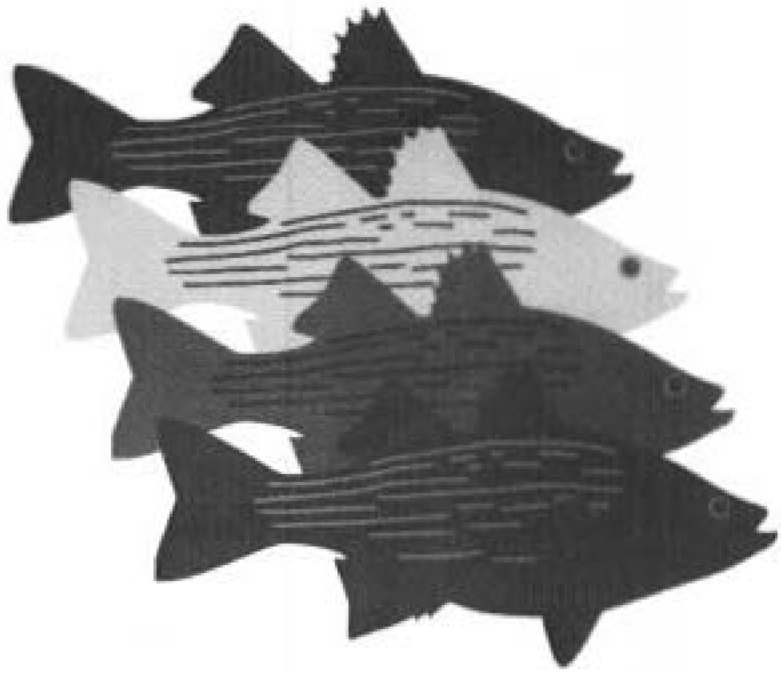
# *The Hybrid Striped Bass Industry*

## *From Fish Farm to Consumer*



# The Hybrid Striped Bass Industry From Fish Farm to Consumer

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## Introduction

The hybrid striped bass culture industry has expanded substantially during the past several years with U.S. production of food fish estimated to be almost 9,000,000 pounds in 1995. As markets expand, it becomes increasingly important that product be properly handled to ensure market demand. In addition to the traditional whole fresh fish product, new products are being developed that will require more processing facilities which comply with federal standards.

This brochure provides guidance to new and seasoned farmers in the proper handling of their fish from the farms to the consumer. Current information on sanitation requirements and products as well as the HACCP model for aquaculture is presented. Further, unique aquaculture safety considerations are discussed including a listing of FDA low regulatory priority drugs and substances for use in aquaculture. Adherence to the information contained in this brochure will help maintain hybrid striped bass as a high quality and highly desired product.

## Quality

There are three basic tenets of quality: (1) quality is the extent to which a product fulfills a customer's needs and wants; (2) customers are better able to recognize poor quality than identify what is good quality; and (3) certain basic aspects of quality are non-negotiable (i.e., consumers and customers require that products are safe and wholesome). A step above the basics is that the product must meet the customer's needs and fulfill all of its expectations. Customers demand that "they get what they pay for".

Quality encompasses all activities of the business operation. In most cases, customers who demand quality are willing to pay the extra cost, provided the product delivers top quality.

Quality loss can begin during the harvesting process and continue throughout post-harvesting activities. Physical damage, adhering dirt and filth to the fish, bacterial spoilage, and enzymatic and chemical changes all contribute to the loss of quality in fish. Quality loss will ultimately impact price and reputation of the company.

Immediately upon harvest, deleterious changes occur in the fish. These changes occur as a result of enzymes, bacteria, and chemical actions. Deleterious changes can be minimized and the rate of degradation reduced by proper planning of harvesting and post-harvesting activities, general cleanliness, good temperature control, and rapid movement of the product throughout the distribution process.

## Post Harvest Activities

The first step in maintaining quality is to harvest the fish quickly and efficiently with minimal stress. As soon as the fish are removed from the pond or tank, they should be rinsed with clean water to remove bacteria, mud/dirt, and other adhering extraneous material. The gill areas directly under the operculum should receive special attention as mud and debris may have accumulated during the removal of these fish from earthen ponds or tanks.

The fish should be "chill/killed" quickly using an ice slurry tank to minimize bruising, stress, and quality loss. Good planning is important at this step, since any substantial delay will result in some loss of quality. As the harvesting process may take several hours to complete, a building, shed, or, at the very least, white tarp should be set up to provide shade to store the harvested iced, chilled, and/or packaged fish.

Most fish farms will not have a sufficient number of chill tanks to hold all of the harvested fish. In such situations, fish farms will use the "chill" tank to "kill" the fish. The fish are then removed from the tank and placed into insulated containers where flaked or crushed ice is used to chill the fish to the desired final temperature.

## Determining Ice Requirements

Determining the amount of ice needed to chill the fish to the desired temperature is dependent on: (1) expected weight of fish harvested; (2) initial temperature of the fish and the pond/tank water; (3) volume of the chill tank or container; and (4) amount of thermal loss in the chill tank or ice box due to heat transfer from the outside environment.

