"Prospects for Commercial Pompano Mariculture – 2003"

M.F. McMaster, T.C. Kloth, J.F. Coburn

Aquaculture America 2003
February 18-21, 2003
Louisville, Kentucky

Abstract:

Mariculture Technologies International, Inc. (MTI) has had pompano projects over the last 25 years both in Florida and offshore. Predicated on the belief that opportunities once-again exist for premium fish and not just meeting the needs for diet protein, MTI has re-established a broodstock program at its aquaculture plant in Oak Hill, Florida.

Given environmental constraints in much of continental United States coupled with overseas advantages of labor and feed, the pompano enterprise of 2003 and beyond will be global in nature. "Prospects for Commercial Pompano – 2003" will examine the state-of-the-art and economic considerations for the Stages in production of market pompano, i.e., Broodstock (Stage 1), Hatchery (Stage 2) and Growout (Stage 3).

The process begins with the careful selection of breeding stock. Female pompano are induced to develop eggs and to spawn on demand. This controlled reproductive cycle is essential to steady-state farm production. Once spawned, eggs hatch in twenty-four hours. Newly hatched larvae quickly develop into juvenile fish although the Pompano take almost a year to reach marketable size.

In a previous Broodstock operation, a total of 10.4 million normal fertilized eggs were produced and made available to the hatchery. The annualized spawning success was 62%. This means that of all female pompano 62% of them spawned normally. The average yield of eggs per female was 114,000.

Historically, the hatchery development phase of larval rearing the Florida Pompano was the great stumbling block. Earlier successes included an average 37,539 pompano fry produced per month. This fry output was accomplished in a hatchery building that consisted of hatchery tanks holding a total of 20,000 gallons. Of the 10.4 million viable eggs produced by the Broodstock center only 4.7 million were actually used for hatchery stocking. The pompano hatchery was harvested when the larvae had reached full metamorphosis, a total length of 15 mm, and weighed at least one gram. This hatchery period required, on the average, 22 days.

The accumulative effect of shallow water, bright sun light, poor water quality and over crowded conditions all stressed this fish. This intense stress interfere with its normal metabolic growth abilities. The authors believe that if the Florida Pompano are transferred at 100 grams into large sea cages growout results will show economic results.

Overview:

Considering the many high value species of marine tropical finfish that could be farmed in Florida and elsewhere in the tropical and subtropical oceans, there are surprisingly few species that have met the test for commercial farming in North America. The test is whether the total vertical and integrated technology from spawning to market ready product is known and practiced. As most researcher and commercial practitioners in this field know, there are no high value and profitable tropical marine finfish farms in existence in North America at this time. The authors of this presentation hope to illuminate the factors that have limited these enterprises and suggest some practical solutions to these problems.

For reasons we will explain, it would be a reasonable estimate that at least 100 million dollars (US) has been invested in mariculture research in Florida since 1970 by both private and public institutions with the goal of developing technologies for maricultured seafood. It can also be a reasonably estimated that about 20% of these funds were targeted towards finfish mariculture and the balance targeted towards marine shrimp, clam, and other edible species along with stock enhancement projects.

The Florida Pompano (Trachinotus carolinus) has been, historically, the largest recipient of marine tropical finfish targeted research and commercial development funds. The majority of Pompano mariculture development funds were provided by private industry. The technical development challenges for this fish have been met and were reported on by Mr. McMaster in a presentation entitled "*Pompano Mariculture: Past Success and Present Opportunities"* presented September 1987 at the Caribbean Aquaculture & Trade Expo '87 in Puerto Rico. Further development of this science has been ongoing by Mr. McMaster and his associates.

Figure 1 Florida Pompano (Trachinotus carolinus)

The authors believe that the proper method for growing out Pompano would be in floating sea cages. The rational for this is based on the behavior of the pompano and the reduced operating costs. Historically, the pompano has been raised in tank farms with large amounts of running seawater and some attempts at pond raising them with questionable success. We believe that those old attempts to pond raise pompano were poorly conceived and the cause for lack of success was poor design and mechanical operation.

