that, to date, although competent people have repeatedly tried in several parts of the world, no one has been able to rear them through to the metamorphosis stage. (Ingle and Witham, 1969).

That is, no successful rearing of Panulirus argus from egg to puerulus (first stage postlarva) has been published! But, I believe that one or two individuals in Florida have reared the spiny lobster from egg to the puerulus, if not beyond; getting to the puerulus is the hard part. My reasons for this belief are as follows.

First, the only published works on the rearing of P. argus phyllosoma that I have been able to find, or find referenced, are Crawford (1922), Crawford and DeSmidt (1922), and Lewis (1951). They were all able to hatch the eggs but could not keep them alive long enough to even molt once. Abrupt change in water temperature was the reason for Crawford and DeSmidt's failure of 50 years ago. Lewis gives no description of his techniques or reason for their death. I can not believe that no one has tried within the last twenty years without some degree
of success in view of what has been done with other species of lobster. Furthermore, the knowledge, equipment, and techniques of culturing organisms has definitely improved within the past 20 years. Still, a rather tenuous foundation for advocating a full-scale commercial enterprise.

Second; the northern lobster, *Homerus americanus*, has been successfully reared for twenty years in Massachusetts (Hughes, 1962). Primarily through temperature control and feeding, Hughes has been able to rear lobsters from egg to market size in 18 months; under natural conditions it may take from 5 to 8 years. (Shleser, 1972). Granted, *H. americanus* and its larva are different than *P. argus* and its larva, but I think there is a greater difference in the rearing techniques of Hughes vs. all that have worked with the spiny lobster. Hughes provided his lobster with the optimum water conditions continuously, and with food of their liking; whereas, those working with spiny lobster made little or no effort to control water temperature or salinity simply used that water which happened to be available and in one instance unsuccessfully tried to feed the lobster cat and dog food and chocolate. (wow!)

Third; the Japanese have been progressively improving their techniques and therefore obtaining better results in rearing their spiny lobster, *Panulirus japonicus*. Being of the same genera as *P. argus*, their larval morph-
ology and physiology are very similar. The results of some of these rearings are as follows:

Inoue and Nonaka (1963) 6 successive molts,
Saisho (1962) 10 successive molts,
Saisho (1966) 12 successive molts.

Also another similar species, Panulirus longipes, was raised through 3 successive molts (Saisho and Nakahara, 1960). Since P. japonicus is believed to have 14 phyllosoma stages before the puerulus (Inoue and Nonaka, 1963), they did not have much farther to go in 1966. At the rate that they were advancing, they have probably carried P. japonicus all the way through and beyond the puerulus.

Last; one of this country's leading experts on decapod (includes spiny lobster) larva culture has gone into private business. The details are not known but the business is related to his expertise (Beardsley, 1972).

Adding these four things together sums up to my belief that spiny lobster has been or is being reared from the egg on up. Work with and beyond the puerulus is rather complete and documented (Table 4.).

Even if it is now biologically possible to culture spiny lobster larva as I have strongly suggested, for mariculture purposes the method is probably not economically feasible. But, there is an alternative means of farming
spiny lobster not involving the phyllosoma larva (Ingle and Witham, 1969). This method simply combines "fishing" with mariculture. Spiny lobster puerula and early postlarva are caught then contained in an area where they are reared until marketable. With the present knowledge on the environmental needs, diseases, etc. of the postlarva and adult spiny lobster, this method is biologically feasible. Furthermore, such a method is successfully used in Scotland catching only adult lobster (Mundey, 1969; Bowbeer, 1971).
GENERAL PLAN FOR SPINY LOBSTER MARICULTURE

This plan consists of seven systems; three of which could presently be put into operation with the other four added when science and technology make it possible and economically feasible (Figure 3.)

The systems for the present are based on Ingle and Witham's suggestions but with some modification and additions. The first system is postlarva collecting. This would involve the use of Witham habitats or other suitable devices for catching the postlarva plus a means for transporting them to the next system. The second system is for the rearing of the postlarva. Unlike Ingle and Witham, I suggest rearing the postlarva in land based facilities. Here, they could be raised in physical isolation of each other and under controlled environmental conditions and feeding. As found with other species, such methods decrease the mortality and increase the rate of growth. When these juvenile spiny lobsters obtain a certain size, they are transferred into the adult rearing system located in leased wetlands. This system involves the use of large cages or fully enclosed pens only a foot or two in height. Provisions to supplement the natural food supply would have to be considered.

The systems to be added on at some future date in-
volve the breeding of adults, the hatching of eggs, and the rearing of larvae. At first an additional system to supply gravid females and adults for breeding may be necessary. These future systems, except of course adult catching, would be land based so that optimum conditions could be provided at these critical stages of the spiny lobster's life cycle. Adult collecting and postlarve collecting systems would be phased out as the mariculture operation becomes able to rear spiny lobsters through their entire life cycle.
CONCLUSION

The following conclusions can be made about the potential for spiny lobster mariculture in Florida.