The approximate amount of ice needed by the fish farmer to chill a known weight of fish to the final desired temperature can be calculated from the following equation (adapted from Kolbe et al., 1985):

$$WI = WF\,(.85)\,(T1 - T2) / 144$$

Where WI = weight of ice needed (lbs)
WF = weight of fish (lbs)
T1 = initial temperature of water (°F)
T2 = final desired temperature of the fish (°F)

As an example, the estimated amount of ice needed to cool 2,000 pounds of fish from 75°F to 32°F can be calculated from the equation developed by Kolbe. In this instance, WF = 2,000 pounds, T1 = 75°F, T2 = 32°F. Solving the equation: WI = 2000(.85)(75-32)/144 results in approximately 507.6 pounds of ice needed to cool 2,000 pounds of fish from 75°F to 32°F.

In practice, much more ice is needed to efficiently cool the fish to compensate for thermal losses. These thermal losses can be estimated from ice consumption studies described in the next section. A combination of the results from thermal ice consumption studies and the above equation can then be used to estimate the total amount of ice required to chill the harvested fish to the desired final temperature.

## Ice Consumption Studies

Use of a shaded area and an insulated tank will reduce the amount of outside heat which leaks into the chill tank. Thermal losses can be calculated, but more accurate estimates can be determined if on-site meltage studies are conducted under actual working conditions. Water chill/kill tank temperature tests are easy to conduct and require no fish to conduct the study. The insulated chill tanks are filled with an estimated quantity of ice and water. Temperatures are recorded at set time periods under actual field conditions.

Ice meltage tests for boxed fish can also be conducted in a similar manner. The containers or boxes are filled with ice and weighed at the start of the test. At set periods of time, under actual field conditions, the water is drained and the container is weighed again. The loss of weight is an indication of ice meltage due to thermal losses (Huss 1995).

## Chill Tanks

The fastest method for cooling fish is with chilled water, although the practical difference versus flaked ice alone is not great (Huss 1995).

Add water to the level of the ice mass in the chill tank before adding the fish. As the ice melts, add more ice to maintain an ice-to-water ratio of approximately one-to-one. Crushed or cubed ice is the most desirable form for use in the chill/kill tank.

Fish should remain in the chill tank until their core temperatures reach a minimum of 38°F and as close to 32°F as is practical. The freezing point of water is 32°F. The addition of 3% salt to the ice (weight-to-weight basis) will reduce the freezing point of the ice water slurry to approximately 29°F, chilling the fish more rapidly.

Figure 1.
Harvested fish should be quickly chill-killed in an ice water slurry.

## Box Chilling

The cooling rates depend on the surface area of the fish per unit weight of the fish. In other words, "the thicker the fish the slower the cooling rate" (Huss 1995). Similarly, the warmer the fish the longer the cooling time.

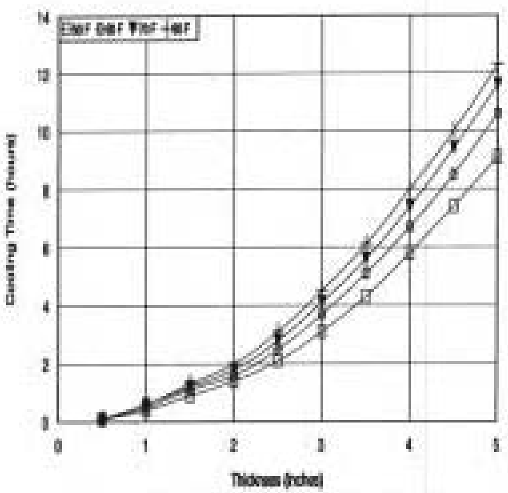
Flaked or crushed ice should surround the fish. Ice should be placed on the top and bottom of the container for maximum cooling effectiveness. Flaked ice will chill fish more rapidly than crushed, cubed, or block ice. The cooling abilities of crushed and flaked ice are similar. Crushed ice, however, will last longer than flaked ice, and is, for that reason, the recommended form of ice for chilling boxed fish (Huss 1995).

Fish should remain in the ice until their core temperatures reach a minimum of 38°F and as close to 32°F as is practical. The time needed to cool the fish to the desired temperature must be determined on a farm-to-farm basis under actual field conditions.

Figure 2.
Fish being iced and boxed.

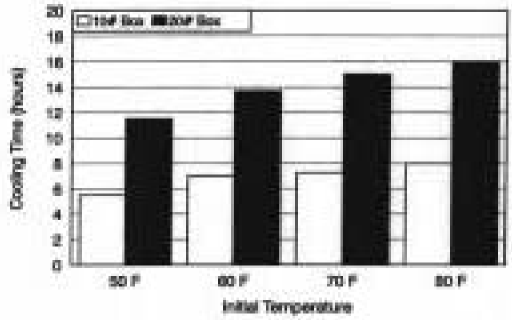
The effects of time and temperature on cooling rates of fish are shown in Figures 3 and 4.

