Shipping Practices in the Ornamental Fish Industry

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Introduction

One of the most critical determinants of the success of these farms is the problem of delivering a quality product to market destinations. At times, Hawaii's geographic location (Figure 1) offers a strategic advantage for growers, but our islands' isolation also presents an obvious constraint - the relatively long distances to final market destinations. The location of the main markets dictates that the mode of transportation will be through the various airline carriers operating out of Hawaii, and the duration of transport will range between 48 and 72 hours. The purpose of this manual is to address some of the critical handling and packing methods that are essential for insuring the successful transport of live tropical fish to their final market destination.

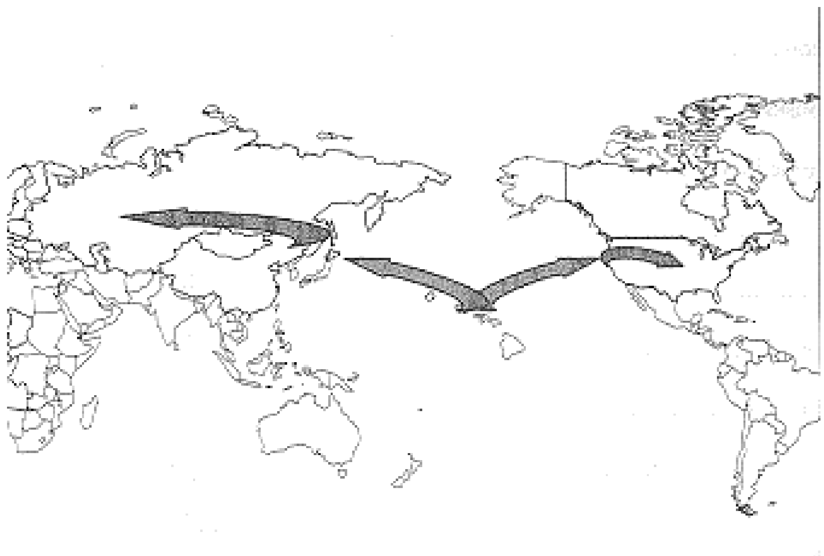


Figure 1. Schematic diagram of routes for transporting ornamental fish from Hawaii.

In the course of a 72-hour trip from the farmsite to the delivery site, fish are confined within plastic bags charged with oxygen. During transport, the water in these closed containers may become oxygen-depleted, and may accumulate excessive carbon dioxide and consequently undergo a reduction in pH. Metabolic activity may also lead to elevated ammonia levels in the water, which can be damaging to fish health, or become lethal in extreme cases. A densely-packed shipping container increases these risks but reduces the cost of transportation - a critical cost in the delivery of product at competitive prices. The dilemma of the shipper is to strike the ideal balance of conditions under which fish can be shipped cost-effectively, without unnecessary risk of injury or mortality. Fortunately, much of the guesswork has been eliminated, and this manual will outline procedures and packing densities that should get the fish to their destination in good condition.

Freight Considerations

When you consider total transport time, perhaps the most important aspect of shipping fish lies with the airline itself, and for that reason air freight considerations are being presented prior to any discussion about the other requirements for shipping of live fish. Very careful consideration must be given to the airline schedule and procedures it uses to handle freight. These parameters vary widely from airline to airline, and also depend upon whether or not the fish have to be transferred to another plane to reach their final destination. For farmers just beginning to ship fish to markets outside the state it is suggested that they initially concentrate on markets that have direct flights from Hawaii. This will minimize the risk of lost freight or delayed shipping, which most often occurs during transfer from one plane to another. The state of Hawaii has many direct flights not only to destinations in the United States but also to other parts of the world. Check with the individual airlines for the destinations that they serve with a schedule of direct flights, and inquire about their policies of available freight space, which can change with demand and time of year.

Some important questions to consider when choosing a carrier are:

- What is the total transit time to the final destination? Be sure to calculate this beginning from the time the bag is sealed at the farm.
- Is there a plane transfer en route?
- If there is a transfer, do they have climate controlled freight holding? (This can be particularly important during the winter months.)
- What time does the shipment actually arrive? (If the shipment arrives late it may sit in a freight office overnight adding considerably to total transit time.)
- Do live or perishable products have first priority? (During the Christmas season, mail has priority on all U.S. carriers.)
- Does the airline freight office notify the destination customer when the freight arrives?
- If inspection is required will the shipment be delayed if it arrives after normal business hours?