1. The demand for spiny lobster in the U.S. is more than adequate to make a venture into spiny lobster mariculture worthwhile.

2. Florida law provides for the leasing of public wetlands for aquaculture purposes. Leases for spiny lobster farming should be easier to obtain than the leases for shrimp farming that have already been obtained under this law.

3. Until the culture of spiny lobster larvae is both biologically possible and economically feasible, farming of this species will have to be done by raising postlarvae that have been captured. A similar method of farming lobster has been successful in Scotland.
REFERENCES CITED


Crawford, D. R., 1922, Spawning habits of the spiny lobster (Panulirus argus), with notes on artificial hatching, Trans. Am. Fish. Soc. 50: 312-319.


Huguenin, J., 1972, Aquaculture presentation in marine affairs seminar, Univ. Rhode Island.

Hull, E. W. S., 1972, Mariculture vs. coastal zone law and planning, Coastal Zone Management 3(2): 1-3.


TELEPHONE CALLS

Beardsley, G., 5/12/72, Univ. Miami
Ms. Gross, 5/16/72, Marifarms, Inc.
Figure 1. An adult Panulirus argus copied from Chace and Dumont (1949) and its first stage phyllosoma larva from Crawford and DeSmidt (1922).
Figure 2. Total length growth of P. argus phyllosoma and postlarva vs. time and molts: A. from Lewis (1951), B. from Sweat (1968), and C. from Witham et al. (1968). When carapace length was given in the reference, the value was multiplied by 3 to get total length.
Figure 3. A schematic representation of the three systems that could presently be put into operation. An overleaf shows the future additions.
Table 1. - U. S. market of the top eight fisheries based on total market value; percent import of each fishery based on weight.

<table>
<thead>
<tr>
<th>Fishery</th>
<th>$million/yr.</th>
<th>% imported</th>
</tr>
</thead>
<tbody>
<tr>
<td>shrimp</td>
<td>200</td>
<td>60</td>
</tr>
<tr>
<td>spiny lobster</td>
<td>75</td>
<td>90</td>
</tr>
<tr>
<td>tuna</td>
<td>65</td>
<td>40</td>
</tr>
<tr>
<td>northern lobster</td>
<td>42</td>
<td>39</td>
</tr>
<tr>
<td>crabs</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>oysters</td>
<td>32</td>
<td>10</td>
</tr>
<tr>
<td>menhaden</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>scallops</td>
<td>25</td>
<td>40</td>
</tr>
</tbody>
</table>

* This table was presented by John Huguenin at a Marine Affairs seminar at the Univ. of Rhode Island on 5/10/72. The spiny lobster percent was originally given as 70 which was not calculated properly. He had used the total weight of the domestic supply and the tail weight of the imports.
Table 2. - Tail weights (millions of pounds) of domestic and imported spiny lobster supplied to the U. S. from 1959 to 1970.

<table>
<thead>
<tr>
<th>Year</th>
<th>Domestic</th>
<th>Imports</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1959</td>
<td>1.1</td>
<td>28.1</td>
<td>29.2</td>
</tr>
<tr>
<td>1960</td>
<td>1.0</td>
<td>27.9</td>
<td>28.9</td>
</tr>
<tr>
<td>1961</td>
<td>1.0</td>
<td>26.6</td>
<td>27.6</td>
</tr>
<tr>
<td>1962</td>
<td>1.1</td>
<td>31.3</td>
<td>32.4</td>
</tr>
<tr>
<td>1963</td>
<td>1.3</td>
<td>28.8</td>
<td>30.1</td>
</tr>
<tr>
<td>1964</td>
<td>1.2</td>
<td>29.3</td>
<td>30.5</td>
</tr>
<tr>
<td>1965</td>
<td>1.9</td>
<td>30.4</td>
<td>32.3</td>
</tr>
<tr>
<td>1966</td>
<td>1.8</td>
<td>29.3</td>
<td>31.1</td>
</tr>
<tr>
<td>1967</td>
<td>1.5</td>
<td>27.3</td>
<td>28.8</td>
</tr>
<tr>
<td>1968</td>
<td>2.3</td>
<td>35.8</td>
<td>38.1</td>
</tr>
<tr>
<td>1969</td>
<td>2.4</td>
<td>37.3</td>
<td>39.7</td>
</tr>
<tr>
<td>1970</td>
<td>3.1</td>
<td>32.5</td>
<td>35.6</td>
</tr>
<tr>
<td>average</td>
<td>1.6 (5%)</td>
<td>30.4 (95%)</td>
<td>32.0</td>
</tr>
</tbody>
</table>