Figure 3.
Time needed to cool individual fish to approximately 32°F using ice (NFI 1991, reproduced with permission).




Curves correspond to the temperature of the fish prior to cooling as designated above in the legend.

Figure 4.
Time needed to cool 10 and 20 pound boxes of fish to approximately 32°F using ice (NFI 1991, reproduced with permission).




## Sensory Evaluation

Before making final arrangements for harvest and sale, a sample of fish should be removed from the pond or tank and evaluated for their sensory characteristics. Whole fish should be examined with regard to the sensory characteristics shown in Table 1.

Table 1.
Sensory characteristics for harvested whole fish.

| GOOD | BODY PART | POOR |
|---|---|---|
| Clear, Bright; Bulging; Black Pupil | Eyes | Dull; Sunken; Cloudy; Gray Pupil |
| Bright Red; Free of Slime; Clear Mucus | Gills | Brown to Grayish; Thick, Yellow Mucus |
| Firm and Elastic to Touch; Tight to the Bone | Flesh | Soft and Flabby; Separating from Bone |
| Inoffensive; Slight Seaweed Scent | Smell | Ammonia; Putrid Smell |
| Adhere Lightly to Skin; Bright Color; Few Missing | Scales | Dull; Large Quantities Missing |
| Complete Washing and Evisceration, Lining Intact, Slight Gloss | Belly Cavity (gutted) | Incomplete Evisceration; Cuts; Bones Loose from Flesh |

The fish should also be filleted and evaluated in the raw and cooked state for color, odor, and flavor characteristics. The fillets should have good odor and flavor with no unpleasant off-flavors or odors. Particular attention should focus on the dark lateral line muscle meat, as this tissue tends to deteriorate more rapidly than the white muscle meat.

Cooked fillets can be prepared by placing a two to three ounce portion in a covered dish in a microwave for two to three minutes on high power. Attention should focus on determining the presence or absence of geosmin, earthiness, and blue-green algae flavors and odors, in newly harvested fish (Table 2).

If the fish have been stored on ice or frozen, they should also be evaluated for the presence of sourness, rancidity and ammonia. The detection of these characteristics should be cause for rejection of the fish (Table 2).

Table 2.
Sensory characteristics used in the rejection of fish.

**Geosmin/Dry Musty** - Flavor and odor associated with musty old books.

**Earthiness** - Flavor and odor associated with slightly undercooked boiled potato, soil, or muddy fish.

**2-methylisoborneol (MIB)/Wet Musty** - Flavor and odor associated with mud and blue-green algae.

**Sourness** - Taste sensation produced by acids. The taste of vinegar or lemon are typical examples.

**Rancidity** - Flavor associated with strong, oxidized, rank, acrid flavor.

**Ammonia** - Flavor and odor associated with ammonia.

## Packaging and Transport

The fish should be chilled to as close to 32°F as possible for maximum freshness. Temperature of packaged fish can be maintained, but it is not easily reduced. Packaging materials have different abilities for effective insulation of seafood products. The insulation properties of materials used to package seafood are shown in descending order of effectiveness in Table 3 (NFI 1991).

Table 3.
Insulation properties of different materials used to package seafoods (NFI 1991, reproduced with permission).

| | |
|---|---|
| • Urethane Foam | **GOOD INSULATOR** |
| • Polystyrene Foam | ↓ |
| • Shredded Paper | |
| • Double-walled Corrugated | |
| • Excelsior | **POOR INSULATOR** |

Basic packaging guidelines should be followed to ensure that the product arrives at its intended destination in ex-cellent quality. Guidelines include: (1) the packaging should be chosen according to its durability, insulation ability, ease of handling, and water tightness; (2) fish should be pre-chilled to as close to 32°F as possible; (3) pre-chill the inside of the packaging container before placing the fish in the container; (4) chose the proper coolant (e.g., gel refrigerant, wet ice in sealed bags, or dry ice); (5) put coolants to absorb heat on the top and bottom; and (6) minimize the time between packing and shipment (NFI 1991).

The proper sized container should also be chosen to hold the product and refrigerant with a minimum of extra space. Excess air space reduces efficiency by setting up convection air currents in the container.

The fish should be placed in polyethylene bags inside the packaging container to prevent drip loss from soaking the package. Bagging the fish with three mil or double bagging with two mil polyethylene is recommended. The outer box should be constructed of corrugated paper board or solid fiberboard. Banding and other outside sealing methods should be designed not to cut into the packaging box (NFI 1991).

The boxes should be palletized to better maintain package integrity and product temperature. Figure 5 shows a generalized example of the warming of single packages versus cartons during transit. The size and shape of a container has a direct effect on its ability to maintain temperature. In a single package versus palletized containers, the surface area in relation to volume is larger and it will warm faster (Graham 1985).

Figure 5.
General example of the rate of warming of single packages and cartons during transit (Adapted from Graham 1982).

