AQUACULTURE

Timeline of Events

1960's

- Increased global concerns about overpopulation, scarcity of resources, food supplies
- Efforts to supply developing countries with fish-protein concentrate
- Peace corps incorporates aquaculture efforts in developing countries
- Development of SCUBA gear after WWII leads to increased interest in sea world
- Research leads to improvements in feeding practices, disease control, and organism growth - allows for larger scale production, and industry expansion
- Aquaculture not seen as agriculture (exception - catfish) - doesn't receive funding, extension agents for training, etc.
- Sea Grant College Program (1966) - granted funding to land grant colleges for aquaculture research

1970s

- Research leads to better farming techniques; find can improve specific traits - better growth, feed conversion, efficiency
  -US catfish pond acreage increases from 400 in 1960 to 40,000 in 1970[1]
  -abalone - found adding hydrogen peroxide to water leads to synchronous spawning of males and females - increases production
- Less government spending
- Food and Agriculture Act of 1977 - Congress designates aquaculture as a basic mission of the Department of Agriculture

1980s

- Aquatic bioengineering; produces sterile oysters which are sweet year round - increases production
- Aquaculture not always well received - ie. heavy regulations regarding pollution
- National Aquaculture Act of 1980 - allowed for the establishment of the National Aquaculture Development Plan.
- Fragmentation of the industry - marine verses freshwater. Within groups no cohesiveness; abalone farmers had marine laboratory background, while catfish farmers were farmers raising an unusual crop. Catfish farmers had backing of government paid university extension agents to assist with farming problems and training of new farmers - this was not true with all other aquaculture programs.
- Marketing of catfish expands consumption beyond traditional catfish eating regions - emphasize delicate flavor, nutritional value and year round availability
- Funding increased in 1986 -Farm Bill established four regional aquaculture research centers
- Harvest limitations on commercial fishing (ie redfish in the Gulf of Mexico)[2]
- Salmon farming expansion in Washington and Maine - floating net cage enclosures

in bays.

1990's

- Aquaculture IS agriculture - perception of aquaculture is changing
- U.S. aquaculture production by species, 1995 - top 6 species *(graph 1.1)*
- U.S. aquaculture production doubles in the years from 1984 - 1994[3] *(graph 1.2)*
- Expansion to open water pens explored - gets away from inshore pollution problems
- World capture fisheries increases from 20 million metric tons (MT) in 1950 to over 100 million MT in the mid 1990's when numbers stabilize
- Traditional fishing grounds closed, commercial fishing banned/reduced in some fisheries[5]
- Some fishermen make transition from traditional fishing to aquaculture through aquaculture training programs - especially in Florida where transition program was state sponsored[6]
- 46% increase in Consumer Price Index (CPI) for seafood between 1985 and 1993. Contrasted to 29% and 27% CPI increases in poultry and ground beef respectively[5]

Trends

- U.S. aquaculture production has continued to increase since the 1970's
- Seafood total consumption (not per capita) in the United States gradually increases as does import of fish and shellfish products. Exports of fish and shellfish from the United States doubled in the period from and 1985 - 1990. *(graph 1.3)*
- Seafood consumption - has remained a relatively minor component of overall protein consumption. Per capita seafood consumption has grown from 11.8 in 1970 to its peak of 16.2 in 1987 and has currently leveled at about 15.0.[3] *(graph 1.4)*
- Increased world population so that even if per capita consumption remains the same there will be an a need for more seafood
- Increasingly consumer driven market with consumers interested in safety, freshness, and nutritional value of food products
- Increasingly common closure, or temporary ban, of fishing in traditional fishing grounds

Uncertainties For The Future

Demand

- **C**onsumption will be dependant on an ability to fill a niche left by declining wild catches, access to high quality seafood will be essential
- **High seafood prices could affect seafood demand** - competitive disadvantage when compared with poultry and red meats. This will depend principally on cost

and availability of raw materials used in aquaculture feeds but also on production efficiencies.