* Data for this table was gotten from Surdi and Whitaker (1971) and Fisheries of the United States, 1970. Tail weight is 33.3% of round weight (Erickson, 1970).
<table>
<thead>
<tr>
<th>POPULATION:</th>
<th>New England</th>
<th>Middle Atlantic</th>
<th>E. North Central</th>
<th>W. North Central</th>
<th>South Atlantic</th>
<th>E. South Central</th>
<th>W. South Central</th>
<th>Mountain</th>
<th>Pacific</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Thousands)</td>
<td>11,466</td>
<td>17,742</td>
<td>39,719</td>
<td>16,206</td>
<td>30,145</td>
<td>13,054</td>
<td>19,317</td>
<td>8,102</td>
<td>26,095</td>
<td>201,406</td>
</tr>
<tr>
<td>%</td>
<td>5.67</td>
<td>18.49</td>
<td>19.74</td>
<td>8.04</td>
<td>14.96</td>
<td>6.68</td>
<td>9.60</td>
<td>4.02</td>
<td>12.93</td>
<td>100.0</td>
</tr>
</tbody>
</table>

**CONSUMPTION:**

**Shrimp:**
- Per capita: 0.998
- Total: 11,443

**Oysters:**
- Per capita: 0.125
- Total: 1,432

**Crab:**
- Per capita: 0.161
- Total: 1,846

**Lobster:**
- Per capita: 1.895
- Total: 21,228

**Lobster tails:**
- Per capita: 0.052
- Total: 596

**Clams:**
- Per capita: 0.649
- Total: 7,441

**Scallops:**
- Per capita: 0.275
- Total: 3,153

**Other shellfish:**
- Per capita: 0.009
- Total: 103

**Total shellfish:**
- Per capita: 14,164
- Total: 47,744

**Total fish:**
- Per capita: 3,802
- Total: 66,526

**Total shellfish and finfish:**
- Per capita: 8,966
- Total: 114,270

**Total canned fish:**
- Per capita: 6.977
- Total: 65,029

**Total shellfish, finfish and canned fish (includes specialty items not shown):**
- Per capita: 17.609
- Total: 201,705

* Per capita consumption in pounds, total in thousands of pounds.

* Table from Miller and Nash (1971).
Table 4. - Results of research on spiny lobster 
puerula and postlarva.

<table>
<thead>
<tr>
<th>INVESTIGATOR</th>
<th>SIZE (mm)</th>
<th>MOLTINGS no.</th>
<th>dur. (dy)</th>
<th>OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lewis 1952</td>
<td>18-54</td>
<td>6</td>
<td>33</td>
<td>est. 10 molts/year</td>
</tr>
<tr>
<td>Travis 1954</td>
<td>60-276</td>
<td>5+</td>
<td>60-90</td>
<td>est. 3-5 molts/year</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>26-30°C optimum for molting varied temperature</td>
</tr>
<tr>
<td>Sutcliff 1957</td>
<td>60-90</td>
<td></td>
<td></td>
<td>kept 19 for 2 weeks</td>
</tr>
<tr>
<td>Sweat 1958</td>
<td>17-85</td>
<td>15+</td>
<td>20-100</td>
<td>dur. til molt fun. size kept for approx. 2 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>19-29°C.; 34-49%</td>
</tr>
<tr>
<td>Witham et al.1958</td>
<td>17-132</td>
<td>7+</td>
<td>30</td>
<td>mass rearing experiments</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16-30°C.; 26-35%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>below 19% fatal</td>
</tr>
</tbody>
</table>
APPENDIX A.

* copied from Cowan (1971)
CHAPTER 69-46

Committee Substitute for House Bill No. 526

AN ACT relating to submerged lands; amending chapter 253, Florida Statutes, by adding sections 253.67, 253.68, 253.69, 253.70, 253.71, 253.72, 253.73, 253.74, and 253.75; authorizing the Trustees of the Internal Improvement Fund to lease submerged lands and the water above to persons desiring to engage in aquaculture activities; prescribing procedures; prescribing the essential features of lease contracts; providing penalties; authorizing the trustees to adopt rules and regulations; requiring the trustees to request recommendations from the Board of Conservation or Game and Fresh Water Fish Commission prior to granting a lease; authorizing the Board of Conservation and Game and Fresh Water Fish Commission to designate areas of state-owned submerged land for which they recommend reservation for uses that are possibly inconsistent with aquaculture activities; directing the Board of Conservation and Game and Fresh Water Fish Commission to supervise and report on the operations of lessees; providing an effective date.

Be it Enacted by the Legislature of the State of Florida:

Section 1. Chapter 253, Florida Statutes, is amended by adding sections 253.67, 253.68, 253.69, 253.70, 253.71, 253.72, 253.73, 253.74, and 253.75 to read:

253.67 Definitions.--As used in this act:

(1) "Aquaculture" means the cultivation of animal and plant life in a water environment.

(2) "Water column" means the vertical extent of water, including the surface thereof, above a designated area of submerged bottom land.

(3) "Board" means the State Board of Conservation.

(4) "Trustees" means the Trustees of the Internal Improvement Fund.