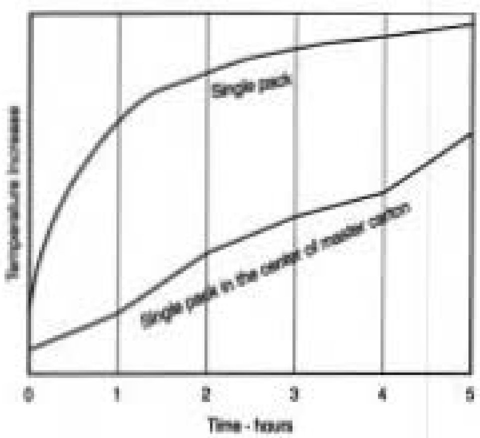
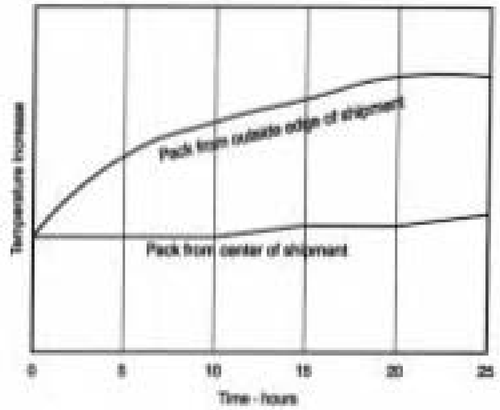



Figure 6 shows a generalized example of the effect of load position in the truck on temperature of boxed product. Fish boxes at the edge and corners of a truck warm faster than at the center. Air spaces should be left between the boxes and the truck walls so that cold air can be circulated (Graham 1985).

Figure 6.
General example of affect of temperature on position of load (Adapted from Graham 1982).




## Labeling Requirements

The insulated boxes should be clearly labeled with the name and address of the packer and receiver, product identification information, and net weight of the fish. Ideally, the shipments should be labeled on the outside of each box with the words "PERISHABLE FRESH BASS" or "PERISHABLE SUNSHINE BASS".

*Air Transport*

Air shipment of seafoods requires that the air bill includes the name and address of the shipper and consignee and indicates the number of packages and weights of the shipment. Inclusion of a 24-hour telephone number is required on the container as well as on the air bill. Ideally the shipments should be labeled on the outside of the container with the common name of the species such as "PERISHABLE FRESH BASS", "PERISHABLE SUNSHINE BASS" or "PERISHABLE FROZEN BASS". On the outside of the container the contents should be identified as "LIVE", "FRESH", or "FROZEN".

## Further Processed Fish

Some information is available from the National Marine Fisheries Service (NMFS) on the composition, sensory characteristics and storage shelf life of hybrid striped bass (Jahncke et al., 1988; Jahncke 1989). Sensory studies indicate that newly harvested fish have a mild total odor and flavor intensity with moderate sweetness. The flesh is moderately flaky, slightly fibrous, moist, soft, and easy to chew. The dark lateral line flesh may have a slight earthy flavor, which can be reduced by deep skinning the fillet to remove some of the dark lateral line muscle meat.

During iced or frozen storage whole fish or headed and gutted hybrid striped bass retain quality for a longer time and have a longer shelf life than fillets. The additional processing of fillets results in larger exposed surface areas which accelerate quality degradation due to enzymatic, chemical, and bacterial action.

Research studies showed that if fish are handled and packaged properly, iced skinless hybrid striped bass fillets had a shelf life of approximately 13 days. Skinless fillets stored at 0°F developed unacceptable rancid, oxidized odors and flavors at six months of storage. The highest quality in these fillets was maintained up to six days in iced storage and four months in frozen storage (Jahncke et al., 1988; Jahncke 1989).

In contrast, iced headed and gutted fish have a shelf life of 16 days. Headed and gutted fish had acceptable flavor and odor for more than 12 months in frozen storage. High quality in these fish was maintained up to nine days in iced storage and ten months in frozen storage (Jahncke et al., 1988; Jahncke 1989).

## Sanitation

The hybrid striped bass industry is growing. To reach its full potential, the industry must expand beyond the whole, fresh fish market.

An effective sanitation program is needed for further processing of value added, high quality finfish products. Effective sanitation consists of two components covering personal hygiene and product wholesomeness.

Finfish must be processed in a manner that reduces enzymatic action, controls the growth of bacteria, and prevents outside contamination of the product. Processing plant personal must be educated on the basics of personnel hygiene requirements and proper food handling procedures. The Good Manufacturing Practices (GMP) (21 CFR 110) are published by the Food and Drug Administration (FDA) and describe the basic sanitation requirements covering plant grounds, building construction and design, equipment and utensils, sanitary facilities and operations, pest control, potable water, acceptable processes, and personnel practices. The GMP documents can be obtained from the FDA and state health departments.