So, where are the Pompano farms or any other floating cage marine finfish farms in tropical to subtropical waters in North America? One might first direct that question to the State of Florida Department of Agriculture and its sister agencies and to the Federal Department of Commerce and its sister agencies. After an elementary examination of State and Federal laws one will find that there are no regulations that allow for the existence of floating cage marine fish farms. This problem is not only in Florida but also anywhere along the subtropical to tropical shores of North America. If there are no regulations that permit the commercial use of near shore marine waters for floating cage mariculture then clearly there will be no business interest in this type of mariculture in those States. Many millions of development dollars have been spent in North America trying to develop techniques for producing various species of tropical fish fry while there remains nowhere to grow these fish in tropical and subtropical North America. This dilemma has been the major block in developing commercial Pompano farms in Florida.

The dilemma of where to grow pompano brings us to the second and most important subject of this presentation: global consideration for the farming of this marine finfish species. It is clear to these authors that if you want to create a profitable Pompano farm you must farm them off shore. For the purposes of demonstration we will use the Northern Bahama island of Grand Bahama as an example. However, the Pompano can be farmed anywhere there is proper water and industrial infrastructure to support the business.

Most of the commercial seafood mariculture attention in this field has been focused on farming invertebrates such as shrimp and clams. The reason for this is twofold: available technology and high commercial value. Without both of these conditions being met from the outset an investor in mariculture is subject to wasting their time and money. For the Pompano the first criteria is met and the second criteria we believe has been met as well. Recent fresh fish market reports demonstrate fair market values to the producer (fishermen) of between $3.50 and $5.50 per pound in the round. Direct sales to gourmet restaurants of farm raised, fresh iced pompano would command a premium over ex-vessel price. The live fish market, be it small relative to the national fresh seafood market, has offered up to $10.00 per pound for live Pompano and other high value finfish. These prices meet the test for high value seafood.

Commercial Pompano production has taken place by the authors in three different areas and businesses over the last 32 years. A pompano farm in the Dominican Republic in the early 1970’s, a pompano broodstock and hatchery center in Plantation Key, Florida in the late 1970’s to early 1980’s and currently a broodstock and hatchery center in Oak Hill, Florida. Grow out facilities for farming of the Pompano does not exist anywhere to our knowledge. Therefore, one of the obvious points of our presentation is to make the industry aware of the technology opportunities and the business opportunities for those that desire additional high value marine finfish in the market place.

North American Market Demand for Premium Seafood:

It is of no surprise to anyone in the seafood business or to consumers of seafood that high value marine finfish are becoming more and more limited in supply. Upscale seafood restaurants coast to coast increasingly find it difficult to print menu's with high price finfish as a permanent offering. The modern approach in dealing with this shortage is by printing statements such as "fish of day", "special of the day", "when available", and of course "market price". The reader of this presentation must understand from the outset that the authors are not proposing to meet the protein needs of the world's population with pompano. Rather, our focus here is to deal with the problem of providing more high quality and high priced fish to gourmet restaurants in North America.

Figure 2 Fish Market

It is common knowledge that the world fish catch has leveled off and at the same time fish consumption is rising. This state of affairs has led to catch fisheries fishing not only deeper and farther away from port but also filling demand with new species of fish previously not considered edible or marketable. Has anyone ever seen a munk fish up close? Most people would run from it, not try to eat it. In America, recreational time and more expendable income drives an upscale market demand for more and finer table fish. However, it is difficult to find any data that would suggest that the catch fisheries would ever be able to address the shortage in this upscale portion of the seafood market. All the Pompano, Grouper, Snapper, etc. are purchased these days before the fishing boat ever makes it to port. The catch fishermen generally never concern themselves with the problem of selling these high value fish. Their only concern is how many can they catch. The Florida Pompano at one time supported many fishing families and even some small towns in Florida until the gill net was deemed bad for the fisheries and banned from use. When that law went into effect all the families and fish houses that depended on Pompano and their restaurant customers that depended on stable supplies of Pompano went out of business or took the fish off the menu. Pompano availability in Florida has never been high. The difficulties in catching this fish are the primary reasons for low landings and not the lack of natural stocks. The largest recorded annual pompano catch in Florida was only 1.5 million pounds. However, at one time it was reported that pompano represented 1 percent of the Florida catch by weight but represented 5 percent of the total value of the annual catch. No longer is that the case. Anyone visiting his or her local fresh seafood counter in Florida would almost never find a fresh iced pompano for sale. Generally, if the signage at a fish counter listed pompano,

like one in Destin, Florida in early January 03, listed pompano at $5.95 per pound but when asked for one, the attendant replied that they had none. We believe that it is common knowledge to anyone familiar with the seafood trade that there are not enough high value fish available to the market.