253.68 Authority to lease submerged land and water column.--To the extent that it is not contrary to the public interest, and subject to limitations contained in this act, the trustees may lease submerged lands to which they have title for the conduct of aquaculture activities and grant exclusive use of the bottom and the water column to the extent required by such activities. Such leases may authorize use of the submerged land and water column for either commercial or experimental purposes. Provided
however that no lease shall be granted by the trustees when there is filed with them a resolution of objection adopted by a majority of the county commission of a county within whose boundaries the same were extended to the extent of the interest of the state the proposed leased area would lie. Said resolution shall be filed with the trustees within 30 days of the date of the first publication of notice as required by section 253.70, Florida Statutes.

Prior to the granting of any such leases the Trustees shall establish and publish a list of guidelines to be followed when considering applications for lease. Such guidelines shall be designed to protect the public's interest in submerged lands and the publicly owned water column.

253.69 Application to lease submerged land and water column.--Any applicant desiring to lease a portion of the submerged lands of this state for the purpose of conducting aquaculture activities shall file with the trustees a written application in such form as they may prescribe, setting forth the following information:

(1) The name and address of the applicant.

(2) A reasonably concise description of the location and amount of submerged land desired and either:

(a) Attaching a map or plat of a survey of such lands; or

(b) Enclosing a sum sufficient to defray the cost of such survey as estimated by the board.

(3) A description of the aquaculture activities to be conducted, including a specification whether such activities are to be experimental or commercial and an assessment of the current capability of the applicant to carry on such activities.

(4) Such other information as the trustees may by regulation require.

253.70 Public notice and hearings.--

(1) Upon receiving an application under this act that satisfactorily sets forth the information required by section 253.69, Florida Statutes, the trustees shall give notice of the application by publication in a newspaper published in the county in which the submerged lands are located not less than once a week for three (3) consecutive weeks and mail copies of such notice by certified or registered mail to each riparian owner of upland lying within one thousand (1,000) feet of the submerged land proposed to be leased, addressed to such owner as his name and address appears on the latest county tax assessment roll.
(2) If no written objections are filed within thirty (30) days after the date of first publication of the notice and if the trustees find that the proposed lease is not incompatible with the public interest, the trustees have authority to consummate the lease contract as hereinafter provided. However, failure to mail the notice to the riparian upland owners shall not invalidate such lease.

(3) If written objections are filed, the trustees or their designee shall hear and consider the same at a public hearing which shall be held in the county from which the application was received. Timely notice of such hearing shall be given by at least one (1) publication in a newspaper published in the county in which the submerged lands are located and by certified or registered mail to each riparian owner of upland lying within one thousand (1,000) feet of the submerged land proposed to be leased, addressed to such owner as his name and address appears on the latest county tax assessment roll.

253.71 The lease contract.--When the trustees have determined that the proposed lease is not incompatible with the public interest and that the applicant has demonstrated his capacity to perform the operations upon which the application is based, they may proceed to consummate a lease contract having the following features in addition to others deemed desirable by the trustees:

(1) TERM.--The maximum initial terms shall be twelve (12) years for commercial leases and five (5) years for experimental leases, ten years. Leases shall be renewable for successive terms up to the same maximums upon agreement of the parties. However, before renewing the term of any lease, the trustee shall invite objections by following the publication procedures of section 253.70, Florida Statutes.

(2) RENTAL FEES.--

(a) The lease contract shall specify such amount of rental per acre of leased bottom as may be agreed to by the parties and shall take the form of:

1. Fixed rental to be paid throughout the term of the lease; or

2. A basic rental charge which will be supplemented by royalties after the productivity of the aquaculture enterprise has been established.

(b) In setting the amount of the rental charge or royalties the trustees shall consider such factors as the probable rates of productivity and the marketability and value of the product of the enterprise.

(c) All leases shall stipulate for the payment of the annual rental in advance on or before January 1. Failure of the lessee to pay such rent
within thirty (30) days of such date shall constitute ground for cancellation of the lease and forfeiture to the state of all works, improvements, and animal and plant life in and upon the leased land and water column.

(d) No taxes, assessments, or licenses other than those imposed or authorized by this act shall be levied or imposed on said leases or leased lands, but the annual rent or royalties exacted and paid shall be held and considered all that can be exacted by the state or any of its instrumentalities, including municipalities.

(d) At periodic intervals, not less frequent than annually the lessee shall file with the trustees a certified balance sheet and profit and loss statement showing in detail all expenses paid and all receipts from its activities under the lease.

(3) MAXIMUM AREA TO BE LEASED.--The trustees shall not lease a larger area of submerged land to any single lessee than has been demonstrated to be within his capacity to utilize efficiently and consistently consistent with the public interest. However, the trustees may hold a reasonable area of adjacent bottom land in reserve for the time when a holder of an experimental lease will begin operation under a commercial lease. Successful conduct of aquaculture activities on an experimental basis may be accepted as a demonstration of capacity to conduct such operations on a commercial basis.

(4) PERFORMANCE REQUIREMENTS; BOND. Failure of the lessee to perform substantially the aquaculture activities for which the lease was granted shall constitute ground for cancellation of the lease and forfeiture to the state of all the works, improvements, and animal and plant life in and upon the leased land and water column. In addition, the trustees shall require execution of a bond in an amount and with a surety satisfactory to them and conditioned upon the active pursuit of the aquaculture activities specified in the lease.