The mandatory FDA Hazard Analysis Critical Control Point (HACCP) regulations contain provisions encouraging, but not requiring, Sanitation Standard Operating Procedures (SSOPs) in eight sanitation areas. The eight areas are: (1) safety of water that comes into contact with food or food contact surfaces, or water used in manufacture of ice; (2) condition or cleanliness of food contact surfaces, utensils, gloves, and garments; (3) prevention of cross-contamination; (4) maintenance of hand washing, hand sanitizing, and toilet facilities; (5) protection of food, packaging material, and food contact surfaces by adulteration with chemical, physical, and/or biological contaminants; (6) proper labeling, storage, and use of toxic compounds; (7) control of employee health conditions; and (8) exclusion of pests from plant (USSI News 1996).

## Common Detergents and Sanitizers

Prerequisite sanitation procedures within a facility in conjunction with a HACCP program can help to ensure that the fish are produced free of harmful bacterial and chemical hazards. Sanitation programs follow four basic steps: (1) pre-rinse of equipment to remove food particles and dirt; (2) physical removal of food particles and dirt by detergents; (3) rinse with potable water to remove detergents; and (4) application of sanitizers to control both pathogenic and non-pathogenic bacteria.

A variety of detergents and sanitizers are used in the seafood industry (Table 4). Quaternary Ammonium Compounds (Quats) are cationic surfactants used on floors, walls, and aluminum equipment. Iodophors are compounds which contain free elemental iodine and function as antimicrobial agents. Active chlorine compounds (especially sodium hypochlorites) are commonly used as sanitizers. Acid-anionic sanitizers (especially phosphoric acid) are particularly suited for stainless steel and can help prevent mineral deposits. Additional information is available from local state health departments (Giese 1991).

Table 4.
Common detergents and sanitizers used in processing seafoods (Adapted from Flick 1991).

| Situation | Sanitizer | Concentration (ppm) |
|---|---|---|
| Organic Matter | Quaternary | 200 |
| Plastic Crates | Iodophor | 25 |
| Porous Surfaces | Active Chlorine or<br>Quaternary | 200<br>200 |
| Stainless Steel | Acid Sanitizer<br>Active Chlorinate<br>Iodophor | 130<br>200<br>25 |
| Rubber Belts | Iodophor | 25 |
| Walls | Active Chlorine<br>Quaternary | 200<br>200 |
| Water Treatment | Active Chlorine | 20 |
| Wood Crates/Pallets | Active Chlorine | 1,000 |
| Hand Dips | Iodophor<br>Active Chlorine | 25<br>50 |

## Unique Aquaculture Safety Considerations

*Pesticide Action Levels*

Aquacultured products are wholesome. Nevertheless, aquacultured products can present some unique safety hazards. The FDA is responsible for ensuring the safety, wholesomeness, and proper labeling of food products, ensuring the safety and effectiveness of animal drugs, and protecting consumers from economic fraud.

The Environmental Protection Agency (EPA) has established federal action levels for some pesticides in fish (Table 5).

Violative concentrations may occur in farmed fish from pesticide runoff into production waters or from contaminated feedstuffs.

*Animal Drugs and Vaccines*

The Federal Food, Drug, and Cosmetic Act (FFDCA) includes provisions for regulating the manufacture, distribution and use of new animal drugs and feeds. Table 6 provides a list of FDA approved new animal drugs as well as unapproved drugs of Low Regulatory Priority (LRP) for aquacultured species. The FDA is not aware of any safety problems associated with the use of LRP unapproved animal drugs. Regulatory action is unlikely if the drugs are used for prescribed indications at the prescribed dosages; an appropriate grade is used; good management practices are followed; and local environmental requirements are followed (NAA 1996).

Table 5.
The federal action level for pesticides in fish. Product recall may occur if pesticide concentrations exceed these levels (Adapted from FDA 1996, Fish and Fishery Products Hazards and Controls Guide).

| Deleterious Substance | Level (ppm) | Food Commodity | Reference |
|---|---|---|---|
| Aldrin/Dieldrin[1] | 0.3 | All fish | CPG sec. 575.100 |
| Chlordane | 0.3 | All fish | CPG sec. 575.100 |
| Chlordecone[2] | 0.3 | All fish | CPG sec. 575.100 |
| DDT, TDE, DDE[1] | 5.0 | All fish | CPG sec. 575.100 |
| Diquat[3] | 0.1 | All fish | 40 CFR 180.226 |
| Fluridone[3] | 0.5 | Fin fish and crayfish | 40 CFR 180.420 |
| Glyphosate[3] | 0.25 | Fin fish | 40 CFR 180.364 |
| Heptachlor/ Heptachlor Epoxide[1] | 0.3 | All fish | CPG sec. 575.100 |
| Mirex | 0.1 | All fish | CPG sec. 575.100 |
| PCBs[3] | 2.0 | All fish | 21 CFR 109.30 |
| Simazine[3] | 12.0 | Fin fish | 40 CFR 180.213a |
| 2, 4-D[3] | 1.0 | All fish | 40 CFR 180.142 |

[1] The guidance levels are for residues of the pesticides individually or in combination. Do not count aldrin or dieldrin found at or below 0.1 ppm. When adding amounts, do not count DDT, TDE, or DDE found below 0.2 ppm. Do not count heptachlor or heptachlor epoxide found below 0.1 ppm.
[2] Previously listed as Kepone, the trade name of chlordecone.
[3] The levels published in 21 CFR and 40 CFR represent tolerances, rather than guidance levels.