One may also inquire as to how much new production of high value finfish could the market easily absorb. The most obvious starting place is to first replace the million plus pounds of Pompano that were once captured annually in Florida. Also, Florida is not the only coastal State with a pompano fishery. There still remains a very small hook and line pompano fishery in Florida and a net fishery outside the three-mile zone. The most recent data available for the last few years indicates that the total commercial pompano landing from the State of Florida averaged 500,000 pounds per year (Florida Fish and Wildlife Conservation Commission, April 2002). The potential market for this high value finfish is enormous when considering domestic and international market demand for a premium finfish like a Pompano. Ten years into a pompano farming venture it would not be unrealistic to expect to be selling upwards of 20 million pounds per year. We believe that the starting place for the design and manageable start up of a pompano farm would be one million pounds per year. This level of a Pompano farm has already been achieved back in the early 1970's. Due to international oil shortages in those years that significantly affected the offshore operation of the pompano business, it was unable to sustain operations.

Figure 3 Oak Hill Broodstock

Predicated on the belief that opportunities once-again exist for premium fish, and not just meeting the needs for diet protein, MTI has re-established a broodstock and hatchery program at its mariculture plant in Oak Hill, Florida.

Given environmental and governmental constraints in all of the continental United States coupled with overseas advantages of lower operating expenses and accepting governmental policies, the pompano enterprise of 2003 and beyond will be global in nature. "Prospects for Commercial Pompano Mariculture –2003" will examine the state-of- the- art and economic considerations for the Stages in production of market pompano.

The Stages in the Process from Hatch to Market Pompano:

Stage One – Broodstock Facility

Adult pompano (1-2 pounds) are readily available on the east coast of Florida from Sebastian inlet north. Their abundance is greatest in the winter and decreases markedly during the summer. A thriving net fishery for pompano once existed here, but due to the ban on net fishing, pompano must now be caught with hook-and-line techniques.

Wild pompano readily adapt to captivity with a minimum of mortality. Although wild pompano rarely exceed 3 pounds, broodstock pompano often weigh 3 ½-5 pounds after several years of captivity. There is a degree of mortality among spawned fish (especially during the natural spawning season), but the same broodstock fish (male and female) can often be used for spawning over a period of several years.

Although the initial stocking of a broodstock facility would be with wild fish, broodstock replenishment would come from selected, farm raised fish. By using farm raised fish, a genetic enhancement program (fast growth, disease resistance, etc.) would also be started. At the Dominican Republic project, F_1 generation fish were successfully spawned to produce F_2 generation.

The success of any marine fish farm is predicated on a supply of viable eggs to start the production process. Ideally, the eggs should be available throughout the year and not just during the natural spawning season. This produces a predictable, steady-state production cycle for producing fresh fish product instead of inventoried frozen product.

Although most pompano ventures involved spawning only during the natural spring time cycle, the authors designed and operated a broodstock/spawning facility in the Dominican Republic. This facility produced more than 14,000,000 eggs during one calendar year. Furthermore, pompano were successfully spawned in every month of the year.

Figure 4 Dominican Republic

Spawnable pompano were produced by keeping adult pompano in a building where environmental parameters (light cycle and water temperature) could be strictly controlled. During the 24 week cycle, pompano were put through a “down” or resting phase and then an “up” or spawning phase. Each group of pompano would then go through 2 cycles per year.

The actual spawning was accomplished with the use of hormone injections. This made the spawning process very predictable. Male and female fish were examined for gonadal

development, and spawnable fish were then injected. Viable eggs and sperm were produced within 36 hours post-injection. Eggs and sperm were physically stripped from the fish and mixed for fertilization. The average fecundity was 100,000 eggs per female, although the fecundity can vary during the year. Fertilized eggs were incubated for no more than 20 hours and then placed in hatchery tanks. Spawned fish were then placed back into the broodstock/spawning cycle for future spawns.

If the production goal is 100,000 one pound fish per month, approximately 700,000 fertilized eggs per month are required:

700,000	eggs
.85	hatch
595,000	larvae
.30	hatchery survival
176,500	fry
.75	juvenile survival
133,900	juveniles
.75	grow out survival
100,000	one pound fish

The 700,000 eggs per month requires 7 spawning females per month. This rate of egg production was achieved numerous times in the Dominican Republic.