(5) DISPOSITION OF IMPROVEMENTS AT TERMINATION OF CONTRACT.--Each contract entered into under this act shall stipulate the disposition of improvements and assets upon the leased lands and waters, including animal and plant life resulting from aquaculture activities.

(6) ASSIGNABILITY OF LEASES.--Leases granted under this act shall be assignable in whole or in part with the approval of the trustees.

253.72 Marking of leased areas; restrictions on public use.--

(1) The trustees shall require all lessees to stake off and mark the areas under lease by appropriate ranges, monuments, stakes, buoys, and fences, so placed as not to interfere unnecessarily with navigation and other traditional uses of the surface. All lessees shall cause the area
under lease and the names of the lessees to be shown by signs appropriately placed pursuant to regulations of the trustees.

(2) Except to the extent necessary to permit the effective development of the species of animal or plant life being cultivated by the lessee, the public shall be provided with means of reasonable ingress and egress to and from the leased area for traditional water activities such as boating, swimming, and fishing. All limitations upon the use by the public of the areas under lease that are authorized by the terms of the lease shall be clearly posted by the lessee pursuant to regulations by the trustees. Any person wilfully violating posted restrictions shall be guilty of trespass and shall be punished by imprisonment for not more than sixty (60) days or by fine not exceeding fifty dollars ($50), or both.

253.73 Rules and regulations.--Subject to the requirements of chapter 120, Florida Statutes, the trustees may adopt rules and regulations necessary and appropriate to carry out the provisions of this act.

253.74 (Penalty) Penalties.--

(1) Any person who conducts aquaculture activities in excess of those authorized by lease agreement with the trustees or who conducts such activities on state-owned submerged lands without having previously leased the same shall be guilty of a misdemeanor and subject to imprisonment for not more than six (6) months or fine of not more than one thousand dollars ($1,000), or both. In addition to such fine and/or imprisonment, all works, improvements, animal and plant life involved in the project, may be forfeited to the state.

(2) Any person who is found by the Board or the Air and Water Pollution Control Commission to have violated the provisions of chapter 403, Florida Statutes, shall be subject to having his lease of state owned submerged lands cancelled.

253.75 Studies and recommendations by the board and the Game and Fresh Water Fish Commission; designation of recommended traditional and other use zones; supervision of aquaculture operations.--

(1) Prior to the granting of any lease under this act, the trustees shall request a recommendation by the board, when the application relates to tidal bottoms, and by the Game and Fresh Water Fish Commission, when the application relates to bottom land covered by fresh water. Such recommendations shall be based on such factors as an assessment of the probable effect of the proposed leasing arrangement on the lawful rights of riparian owners, navigation, commercial and sport fishing, and the conservation of fish or other wildlife or other natural resources, including beaches and shores.
(2) The board and the Game and Fresh Water Fish Commission shall both have the following responsibilities with respect to submerged land and water column falling within their respective jurisdictions:

(a) To undertake, or cause to be undertaken, the studies and surveys necessary to support their respective recommendations to the trustees;

(b) To institute procedures for supervising the aquaculture activities of lessees holding under this act and reporting thereon from time to time to the trustees; and

(c) To designate in advance areas of submerged land and water column owned by the state for which they recommend reservation for uses that may possibly be inconsistent with the conduct of aquaculture activities. Such uses shall include, but not be limited to, recreational, commercial and sport fishing and other traditional uses, exploration for petroleum and other minerals, and scientific instrumentation. The existence of such designated areas shall be considered by the trustees in granting leases under this act.

Section 2. This act shall take effect immediately upon becoming a law.

Approved by the Governor June 4, 1969.

Filed in Office Secretary of State June 4, 1969.
AQUACULTURE LEASE GUIDELINES: State of Florida

1. The proposed use of the leased lands shall have no appreciable detrimental effect on any existing industry.

2. The proposed use of the leased lands shall have no permanent effect on the wildlife or ecology of the leased lands, and surrounding areas.

3. The wildlife and ecology of the leased lands must be able to be naturally restored within one year of the termination of the lease.

4. No lease shall be made without an opportunity provided for competitive bidding among prospective lessees, similar to the bidding outlined in Ch. 253.54, F. S., (concerning oil and gas leases).

5. The Department of Natural Resources shall make a survey of each site as required by Sec. 253.75, F.S., that is the subject of an application to lease. Based upon the survey data, an estimate will be made of the quantity of marine resources that will be forfeited by the general public to the private lessee. In those cases where the surveys indicate that the resources that would be denied to the public by exclusive lease are substantial enough to require restitution, the Board may require the lessee to perform rehabilitation, stocking or other remedial projects as would tend to improve the marine productivity diminished for the general public by the lease concerned.

6. The findings and conclusions of such survey shall be permanently filed as public information with the State of Florida Board of Trustees of the Internal Improvement Trust Fund.