Table 6.
Federally approved drugs currently labeled or of Low Regulatory Priority (LRP) compounds for use in aquaculture with their species and withdrawal times. This list may change. Follow product label instructions or use as directed below. Each drug is approved for specific species, specific diseases, and specific dosages with specific withdrawal times. Currently, there are no approved drugs for hybrid striped bass (Adapted from FDA Fish and Fishery Products Hazards and Controls Guide 1996; JSA 1994).

| Product | Sponsor | Use | Withdrawal Time |
|---|---|---|---|
| Formalin:<br>Formalin-F<br>Paracide-F | Natchez Animal Supply<br>Argent Chemical Lab | Control of external protozoa, monogenetic trematodes in salmon, trout, catfish, largemouth bass, and bluegill, and control of egg fungi of salmon, trout, and pike (esocidae) (21 CFR 529.1030). | None<br>None |
| Parasite-S | Western Chemical, Inc. | Use in the above and treatment of shrimp (21 CFR 529.1030). | None |
| Oxytetracycline (Terramycin for fish) | Pfizer, Inc. | Feed use to control ulcer disease, bacterial hemorrhagic Septicemia, pseudomonas disease, and furunculosis in salmonids, catfish, and lobster. Flesh tolerance 0.1 ppm (21 CFR 556.500). Product currently not marketed. | 7 days - Pacific Salmon<br>21 days - Other Salmonids and Catfish<br>30 days - Lobster<br>(21 CFR 558.450) |
| Sulfadimethoxine/ Ormetoprim combination | Hoffmann-La Roche, Inc. | Use in salmonids and catfish flesh. Tolerance in flesh for both drugs is 0.1 ppm (21 CFR 556.640). | 3 days - Catfish<br>42 days - Salmon<br>(21 CFR 558.575) |
| Sulfamerazine | American Cyanamid Co. | Control of furunculosis in trout only. Tolerance in flesh is zero (21 CFR 556.660). | 21 days of harvest<br>(21 CFR 558.582) |
| Tricaine methane-sulfonate (MS-222) | Argent Chemical Lab | Temporary immobilization (anesthetic) for catfish, salmon, trout, pike (esocidae), and perch (percidae) (21 CFR 529.2503). | 21 days of harvest |
| Acetic acid (Vinegar) | *LRP | Parasiticide at 1,000-2,000 ppm dip for 1-10 minutes. | None |
| Calcium chloride | *LRP | Increase water hardness to 150 ppm or increase calcium hardness for egg hardening. | None |
| Calcium oxide | *LRP | External protozoacide at 2,000 ppm for 5 seconds. | None |
| Carbon dioxide gas | *LRP | Anesthetic. | None |
| Fuller's Earth | *LRP | Reduce egg adhesiveness. | None |
| Garlic (Whole) | *LRP | External helminth and sea lice control. | None |
| Hydrogen peroxide | *LRP | 250-500 mg/l for fungal control. | None |
| Ice | *LRP | Reduce metabolic rate. | None |
| Magnesium sulfate (Epsom salt) | *LRP | 30,000 ppm magnesium sulfate plus 7,000 ppm sodium chloride for 5-10 minutes for external trematodes or crustacean infestations. | None |
| Onion (Whole) | *LRP | External helminth and sea lice control. | None |
| Papain | *LRP | Use in 0.2% solution to improve hatchability. | None |
| Potassium chloride | *LRP | Dose to increase chloride concentration to 10-2,000 ppm as osmoregulatory enhancer. | None |
| Povidone iodine | *LRP | Egg disinfectant at 100 ppm for 10 minutes after water hardening or 50 ppm for 30 minutes during water hardening. | None |
| Sodium bicarbonate (Baking soda) | *LRP | Anesthetic at 142-642 ppm for 5 minutes. | None |
| Sodium chloride (Salt) | *LRP | Osmoregulatory aid at 0.5-1% solution indefinitely or parasiticide at 3% for 10-30 minutes. | None |
| Sodium sulfite | *LRP | 15% solution for 5-8 minutes to treat eggs to improve hatchability. | None |
| Urea and Tannic Acid | *LRP | 15 g urea and 20 g NaCl in 5 l of water for 6 minutes followed by 0.75 g tannic acid in 5 l of water for 6 additional minutes. | None |

*LRP = Low regulatory priority drugs. FDA is unlikely to object to the use of these drugs if they are used for the prescribed (above) uses, at the prescribed doses (above) according to good management practices, a product grade suitable for food animals is used and there is not likely to be any adverse effect on the environment. These drugs can be used on any life stage.