- **Marketing** - technological innovations could provide fresh, flavorful, easy to prepare seafood. Marketers could promote advantages of cultured fish over wild-caught fish, ie: freshness, increased longevity, year round availability, size consistency (easier for restaurants), raised in a pollution-free environment, flavor enhanced through diet control. Aquacultured products often are processed within one hour of being killed, and quick processing of the fish increases freshness.[7]
- Marketing surveys have found that chain stores and stores with floor space > 40,000 sq feet are more than 3 times as likely to have seafood counters as non chain stores or stores with < 20,000 sq feet[5]
- Stores with a significant number of non-white customers are more likely to have a seafood counter [8]
- Increased imports of certain fish and shellfish indicate demand of these products has exceeded US supply. The U.S. trade imbalance is partly due to large imports of seafood products.
- There has been a steady annual increase in world consumption of fish

Competition for Resources

- **Limited marine locations suitable for aquaculture** - competition with many industries; oil companies, commercial fishermen, endangered species, recreational boaters, sports fishermen. Currently marine aquaculture in the US occurs within 2 miles of shore, and while 22 of 24 states with coasts report having an aquaculture industry, only one state reported that the industry was growing.[9] The main reasons were competing users, a negative regulatory environment, and foreign competition. Potential resolution for this is offshore production which would avoid competition with most other users, decrease risk of polluted water, reduce problem of waste from farmed fish. Consumer awareness of marine environment and concern for marine mammals - may impact use of offshore production
- **Inland competition with crop irrigation for useable water**. Since aquaculture is new, often water resources have been previously allocated to prior users - possible improvement through use of closed systems, recycling the water for use in hydroponics, or using waste water from geothermal systems.[10] Use of best management practices to decrease the impact aquaculture has on the environment has been recognized by the EPA.

Pollution

- **Best sites for aquaculture seem to be where pollution is also released into ocean.** Calm bays; for example, there has been a decline in wild populations of fish and shellfish due to substandard water quality in Chesapeake Bay and Puget Sound.

Feed

- Highest single cost in intensive aquaculture
- **Competition for grain** (supplies decreased due to increased populations, soil erosion, overuse of land)
- **Competition for fish protein** - 30% of world fish catch is used for fishmeal - 93% of which goes into poultry and other animal feeds.[11] About 2/3 of the protein in aquaculture feeds comes from fishmeal. Future supply of herring family fish is limited. High value, carnivorous fish and shrimp species production would be limited by this (ie 1 lb farmed salmon can require 3 lbs wild-caught fish). For this reason low food chain species such as carp and tilapia may have a large growth potential.[4]

Government Policy

- **Regulations have sometimes inhibited development of aquaculture**: coastal aquaculture development held up due to permit problems, moratorium in Alaska in 1987 to ban commercial finfish (salmon) farming until state legislature could resolve issues raised by commercial fishermen, various state laws over time have not allowed for the sale of striped bass by aquaculture farms even while research was developing large scale culturing of striped bass.

Public Perception of Food Safety

- Aquaculture products have the benefit of controlled water quality so risk for contaminated water, algal toxins (ie. Pfiesteria) is limited. Some food poisoning occurs as a result of mishandled products after capture - processing of fish occurs more rapidly with aquaculture so risk decreased. Still other hazards are present:
- **Chemical -** antibiotics are used for therapy during disease outbreaks, but also for prophylaxis which could lead to several problems; 1) development of antibiotic resistant strains, 2) accumulation of antibiotics in fish which may leave residues [12]
- **Biological** - the presence of microbiological contaminants in the fish causing possible illness. More than half of consumed seafood products are imported (from 172 countries)[13] - many from countries with greater exposure to foodborne disease. It is not always easy to determine where fish have been harvested since there can be an intermediate country exporting fish products. Another source of biological hazard (perceived or real) is the use of hormones which can be used to increase growth rates.
- **Toxicologic** - chemicals used to eliminate competition within the production system.
- Solution: The old system of voluntary participation in the National Seafood Inspection Program for certification and inspection has recently been changed to incorporate an involuntary national inspection; the HACCP - **Hazard Analysis Critical Control Point System**. This is used to identify critical points in the system for disease, contamination control - a multiple barrier approach. This may increase consumer perception of safe seafood.

Disease

- As population density increases in aquaculture production systems, so will risk for disease within the population. As intensive farming practices develop fish could become more susceptible to disease due to increased stress, poor water quality, etc., causing increased use of antibiotics, potential loss of stock, and the risk of inadvertent release of disease into the environment possibly impacting wild fish stocks.
- Imported stock will increase the risk for foreign disease introduction as demonstrated by recent shrimp pathogens.

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