7. Only that amount of the bay bottoms in any County will be leased which shall be considered reasonable and fair as determined by the Board.

8. The maximum initial terms shall be ten (10) years with leases renewable for successive ten (10) year periods upon agreement of the parties.

9. A basic rental charge which will be supplemented by royalties after the productivity of the aquaculture enterprise has been established.

The lessee shall maintain adequate accounting records of their operations. Annual statements of financial position and net income shall be prepared by the lessee and audited by a certified public accountant.

After the initial year of operations, a review of the lessee's financial statements shall be made by the lessor.
Following each year of operation under the lease, the lessee shall forward to the lessor a statement of gross receipts audited by a certified public accountant.

10. All leases shall be subject to cancellation by the Board in the event the cultivation of animal and plant life within the leased area or areas ceases to be actively pursued.

11. All leases to contain a clause holding the Board and the State harmless.

12. Written approval from the upland riparian owner or owners must be filed with the Board prior to issuance of proposed lease.

13. Leased area or areas will be marked and identified as follows:

   Along the shoreline boundaries of each leased area, the lessee shall place at least one (1) sign every 1,000 feet, and additionally at every location on the shoreline where the public is afforded access to the sovereignty waters under lease.

   Where the leased area is enclosed by a net, fence or other type of enclosure, the lessee shall place along said enclosure at least one sign every 1,000 feet. When the enclosure is less than 1,000 feet in length, a sign shall be located at each end of said enclosure and at the midway point between the ends.

   At least one opening shall be provided for by the lessee to allow ingress and egress by the public to and from each leased area for water activities, such as boating, swimming and fishing. Said opening or openings shall be appropriately marked and identified.

   All signs required above are to be a minimum of 4 feet high and 6 feet long, of a durable material, and erected in such a manner above the average high water level to be clearly visible to the general public.

   Each sign shall be conspicuously lettered as follows:

   **RESTRICTED**

   Aquaculture Area

   Leased to (lessee)

   By

   State of Florida Board of Trustees of the Internal Improvement Trust Fund
and each sign shall also be lettered to reflect any restriction on public use authorized by the Board of Trustees of the Internal Improvement Trust Fund.

Each lease area shall also be marked in accordance with U. S. Coast Guard and U. S. Army Corps of Engineers regulation concerning structures in navigable waters.

August 26, 1969
APPENDIX B.

* copied from Jones (1970)
FISH FARMING CHECKLIST

INFORMATION SOURCES

Personal Contacts
1. Federal and state agencies.
2. Universities and colleges.
3. Fish farming associations (state and national).
4. Professional consultants, fish farmers, food distributors, merchandisers.
5. Feed company research departments.

Publications and Printed Materials
1. Federal, state, university and FAO publications and reports.
2. Industry journals and magazines.
3. Popular and professional books and pamphlets on pertinent subject matter.
4. Research reports.

ECONOMICS, MANAGEMENT AND MARKETING

Regulations and Laws on Aquaculture Production and Merchandising
1. Do your state laws and regulations permit introduction, commercial rearing and/or sale of the species of fish you are interested in?
2. What permits or licenses are required?
3. Are there other federal and state regulations which will affect your operations — interstate shipments, predator control, water rights, processing and retailing?

Capitalization and Operating Costs
1. Develop a business prospectus detailing land or space costs, capital expenditure for fishstock, equipment, buildings, water impoundment construction, operating capital needed, labor requirements, costs of financing, production, harvesting and marketing, depreciation schedules and a profit and loss estimate. Such a prospectus is often necessary to obtain financing but, more important, it forces the prospective investor to take a hard look at the economic factors involved.
2. Do you have, or can you obtain, adequate financing for capital outlays and operating expenses through marketing the first harvest — perhaps for a period of a year or more?
3. Are you psychologically and financially prepared to take a loss for the first year of operation?
4. Can your fish in the water or warehouse be used as collateral for financing future operation or expansion costs?
5. Are you aware of all your production and/or processing costs in order to evaluate your ability to meet competition and make a profit?
   a. Overhead as well as operating costs?
   b. Percent of shrinkage or processing losses to expect from live harvest weight to processing plant or consumer product weight?
   c. Have you figured fringe benefit costs in your labor expenses?

Management
1. Personnel
   a. Are you or your production manager technically trained or have the experience to manage your operation at optimum efficiency? If not, have you arranged for management counseling and periodic checks on your operation by expert consultants?
   b. Are you, or do you have available, a biologist or ichthyologist competent to make immediate diagnosis and proceed with proper chemical treatment of diseases, parasites, etc., for fishstocks and to deal with other biological problems of hatching and rearing?
   c. Do you have adequate skilled help to efficiently carry out all phases of your operation to maintain schedules and to meet emergencies?