## Information Sources

Each animal drug is approved for specific species, specific diseases, at specific dosages, and specific withdrawal times to ensure no violative residues. Check with the FDA before using any of these compounds listed in Table 6 as listing classifications may change.

The Guide to Drug, Vaccine and Pesticide Use in Aquaculture (Publication B-5085) is available from:

- Dr. James Davis
  Texas A&M University
  102 Nagle Hall
  College Station, TX 77843-2258
  Tel: 409/845-7473 FAX: 409/845-7103
  Cost: $5.00

It is also available from state Cooperative Extension Services, state Sea Grant Marine Advisory Services, and national aquaculture associations.

### OTHER FEDERAL CONTACTS:

Information on approved drugs, regulations, and policies:

- Office of Surveillance and Compliance Center for Veterinary Medicine
  (HFV-200)
  7500 Standish Place
  Rockville, MD 20855
  301/594-1761

Information on the drug approval process:

- Office of New Animal Drug Evaluation
  (HFV-100)
  7500 Standish Place
  Rockville, MD 20855
  301/594-1620

USDA Animal and Plant Health Inspection Services (APHIS) Licensing and program policy information:

- Veterinary Biologics
  APHIS
  Room 838, Federal Building
  6505 Belcrest Road
  Hyattsville, MD 20782
  301/436-8245

U.S. Environmental Protection Agency: Information on registration requirements, tolerances, and experimental use permits:

- Office of Pesticide Programs, EPA
  Registration Division (7505W)
  Registration Support Branch
  401 M Street, SW
  Washington, DC 20460
  703/308-8340

U.S. Department of the Interior: For assistance with aquaculture INAD exemptions and related information.

- National Aquaculture New Animal Drug Application Coordinator
  Rosalie Schnick
  3033 Edgewater Lane
  LaCrosse, WI 54603-1088
  608/781-2205

U.S. Department of the Interior: Information on Investigational New Animal Drugs (INAD).

- National INAD Coordinator
  Dave Erdahl
  USFWS Bozeman Fish Technology Center
  Bozeman, MT 59715
  406/587-9265

### CONSUMER HOTLINES:

- The Animal & Plant Health Inspection Service (APHIS) Consumer Hotline: 515/232-5789.

Consumer Hotline can be used to report problems with veterinary biologic or diagnostic test kits or to obtain information.

- EPA National Pesticide Telecommunications Network (NPTN): 1-800-858-7378.

Information on pesticide products, human and animal poisonings, protective equipment, safety, health and environmental effects, clean up, and disposal procedures.

- FDA Office of Seafood: 1-800-FDA-4010.

Information on seafood safety, HACCP publications, proper use of drugs and chemicals, etc.

# HACCP MODEL for AQUACULTURE

## HACCP

The Food and Drug Administration published a proposed rule to establish requirements relating to the application of mandatory HACCP principles by processors and importers to ensure food safety to the maximum extent possible. The Final Rule describing the implementation of the proposed HACCP-based inspection system was published December 18, 1995 (Federal Register 1995), and is scheduled for implementation on December 18, 1997.

Hazard Analysis for Critical Control Point (HACCP) is a preventative system of food control that requires a hazard analysis be conducted on the product and process and that Critical Limits (CLs) are set at each Critical Control Point (CCP) of the process. A CCP is defined as a step at which control can be applied to prevent or eliminate a food safety hazard or reduce it to an acceptable level. When "real time" monitoring of the Critical Control Points reveals that Critical Limits are being violated, specific corrective actions are taken to isolate all noncomplying products.

Once the product is noncomplying, a specific hazard analysis is performed on the product to determine its proper disposition as well as to determine what went wrong to produce the noncomplying product. Once the cause of the process malfunction is determined, a "short-term" fix is immediately instituted and a long-term solution is identified and scheduled for implementation. All of these activities are documented through corrective action reports, including the final disposition of the noncomplying product.

By means of these systematic monitoring and surveillance procedures the "nice" from the "necessary" controls are separated, so that major errors can be prevented. This allows focusing of resources, money, people, and equipment on the essential elements of a food control system.

## HACCP Team

HACCP is a two-step process. The first step is to assemble a HACCP team consisting of people who have specific knowledge and expertise of the operation. The team describes the food and method of distribution, intended users, and consumers of the product. Next the team develops a flow diagram which describes the process, followed by on-site verification of the flow diagram.