Shipping Practices

All farms, regardless of whether they are shipping to a transhipper, wholesaler or retailer, base their availability list on what is presently in their holding area. This is basically warehousing your stock, like any other distributor, in anticipation of orders that will be placed for the next two to four weeks. Having a constant supply of fish to sell should be considered just another manufacturing process in which a Asupply pipeline@ should remain full in order to meet orders that are being placed.

Most commonly used shipping methods are a variation on a single theme. Fish are packed in plastic bags that are inflated with pure oxygen, closed with rubber bands, placed in an insulated corrugated box, and sealed. The size and shape of these bags and boxes as well as the insulation can vary widely.

Bags

Many of the domestic producers use square bottom bags, as show in Figure 2. These bags utilize the surface area of the box more efficiently. Use of a pleated bag (flat bottom) is highly recommended. Pleated bags utilize the entire surface area of the box allowing maximum oxygen transfer through the surface of the water. They also reduce the effects of crowding by utilizing all of the available area in the box. If the bag is properly placed in the box, crowding in the corners by the fish is kept to a minimum. Boxes are generally packed in bag sizes of full to the corners by the fish is kept to a minimum. Boxes are generally packed in bag sizes of full to quarter. Full bags are those that utilize the entire box, half bags are packed two to a box, quarter bags four to a box. These bags have the following dimensions: full size, 37.5 cm (W) x 37.5 (L) x 55 cm (H), half size, 40 cm x 20 cm x 55 cm, and quarter bags at 40 cm x 10 cm x 55 cm. Square-bottom bags are available pleated and flat bag sizes are listed in Table 1.

Fish packers in Asia generally use bags manufactured from stock tube plastic and heat-sealed at one end so there is only a single seam. Examples of this type of bags are shown in Figure 3. These are called “pillow bags” in the industry, because when they are inflated there is no flat surface, and packing water surface is increased by shipping these bags on their side.

Due to inexpensive manufacturing costs, there is a much wider size selection available in this type of bag, ranging from small bags (7.5 cm x 17.5 cm), intended for packing of individual fish up to sizes of 35 cm x 65 cm for packing large numbers of small fish. Large bags usually contain 5-7 liters with a water to oxygen volume ratio of from 35% water to 65% oxygen or 20% water to 80% oxygen. The number of fish packed in this type of bag will range from 200-500 fish with the smaller shipping bags containing proportionally fewer fish to insure 48 hours survival of fish in transport.

Table 1. Types and sizes of bags commonly used to ship ornamental fish.

Flat Bags (pillow bags) (Length cm x width cm)	Pleated Bags (square bottom) (length cm x width cm x depth cm)
65 x 35 (bull bag)	37.5 x 37.5 x 55 (full bag
60 x 27.5	40 x 20 x 55 (half bag)
57.5 x 25	20 x 20 x 50 (quarter bag)
57.5 x 22.5 (half bag)	15 x 10 x 45 (eighth bag)
42.5 x 22.5	10 x 10 x 40 (sixteenth bag)
37.5 x 20	
22.5 x 17.5	
25 x 12.5 (quarter bag)	
20 x 10 (eighth bag)	
17.5 x 7.5 (individual bag)	

cm = centimeter 2.45 cm = 1.0 inch

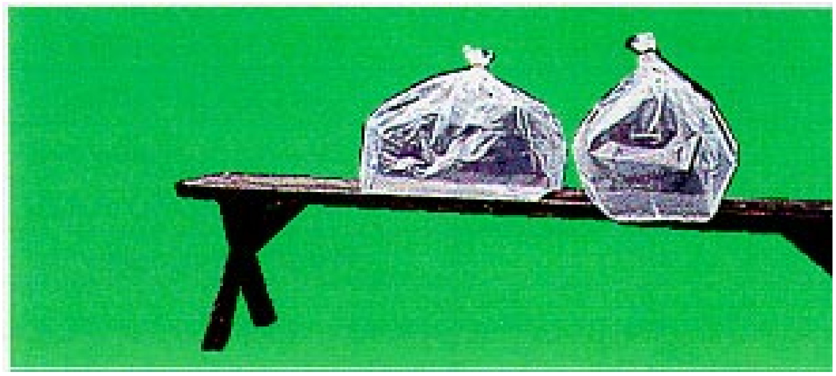


Figure 2. Half (left) and full-sized bags (right) of the pleated type.