2. Production Plant Facilities and Layout
   a. Are your ponds, tanks, hatcheries, processing and shipping areas, etc., laid out for optimum efficiency of labor and time?
   b. Are your facilities accessible during prolonged adverse weather conditions?
   c. Do you have, or can you arrange for on short notice, holding facilities for quarantining incoming or afflicted fishstock, for accumulating pay load shipments or for merchandise display?
   d. Have you accounted for expansion in your production-plant layout?
   e. Are adequate utilities — three-phase electrical power, potable water, sewage disposal — available?
   f. What alternate production facilities should be considered — static ponds, earthen or concrete raceways, pen confinement, aquariums?

3. Equipment
   a. What apparatus and labora-

tory equipment will you require for testing of oxygen levels, disease, and other diagnostic evaluation of your operation?
   b. What emergency power unit is available in the event of failure?
   c. Do you have adequate power equipment (tractors, lifts, conveyors, winches, etc.) to facilitate efficient operations?

4. Biological and Chemical Controls
   a. What is a safe margin of oxygen level that must be maintained? Do you have provisions for emergency oxygenation of water?
   b. What chemicals or other methods will be required, and in what amounts: (1) For control of algae or other oxygen-depleting plant life? (2) For undesirable fish and other aquatic creatures?
   c. What preventive control will be used for the eradication of parasitic infestations of your fish?
   d. Do you have special permits and the cooperation of state and federal wildlife agencies for control of predators?

Marketing
1. Have you studied your market outlets?
   a. Do you have reasonably firm market commitments as to quantity, price, product form?
   b. Do you have alternate market outlets?
   c. Can you adjust your harvest time to take advantage of high points in seasonal demand and price fluctuations, if they exist?
   d. Can you provide maximum product quality, type, form and weight of products and other services your market outlet requires?
   e. Do you have, or can you arrange for, adequate distribution facilities and dependable supply sources to meet the time, quality and quantity demands of your markets?
   f. Are you aware of trends in product forms, packaging, convenience and prices of yours and competing products in the markets?
   g. Do you have a market outlet for your processing scrap?

2. Have you planned for market promotion and education activities?
   a. Scheduled an advertising budget to stimulate sales?
   b. Participated in and contributed to industry association programs to create an appealing image of fish farming industry and products to consumers and merchandisers?
c. Cooperated with news media staffs to develop stories and programs to increase public awareness of the industry.

PHYSICAL FEATURES OF PRODUCTION COMPLEX

Site Location
1. Does your site possess natural elevations so that proper engineering will allow each pond to be drained independently and completely?
2. Does the land elevation permit biological supervision and general physical maintenance without excessive travel?
3. Has analysis of the soils been made to determine physical qualities for water retentation and fish culture?
4. Have core drillings been made to determine impervious qualities of subterranean soils?
5. Are adjacent lands subject to aerial crop spraying for insects and weeds?
   a. Are your production facilities protected by state law from aerial crop spraying on adjacent lands?
   b. Have you tested your land for toxic chemical residue from previous years of crop spraying for insect and weed control?
6. Is the site free of all possible overflow by flooding?
7. Is drainage available to natural waterways without crossing other private lands?
8. Will your federal, state and local water management agencies permit drainage into existing streams?
9. Does the topographic elevation of your site make it possible to utilize the prevailing summer winds without creating excessive water erosion problems on levees?
10. Can you economically secure your production facilities from poaching and to prevent straying or escape of amphibian stock?
11. Can you make or take delivery of fish regardless of weather conditions?

Water Supply
1. What is the source of your water supply — reservoir, well (ground) water or running stream? Is it adequate for present and future needs?
2. Is there an alternate source available in case of emergency?
3. Is it possible to secure the necessary water permits for the needed volume of water for your present and future needs?
4. What are the temperature variations of your water supply?
5. Has the water been tested for chemical adaptability to fish production? Have provisions been made for aerating well water? Are surface waters free of harmful chemicals?
6. Is your water supply adequate to replace evaporation and seepage?
7. Can you control predators and unwanted fish species if surface water is used?

SOURCE OF FINGERLING STOCK
Spawning and Raising Your Own Fingerlings
1. Brood stock procurement
   a. What age brood stock should be purchased?
   b. Where will brood stock be secured?
   c. In the event selected wild brood stock are used, how many years adjustment are necessary in confinement, if any, before they will spawn?
   d. At what age will a female reproduce?
   e. At what size and age is the female most prolific?
   f. How many brood pairs should be stocked per surface acre or water volume in spawning areas?
2. Care of brood stock prior to spawning
   a. How long must the brood stock be placed in spawning surroundings prior to spawning?
   b. How close must the male and female broodfish be selected as to size?
   c. What special protein feeds must be fed and for what length of time prior to spawning?
   d. What hormone injections (intramuscular or otherwise) or other treatment can be made to induce or suppress spawning?
   e. What prespawning chemical treatment should the pond receive?
   f. Does noise or physical activity have any effect on spawning? If so, what consideration should be given to location of spawning areas?
3. Spawning
   a. What water temperature must be maintained and for what length of time to induce spawning?
   b. What physical apparatus must be made available in the spawning areas?
   c. In what location and in what depth of water should such apparatus be placed?
   d. Is spawning apparatus compatible with size of brood stock?
4. Procedure to be followed with fry upon hatching
   a. What diseases can be encountered in fry? What is the chemical treatment for such diseases? Is it readily available?
   b. What measures should be taken to prevent cannibalism of the brood stock on their own young?
5. What food (amount and form) should be fed the fry in nursery area until ready for placing in rearing pond? Where is the food available?
6. How important are natural foods to the young and how can growth of natural foods be stimulated?