In the above example, the broodstock/spawning building design is fairly simple, with a series of 24 tanks (10' diameter or larger and 4' deep) divided into resting and spawning units. The tanks have running seawater (once-through) with temperature control. Our experience was with concrete tanks, but future facilities would use knock-down, portable tanks that could easily be transported to remote and off shore facility sites. The lighting system for the tanks consists of incandescent lights. The actual size of future facilities (number of tanks) depends upon the production goals of the farm. With proper site selection, the broodstock/spawning facility can easily be expanded for increased farm production.

The broodstock/spawning facility requires a good supply of raw seawater (preferably from seawater wells) and the ability to discharge effluent water without treatment (to reduce operating costs). Additionally, a dependable electric supply is required. Broodstock food would be supplied by the farm food production facility. Personnel requirements include a technically trained broodstock manager, an assistant manager and several broodstock workers.

The broodstock facility capital equipment cost for the one million pounds per year Bahamas farm would approximate $300,000 US. This is similar to the capital costs of the adjoining hatchery. Actually, the structures are nearly the same in design and therefore can be considered interchangeable if operations required more or less tanks for either phase. This generalized figure represents a complete broodstock facility loaded into sea

and land containers for ready shipment anywhere in the world. The administration and operational set up costs are not determinable for this limited example.

Stage Two - Hatchery

The current state of the art as practiced by Mariculture Technologies International, Inc. for the controlled (in seawater tanks) hatchery production of the Florida Pompano (*Trachinotus carolinus)* is a yield of metamorphosed pompano fry of one gram in weight, 18 millimeters in length and a hatchery age of 22 days. The production capacity or yield per hatchery tank is an average of one fry per two gallons of hatchery water capacity. These results have been repeated hundreds of times over the last 30 years and are therefore a reliable technology on which to base a commercial Pompano farm. The sizes of the hatchery tanks used have been from 100 gallons (380 liters) to as large as 26,000 gallons (100,000 liters). Generally, the high water capacity hatchery tank systems are not recommended for commercial use due to the difficulty in managing large volumes of water.

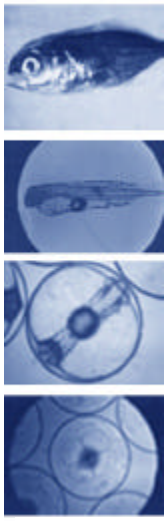


Figure 5 Pompano Early Life

The larval pompano emerge from the egg at about 24 hours post fertilization. The average size of the newly hatched larvae is 3.2 millimeters in total length. Hatchery live foods consist of the commonly used items such as marine rotifers and newly hatched brine shrimp. The pompano is a durable larval form and can withstand less than perfect water quality conditions. The larvae can be weaned off most live foods and on to mostly dry food diets prior to metamorphous or starting at about midway through the hatchery cycle. All in all, this species of tropical marine finfish is one of the technologically easier species that we have reared over the years. Out of approximately 50 tropical marine species that our group has tested we find the Pompano to be one of the easiest to manipulate and thereby predictable.

Figure 6 Florida Keys

Pompano hatchery design has been an interesting evolution over the last 30 years. The first fish hatchery that the group designed (Dominican Republic) was all concrete tanks on concrete floors in concrete buildings all with very high capital costs. These buildings were a beautiful thing to view but we soon found them to be very inflexible. The second hatchery complex the group designed (Plantation Key, Florida) was the most creative (based on operational flexibility) design and the way of the future. That facility was a wood structured green

house with a concrete floor. However, things have changed in the business world of Pompano farming. Now, all the equipment for one standard hatchery unit fits right inside standard 40 foot by 8 foot by 8 foot sea and land container. A number of these containers can carry an entire fry production facility anywhere in the world.

Figure 7 Oak Hill Shell Building

The operational flow of the modern pompano hatchery is not unlike any other finfish operation. The hatchery requires electricity, good seawater, a live food production facility, competent personnel, and the ability to obtain supplies, along with a solid business and operational management team. The hatchery personnel can be folks with reading skills and green thumb ability. Just about anyone with the interest in this business can be trained to operate a pompano hatchery. However, there is a need for one technically trained hatchery manager to oversee the process.