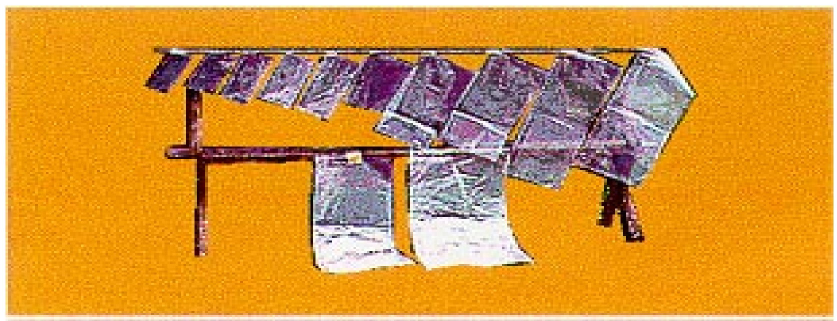


Figure 3. Various sizes of flat or "Pillow" bags.

Boxes

There are many different styles and types of boxes routinely used in the ornamental fish industry. Some of the most commonly used configurations are described in Table 2. Most shippers rely on a box that they purchase locally for the bulk of their shipping needs but typically send out several types of boxes in an effort to recycle or reuse boxes they receive. These types will include not only the standard types of boxes discussed below but also miscellaneous other types, including those illustrated in Figures 4-7. Some have loose panels that are used to line the box walls, which helps to keep required storage space to a minimum. Others have stacking molded styrofoam compartments for use under extreme conditions.

Florida

Domestically, the industry standard is the traditional single Florida box, which is square and has dimensions of 42.5 cm (L) x 42.5 cm (W) x 25 cm (H), as shown in Figure 4. In recent years some large shippers have begun using a double-capacity version of this box, known as "doubles" with a length of 80 cm, and a width of 42.5 cm and a 25 cm depth. The usual insulation on a single box originating from Florida is molded styrofoam that has a taper and lip about midway up the box to facilitate stacking of the empty containers. The doubles have been shipped with any of three types of insulation. A molded styrofoam box, styrofoam panels inserted in the bottom and sides with a lid placed on top, or sheets of fiberglass insulation lining the box.

Hawaii

Producers in Hawaii are currently using a molded styrofoam box that was originally designed for the shrimp industry, as shown in Figure 5. Locally they are called “coffin boxes”. These containers measure 68 cm (L) x 34 cm (W) x 25 cm (H). This box has the same shipping capacity as the Florida box, using two half bags. Each half bag should contain 3.5 liters of water and half the fish listed in Table 3 in each bag to make up a full box. An alternative means of insulating bagged ornamental fish is in use in Hawaii, using rectangular panels of styrofoam rather than formed inserts to line the shipping boxes (not shown).

Asia

Ornamental fish packed from Asia frequently make use of one of two size boxes, 60 cm (L) x 42 cm (W) x 30 cm (H) or, 49 cm (L) x 38 cm (W) x 38 cm (H). The larger of these two types is shown in Figure 5. Both sizes are packed with a minimum of four bags. Although there are many different sizes and shapes used for shipping ornamental fish, the most common types are listed in Table 2.

Table 2. Various styles and dimensions of some common shipping boxes.

Box Style	Box Dimensions (length cm x width cm x depth cm)
Traditional Florida Box	42.5 x 42.5 x 25
Florida Double Box	80 x 42.5 x 25
Asia Double Box	60 x 42.5 x 25
Alternate Asia Box	49 x 38 x 38
Hawaii Box	68 x 34 x 25

cm = centimeter 2.42 cm = 1.0 inch

Figure 4. Typical Florida style single box.

Figure 5. Hawaii style shipping box (bottom and styrofoam insert (top)

Figure 6. Asian style shipping box (bottom) and styrofoam insert (top).

Figure 7. Some of the many other styles of shipping boxes in commercial use.

Fish Packs

Common pack numbers used in the industry based on 48 and 72 hour transit time along with some general packing density guidelines are presented in Table 3. The data presented in this table represent a composite of densities in common use in the aquarium trade, as reflected in a variety of price lists, as well as the personal experience of the authors. Note the pack numbers are based on the number of pieces per 7 liters of water in a single bag (full pleated bag, see Table 1) packed within a Florida box (42.5 cm x 42.5 cm x 25 cm). The packing densities vary depending on the size of the fish. Because of differences in the volumes and surface areas of packing boxes, standard pack numbers for Hawaii boxes can be estimated at 1.3 times the numbers given in Table 3 for Florida boxes.