Purchasing Fingerlings from Other Producers
1. What price can you economically pay for fingerling stock?
2. What size fingerling should you stock to produce a marketable fish in a minimum feeding period?
3. What chemical treatment for disease control should the fingerlings be given before planting in rearing areas?
4. What water preparation is necessary before the planting of fingerlings?
5. How will your fingerlings be graded to size prior to planting in order to produce maximum uniformity at harvest?
6. How many fingerlings or other young stock should be stocked per surface acre or volume of water?
7. How many fry per unit of water can be feasibly carried through the growing season to produce feeder fish for the following year?
8. What maximum temperature change will the fingerlings withstand in transporting, treating or planting without experiencing thermal shock?
   a. Is permanent damage caused by thermal shock and what treatment is effective if shock is experienced?
   b. What equipment is necessary in handling fingerlings to overcome thermal shock?

FEEDING
Feed Source
1. Is feed readily available in quantities needed and constant supply?
2. Have your feed rations been proven through experimentation to achieve optimum growth or maintenance for the stock you are feeding?
3. Are the ingredients of your feed supply dependable and relatively constant from batch to batch?
4. Do you have laboratory facilities available for periodic feed analysis?
5. What kinds and amounts of fertilizers are needed to induce plant and plankton growth for natural feeds?

Feeding Procedure
1. What special equipment will be needed for an efficient feeding system?
2. How will you determine daily feeding rates? What factors will determine the rate of increasing feed to maintain maximum consumption and growth?
3. At what water temperature do you plan to begin and to cease or reduce feeding?
   a. If you continued feeding, what amount of feed would you feed during cold weather?
   b. What system will you use for control of ice cover in winter? Will clear or cloudy ice cover create any problems?
   c. What physical apparatus or observation procedure will you use to check food consumption?
   d. What adjustments will you make in your feeding program to compensate for cloudy, humid, hot days?
   e. If food consumption stops, what biological analysis must be made immediately?
   f. What feeding schedule will you follow?
      a. How often?
      b. What is the best time of day?
      c. In what depth of water?
   g. How many areas in a given pond and over how large an area will you feed for best results?
   h. If pelleted feeds are used:
      a. What percentage of fines in your pelleted feed is permissible without creating water contamination?
      b. What size feed pellets are best suited for fry, fingerlings and feeder fish?
      c. Does your pellet feed have adequate binder to prevent disintegration in water before being consumed?
      d. Should you use a floating or sinking feed?
   i. What procedure must be followed — and for how long — prior to slaughter to eliminate feed flavoring in the processed meat?

4. What adjustments will you make in your feeding program to compensate for cloudy, humid, hot days?
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HARVESTING, TRANSPORTING and PROCESSING

Harvesting
1. What is the most economical type of harvesting method for your present and future facilities?
2. How will you construct your ponds or other production facilities for the most efficient harvesting techniques?
3. What special equipment will be needed for expeditiously handling fish from harvest facilities to transportation vehicles?
4. Will you need special holding tanks or ponds to keep quantities of fish ready for immediate delivery?

Transporting
1. What facilities do you have available for handling fish from harvest to market or processing plant?
2. What will you use for water cooling purposes in transporting live fish — ice, refrigerated vans, refrigerated water tank?
3. What percentage of chlorination in the water will the fish tolerate?
4. How will a suitable water supply for long distance shipments be made available in transit? Aeration equipment needed?

Processing
1. If you plan to dress and/or package fish for resale, will your facilities conform with state food processing and sanitation codes? Do you need processing and retail sales licenses?
2. Are your production facilities reasonably convenient to a processing plant?
3. Is it to your advantage to contract with a processor for your annual production?
4. Good service and good quality are major keys to sales expansion. Are you equipped to give both?

SUMMARY
To acquire answers to the above questions may appear to be formidable task. But is it? Many answers can be found by reviewing published literature. Others are as near as your telephone or your mail box. However, some information can only be obtained by personal contacts to discuss your particular situation and interest.

Since the above checklist is general in nature, it does not cover all critical questions to be investigated for all forms or even a specific type of fish farming. Consequently, it is intended as a guide to evaluate your chances of success in a fish farming enterprise of your choice.

We would like to hear from readers about other possible points that aquaculturists should consider in commercial operations as well as any experiences in fish farming they might wish to relate. Address all such correspondence to the author, Walter Jones, in care of THE AMERICAN FISH FARMER, P. O. Box 1900, Little Rock, Ark. 72203.