Figure 8 Oak Hill Tank

The capital equipment requirements for a modular pompano hatchery that has the capacity to turn out 250,000 one gram pompano fry per year would approximately cost $75,000 loaded into a sea and land container. This figure represents a very generalized situation but at least tells the reader that the cost for a turn key pompano hatchery of this size is very reasonable. Therefore, in order to produce one million fry per year for the Bahamian farm example, four of these self-contained hatcheries are required. The costs for delivery and construction of the hatchery would be additional but not readily predictable since it depends on the geographical location of the facility.

Stage Three – Pompano Growout To Market Ready

The grow out portion of pompano farming technology has gone through an evolution beginning with ponds, advancing to raw water tank systems and closed systems far from the shore and eventually back to raw water tank systems. There have been a few meager attempts to net pen farm the pompano but most failed prior to producing market ready fish. Even though the authors strongly believe the best method for growing out the pompano is the floating sea pen method, there remains no commercial experience using that method for this fish. However, knowing the behavior of the pompano as we do, coupled with grow out experiences in large tanks as compared to small tanks, those results strongly suggest that this fish would be more content in large floating sea pens. A content fish is a fish that stays healthier and grows faster. In practice we refer to this phenomenon as the “happiness factor”.

The pompano growth rate is reasonably fast compared to other farmed fish. The average total grow out time from post hatchery fry to a one pound market ready fish is nine months at an average temperature of 80 degree F.. There are three operational stages for growing out this fish: hatchery (harvest size is one gram), juvenile development center (harvest size is ten grams), and large grow out pens (harvest size one pound/453 grams). The juvenile development center is the intermediate phase of the grow-out cycle and must be undertaken in tanks as opposed to pens due to the small size of the fry. Once the pompano fry has attained ten grams or more it is an extremely durable fish and ready to compete in a large growing area. We stress the need for a large growing area. Previous experience has shown that once a pompano reaches ½ pound (200 to 250 grams) in size, small tanks (20 feet in diameter and 2 feet deep) will cause considerable stress. This stress causes a dramatic slow down in growth and self-imposed damage from contacting the walls of the tank. Grow out experiences at Neptunian Mariculture at Plantation Key, Florida demonstrated that there was no apparent slow down in growth at that size if the fish were kept in large tanks in the range of 100 feet long by 40 feet wide and 8 feet deep. Further, our experience with retaining broodstock size fish also demonstrates that large fish will continue to grow in captive tank environments if the tanks are sufficiently large enough.

Figure 9 Sea Cage (Courtesy NOAA)

Pompano seem not to be significantly impacted by stocking density, as the pompano is by nature a schooling fish. Previous grow out tank farms have raised this fish at densities of one pound of fish flesh per gallon of water. This density is not recommended due to the mechanical limitations for maintaining proper water quality and feed delivery. Our beginning recommendation for sea cage density is one pound per ten gallons of seawater.

Grow out farm design recommendation would be to use a commercially available open water pens designed for moderate sea state. We would also suggest that the pen be round in design, at least 40 feet in diameter, and at least 8 feet deep. A pen of this size would enclose 75,000 gallons (285,000 liters). Stocking density of one pound of fish per ten gallons (38 liters) would yield 7,500 pounds (3,409 kg) per cycle (cycle being 7 months) per cage. In comparison, a stocking density of one pound per gallon would yield 75,000 pounds (34,090 kg.) per cycle per cage. Grow out tests in land based concrete tanks would suggest that the bigger the enclosure the better the 'happiness factor' and therefore better results.

The standard grow out for farmed pompano starts at the 8th week post hatchery release and ends at the 28th week. The juvenile pompano start at an average of 10 grams and finish at one pound (453 grams). The juvenile growth phase is from one gram to ten grams in eight weeks. Then the total growth time from a one-gram hatchery fry to a market ready one pound pompano is 36 weeks. Historically, the standard diet for this growth rate is 45% protein and 7% fat and 3% carbohydrate. This historic standard diet would yield a conversion factor (dry weight of food to wet weight of fish) of 3.1:1. Recently developed diet formulas and protocols significantly out perform the historical standard pompano diet.