Normally, egglayers are bagged with a five percent overpack and livebearers are bagged with a ten percent overpack. For example a box of Mollies shipped at 300 pieces actually contains 330 pieces. Higher priced items, extremely delicate and large fish such as cichlids are not overpacked. Large fish and those with sharp spines or scales should be placed in double bags (one inside the other sealed independently or together) to reduce the possibility of a puncture and leakage. Some buyers may require pack numbers lower or higher than those listed in Table 3. For instance, if you are selling to the retail level the pack numbers are generally lower. If a buyer requests pack numbers higher than normal it should be made clear that he assumes the risk of guaranteed live arrival. If you are shipping a fish you don't have much experience with, use the packing densities listed under "general guidelines". Fish may be packed on a trial basis using the densities given in Table 3, and held for observation up to 72 hours.

Table 3. Common packing densities used in the shipping of ornamental fish. The packing densities listed in Table 3 are based on a single 7 liter capacity size bag in a single Florida box (42.5 cm x 42.5 cm x 25 cm).

Species	Length (inches)	Standard Pack (48 hr)	Extended Pack (72 hr)
Swordtails	1.0	400	300
	1.5	300	250
	2.0	250	200
	2.5	200	150
	3.0	100	75
Mollies			
Regular	1.5	300	225
Medium	2.0	200	150
Large	2.5	150	100
Platies	0.5	400	300
	1.0	300	225
	1.25	275	200
	1.5	250	175
Variatus	0.5	400	300
	1.0	300	225
	1.25	275	200
	1.5	250	175
Guppies			
(Fancy)	1.25	400	300
(Feeder)	1.0	1500	1000
Tetras			
Small	0.5	300	225
Medium	0.75	250	200
Large	1.0	200	150

Table 3. Continued

Species	Length (inches)	Standard Pack (48 hr)	Extended Pack (72 hr)
Angel fish			
Regular	1.0	150	100
Medium	1.5	50	35
Large	2.0	20	15
Kissing Gourami			
Regular	2.0	125	100
Medium	3.0	50	35
Blue Gourami			
Regular	2.0	125	100
Large	2.5	100	70
Paradise Gourami			
Regular	2.0	125	100
Large	2.5	100	70
Dwarf Gourami	1.75	150	100
Tiger Barbs			
Small	0.75	400	325
Regular	1.0	300	225
Medium	1.25	200	150
Large	1.5	125	100
Rosy Barbs			
Regular	1.5	150	100
Long-fin	1.5	150	100
Danios			
Small	0.75	500	400
Regular	1.0	400	300
Large	1.25	300	250
Long-fin	1.0	300	250
Corydoras	1.0	225	175

Table 3. Continued

Species	Length (inches)	Standard Pack (48 hr)	Extended Pack (72 hr)
Rainbow Sharks			
Small	1.5	200	50
Medium	2.0	150	100
Large	2,5	100	75
X large	3.0	75	50
XX large	4.0	50	40
Cichlids			
Regular	1.5	150	100
Medium	1.75	100	70
Large	2.0	20	10
Rainbow Fish			
Regular	1.5	150	100
Medium	2.0	100	75
Large	2.5	50	35
General Guidelines			
	1.5	200	150
	2.0	150	100
	2.5	100	75
	3.0	75	50
	4.0	50	35
	5.0	20	12
	6.0	15	10

Standard pack is based on 48 hour shipping time
Extended pack is based on 72 hour shipping time

Packing Procedures

A schematic diagram illustrating the typical processes involved in packing and shipping is presented in Figure 8. Before harvesting and packing it is important to have all required material available. Any chemicals needed for pond treatment of parasites should be on hand. You should also insure that there is adequate room in holding tanks to house the harvested fish as well as extra tanks for sorting by size and \ or sex. You will also need a comfortable sorting table in a clean, well-lit area. Suitable bags for packing should be in stock as well as the insulated styrofoam inserts and outer boxes, all of which can be obtained through the sources listed in Appendix 1. Other critical supplies to have include a full oxygen cylinder and regulator to inflate the bags, rubber bands to seal the bags, and tape to seal the boxes. If any of these items are missing, packing should not be attempted.