## HACCP Principles

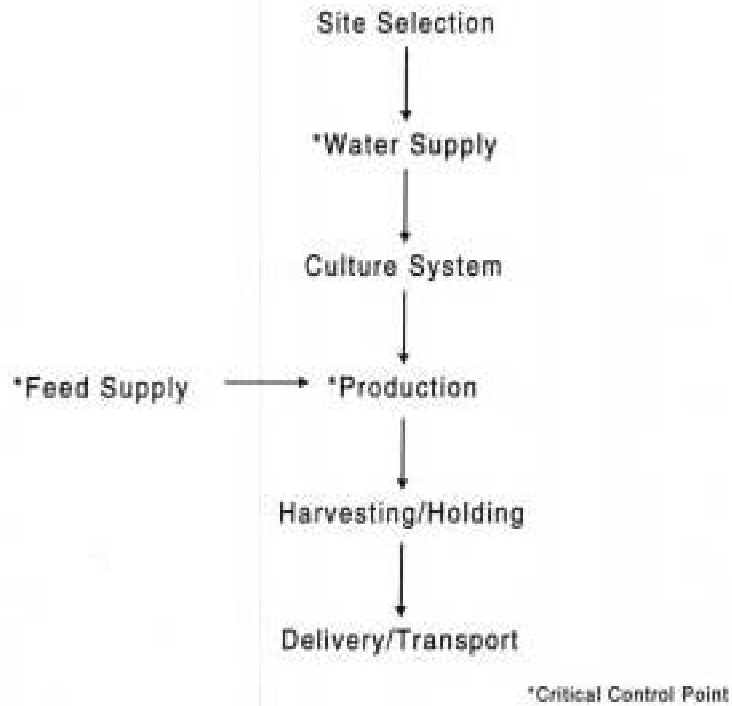
The second step requires the team to apply the following seven HACCP principles which are used to implement the basic HACCP plan structure.

1. Perform Systematic Hazards Analysis
2. Determine Critical Control Points
3. Establish Critical Limits
4. Determine Appropriate Corrective Actions
5. Establish Monitoring Procedures
6. Establish Record Keeping Systems
7. Establish Verification Procedures

# Generic Flow Diagram

This generic flow diagram has been developed for finfish aquaculture which includes identified Critical Control Points (CCPs) (Figure 7).

Figure 7.
Production flow chart for finfish aquaculture showing the CCPs (NMFS 1991).




# Operational Steps

Operational steps in the aquaculture production of finfish range from site selection to delivery and transport (Table 7).

Table 7.
Identification of control points, preventive measures, and monitoring procedures in aquaculture finfish production (Adapted from NMFS HACCP Regulatory Model, Aquaculture 1991).

| STEP | HAZARD | CONTROL POINTS | IMPORTANCE[1] | PREVENTIVE MEASURES | MONITORING | RECORDS |
|---|---|---|---|---|---|---|
| 1. Site selection | Potential transfer of harmful contaminants to fish | Soil | 3 | History of previous use<br><br>If no history, conduct soil analysis | Initial soil analysis prior to construction | |
| 2. Water supply | Harmful chemical contaminants | Water source/ pond | 4 | Review geological and hydrographic survey data<br><br>Review available records on water quality<br><br>Control of point and non-point source of contaminated agriculture run off | Initial chemical analysis<br><br>Conduct water analysis when need arises | Initial water analysis data<br><br>Monitoring data |
| 3. Culture system | Chemical contamination from construction materials and coatings | Culture facilities | 2 | Use proper approved construction materials and coatings<br><br>Check construction<br><br>Proper maintenance | Adhere to maintenance schedule | |
| 4. Feed supply | Chemical, microbiological contaminants (e.g., aflatoxin)<br><br>Unapproved additives<br><br>Antibiotics | Feed mill | 5 | Feed manufacturer compliance with FDA, EPA and state regulations | Appropriate monitoring by federal and state agencies<br><br>Supervisory controls[2] | Source of feed and type of medication used<br><br>Treatment or additive use logs[2] |

[1] The importance rating scale is 1-5 with 5 being the most important. Any step with an importance rating of 4-5 is considered a critical control point.
[2] Reflects the need for documentation of proper chemical or drug use.

Table 7 (continued).

| STEP | HAZARD | CONTROL POINTS | IMPORT-ANCE[1] | PREVENTIVE MEASURES | MONITORING | RECORDS |
|---|---|---|---|---|---|---|
| 5. Production | Misuse of registered or use of non-registered chemicals, pesticides, or drugs<br><br>High antibiotic levels in the flesh due to inadequate withdrawal times<br><br>Human pathogen contamination of fish | Culture facilities | 5 | Use of approved chemicals or drugs at proper concentrations and withdrawal times<br><br>Use in accordance with label<br><br>Do not use human waste contaminated feed and water | Supervisory controls | Chemical or drug use logs and harvesting dates<br><br>Log of Notice of Unusual Occurrence and Corrective Action (NUOCA) |
| 6. Harvesting and holding | None | Harvesting site | 1 | None | None | |
| 7. Delivery and transport | Spoilage<br><br>Microbial or foreign contamination | Shipping | 3 | Proper temperature control<br><br>Use of Good Manufacturing Practices (GMPs) | Proper supervisory controls | |

[1] The importance rating scale is 1-5 with 5 being the most important. Any step with an importance rating of 4-5 is considered a critical control point.
[2] Reflects the need for documentation of proper chemical or drug use.

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