The most efficient model for a commercial pompano farm design would be a land based broodstock center (egg production), a land based hatchery center and a land based juvenile development center with a nearby floating sea pen grow-out facility. There are many locations through out the Caribbean, South and Central America for this type of development. However, not always do the business requirements and interests of the farming parties necessarily match up well enough to have the entire development at one site. The options to this one site model would be regional pompano egg or fry supplier businesses that would support the growers. Pompano eggs have been quite successfully transported by airfreight from Florida to the Dominican Republic and could be done elsewhere. One-gram pompano fry could also be shipped just about anywhere via airfreight or vessel.

With the example of a Bahamian farm site we have considered using large floating barges as the site for a broodstock center, a hatchery center, a processing center and for the grow out farm support. The juvenile development center is still recommended to be on land for various operational reasons. A pompano farm built on large barges would be very independent and mobile.

Operating a modern sea cage farm in 2003 and beyond is not the same challenge it was in 1970 when the pompano research began. In 1970 sea cage farming in North America was most likely non-existent. Today, there is a large pool of experienced sea cage practitioners and a variety of manufacturers with many different designs and systems to choose from. In our conceptual Bahamas pompano farm that is designed to produce one million pounds per year, the projected number of cages would be thirty. This number of cages would allow for one cage per week to be harvested (based on a stocking density of ½ pound per gallon). The pen system design and layout would require that the pens be organized in such away to accommodate a small vessel to tend to the operational

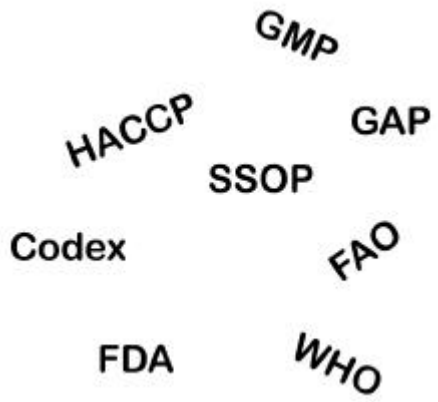
protocols. Considering the calm and protected waters of the area the cage system operational needs could be dispatched from a land based facility as opposed to a barge facility. Further, there are many near shore areas where relatively deep water with reasonable water current and tidal flow conditions exist. Site location for the grow-out farm is very important and great care and due diligence must be exercised prior to selecting a farm site. The Bahamas is not the only place that these conditions and requirements can be found as the entire Antilles chain of islands and Central America have equal geographic and oceanographic opportunities.

The equipment capital requirements for the example Bahamas pompano sea cage farm based on the one million pounds per year of market ready fish would approximate $900,000 US. In addition to this figure would be the construction cost, inventory, personnel, transportation and other operational costs. It is not herein the intent to identify all costs as it requires site specific definition and that can only be achieved in real time analysis for a given project. Generally, one may expect that a turnkey pompano grow-out farm of this size would be twice the above figure.

Stage Four - Product Processing and Distribution

International Processing Standards

In 1997, both the FDA for the US market and the Codex Alimentarius Commission for the European Community, adopted Guidelines for the implementation of Hazard Analysis Critical Control Points (HACCP). In order to export to the US or to Europe, companies must demonstrate that they are operating under a HACCP system. Implementation requires a formal and well documented approach to protecting seafood products from foreign material (metal and glass), chemical, and microbiological contamination. The practice of documentation has been a major stumbling block for many companies and indeed for the entire seafood industries in some countries. A few points from the FDA Fish and Fisheries Products Hazards and Control Guidance, June 2001 could be helpful in establishing operations at an aquaculture site. Note, the FDA specifically plans to develop guidance for aquaculture.



The maintenance of a sanitation monitoring program is an essential prerequisite to the development of a HACCP. A Standard Sanitation Operations Procedure is not limited to the facility in which the seafood product is grown but also processing, holding, and distribution facilities. Table 3-1 of the June 2001 Guidelines does not list any specific parasites or toxin hazards for Pompano. However, pathogens may be found on raw fish as a result of near-shore harvest water contamination, contamination on the harvest vessel and poor aquaculture practices. All drugs, whether for direct medication or for addition to feed, must be approved by the FDA. Control strategies include On-farm visits, Suppliers Certification, Records of Drug Use, Residue Drug Testing, Quality Assurance

program and Control during holding. FDA-approved aquaculture drugs included only 7 drugs as of 2001.