Step 1. Preharvest

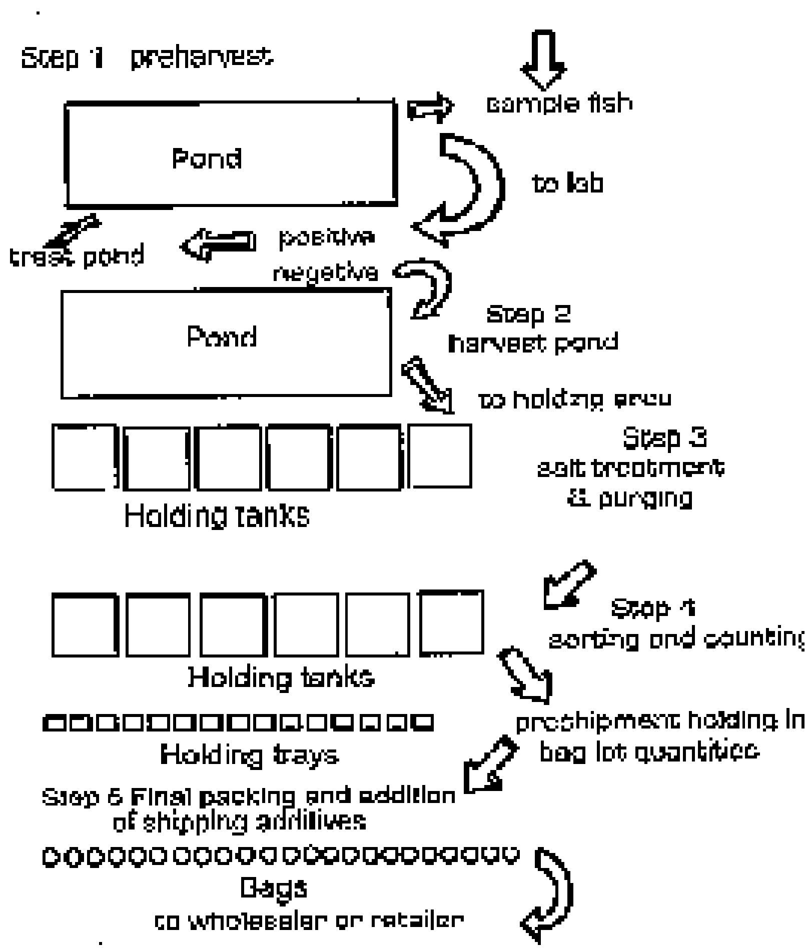


Figure 8. Flow-chart of fish packing steps and procedures.

Step 1. Preharvest Fish should be examined for parasites and diseases at least one week prior to harvesting. This allows sufficient lead time, should and treatments be necessary.

Step 2. Postharvest Fish brought into the holding tanks for sorting and sale should be checked again for parasites and diseases. Holding tanks should have adequate water and aeration. Iodine free salt (NACI) can be added to the holding tank water at nine parts per thousand (9.0 ppt.). This provides an isotonic salt solution, which is effective in reducing stress and promoting a natural slime coating. This helps prevent opportunistic infection as a result of handling injuries.

Step 3. Feeding should be withheld for a minimum of two days and up to five days, depending on species. For example livebearers such as swordtails and monies require two days, whereas goldfish and Corydoras require four days. The feces should be siphoned out of holding tanks once or twice a day to prevent the fish from eating feces. The absence of feces in the tank will indicate that fish have had an adequate purge time prior to sorting, counting and shipping.

Step 4. Fish are now sorted and counted into bag lot quantities and held in individual aquaria, trays or buckets. The pre-shipment containers should have adequate water and air flow. The water exchange rate in these containers should be a minimum of four times per day (4x/day). Ideally, the pre-shipment holding containers should have a standpipe or valves to allow the water to drain to the correct shipping volumes. The fish and water can then be poured directly into the shipping bag, which saves time and minimizes handling.

Step 5. Any shipping additives are placed into the bag at this time. The bag is purged of air and pure oxygen is injected into the bag below the waters surface. The bag is then sealed using rubber bands or one of the commercial grade sealers or banders and placed in its box. Ice or heat packs can be laced on to of the b after seal for best results.