HACCP training materials promote the positive, benefits to the enterprise of an effective HACCP system rather than a cost. It does require, however, a level of knowledge about seafood hazards and avoidance as well as an enterprise management committed to training, implementation, and documentation.

Distribution of Fresh Seafood

Spoilage begins immediately following the death of the fish. It is brought about by an onslaught of chemical, enzymatic and bacteria reactions. In addition to sanitation measures to lessen exposure to, particularly, bacterial damage, low temperature and short holding times maintain the quality of the fish sold to the consumer (or the shelf-life).

The University of Rhode Island has published (as have others) the effects of temperature on shelf life.

Table 1 Temperature Impact on Shelf Life

	Shelf life (days)	
Storage temperature (°F)	**High fat fish (1)**	**Low fat fish (2)**
32	10	14
40	5	7
50	2.5	3.5
60	1.5	2
70	1.2	1.7

(1) High fat fish include salmon, sablefish and Pompano
(2) Low fat fish include halibut, cod, and Pollock.

Robert J. Price, Seafood Technology Specialist, Department of Food Science & Technology, University of California, Davis, generated an enlightening example of how the shelf life is consumed leaving only hours for the ultimate consumer to enjoy high quality.

Table 2 Remaining High Quality Shelf Life Example

	Actual Elapsed Time	Temperature (°F)	Equivalent Age at 32°F
Fish Caught	2 hours	60	0.5 days
Storage on Vessel	3 days	34	3.7 days
Processing	12 hours	45	1.5 days
Distribution	12 hours	36	0.7 days
Retail Case	1 day	38	1.8 days
TOTAL			**8.2 days**
Remaining high quality shelf life at 32°F			5 hours

Since the consumer may not store the fish iced, normal refrigeration (40°F) results in still less time to enjoy that high quality seafood (2 hours). Obviously, this indicates difficulty in delivering high quality. Aquaculture clearly has an advantage in not needing the time for catching the fish nor storing them on vessel. That difference accounts for more than half of the lost shelf life in commercial fishing. The remaining challenge becomes transportation or distribution.

Air Freight fresh seafood became viable in the 1990s with deregulation of the airline industry. It now is the standard distribution system for Alaska and the Pacific Rim. Fortunately, considerable experience has been gained on packaging, labeling, handling and working with the airlines to make Air Freight of high quality seafood standard.

Figure 10 DHL Air Freight (Courtesy Daniel Alaerts)

Conclusion: Globalization

In a modern global business environment there are as many ways to create business opportunities and business relationships, as there are people interested in pompano farming. Essentially, the creativity of entrepreneurs with the desire to farm pompano can do so. The authors have attempted to define where on the globe a pompano farm could operate successfully. It can be concluded that a pompano farm can be created in any tropical to subtropical zone except in the United State. MTI, Inc. is of the belief that the

pompano is a potential mariculture giant and is awaiting commercial development. There is no other high value tropical marine finfish species ready for industrial consideration. Technologies are available for transfer anywhere on the globe.

One option in globalization is to create central pompano hatcheries near grow out sites. This business model would lessen the capital outlay for start up ventures while providing the security of knowing there is a fry provider nearby. This model is in use within the industry and has proven to be reliable. As with any agriculture venture, Mother Nature always has to be dealt with so the reliability consideration is an average performance over time.

The North American market can absorb additional high value species like the pompano. An anecdotal story from an associate in 1994 indicates that a pompano sample taken to The International Boston Seafood Show generated orders for twenty million pounds. The accepted format presentation for pompano in the North American market is fresh, iced and eviscerated, particularly for upscale seafood restaurants. Historically, the fresh iced format has had an acceptable shelf life of 5 to 7 days. Fresh frozen, whole and eviscerated pompano would be the preferred format from the standpoint of distribution efficiencies. Long term freezing has not been an acceptable method for distributors to rely on as the pompano is a reasonably oily fish and should be consumed within sixty days.

An acceptable start up model for the distribution of fresh iced pompano to the North American market would be daily airfreight shipments from the growing farms. Therefore, when it comes to farm site selection an important consideration is whether there is an international airport nearby. Also, for the new start up farming venture there is less of a concern about the quality and safety of fresh iced fish as opposed to processed fish. Certainly all required food safety procedures must be implemented and maintained in order to have access to the market and to keep the market share.