Shipping Additives

Over the last 15 years, several additives to shipping water have been developed or adapted to help reduce stress and increase survivability. They generally fall into three categories: sedatives water quality stabilizers, and antibiotics.

The most common sedatives are quinaldine or quinaldine sulfate, and Tricane methane sulfonate (MS-222), with commonly used concentrations listed in Table 4. Quinaldine is used 25 ppm in shipping water, MS-222 at 60 to 70 ppm with adjustments made for sensitive species. These compounds reduce the metabolic rate offish, and can also prevent injury from jumping or swimming into the sides of the box.

Water quality stabilizers include pH buffers, zeolite at 20 gms/ liter (which removes ammonia), activated carbon also at 20 gms/liter, ice or heat packs to maintain temperature, and sodium chloride at 9.0 ppt. Other products have become available from the bait minnow industry these usually contain a combination chelating agents, buffers, ammonia or chlorine removers and some form of antibiotic.

Table 4. Common shipping additives and concentrations typically used in water for transport of ornamental fish, Adapted from Herwig, 1979.

Concentration	Chemical
Quinaldine	25 ppm
Tricane methane sulfonate (MS-222)	60-70 ppm
pH buffers	As per label
Zeolite	20 gms/L
Activated carbon	20 gms/L
Salt (NACI)	9.0 ppt
Commercial mixtures	As per label
Furanace	0.05-0-2 ppm
Neutral acriflavine	3-10 ppm

ppm - parts per million
gms/L - grams per liter
ppt - parts per thousand

Caution should be used in the application of antibiotics. These compounds are subject to regulatory controls, which should be considered carefully before any applications. One of the most widely used antibiotics for shipping and treatment offish has been tetracycline at 5-20 ppm. This antibiotic has been used extensively, especially from fish shipped out of Asia. There are several indications that some bacteria have developed an immunity to tetracycline due to its wide use, which is one of the reasons that we do not recommend its use (J. Brock, DVM, personal communication). Other antibiotics commonly used in shipping are furnace at 0.05-0.2 ppm, and neutral acriflavine at 3-10 ppm. Other antibiotics such as kanamycin and phenicol are used much less frequently and are primarily used as on-farm treatments for disease. The different sulfa base drugs are currently being used due to bacterial resistance to other forms of antibiotics historically used in the industry.

To demonstrate the effect of density on total ammonia concentration during transport, tiger barbs were used as test animals packed in three liters of water and inflated with pure oxygen. Samples of the water were taken at zero, 24, 48 and 72 hours and tested for total ammonia nitrogen by the Hach calorimetric method. Any readings of 3.0 parts per million (ppm) are assumed to be 3.0 ppm and above, (all tests except those that were less than 3.0 ppm were significantly off scale), since this is the upper limit of accurate readings by this test method. Fish were 1.25 inches long and were packed either starved for 48 hours or fed normally prior to packing. For each of the starved and fed treatments, there were either no additives placed in the shipping water, zeolite added at 20 grams per liter, or MS 222 at 20 milligrams per liter added to the shipping water. Figures 9 and 10 show the increase in total ammonia nitrogen concentration over a 72 hour period for fish packed at two different densities with various treatments. Zeolite was the only additive that had a significant effect on ammonia concentrations. Ammonia climbs to 1.5 ppm in the first 24 hours then levels out for the next 24 hours as the zeolite binds with the ammonia. From hour 48 to hour 72 the ammonia starts to climb again as the saturation point of the zeolite is reached. In the bag where the fish were fed prior to bagging and the sedative MS 222 was added, there was a fifty percent mortality by hour 48 and a I 00 percent mortality by hour 72 - Figure 10 shows a similar pattern to Figure 9 with all treatments, but with fish at a higher packing density. Fish were packed at 200 fish in three liters with all other treatments the same as in Figure 9. The zeolite treatment is the only treatment that had a significant impact on total ammonia nitrogen. Zeolite is commonly used in bags that have been overpacked or in shipments offish that produce large quantities of ammonia, such as *Corydoras* spp. and *Carassius auratus*. This adds a negligible cost to each bag and may substantially reduce the risk of mortality-check with local suppliers for current pricing. The treatment that was fed normally with the addition of MS 222 resulted in a 50 percent mortality by hour 48 and a 100 percent mortality rate by hour 72. Survival was 100% in other treatments. These results suggest that a combination of MS-222 and feeding should be avoided, and that zeolite may be a cost-effective shipping additive.

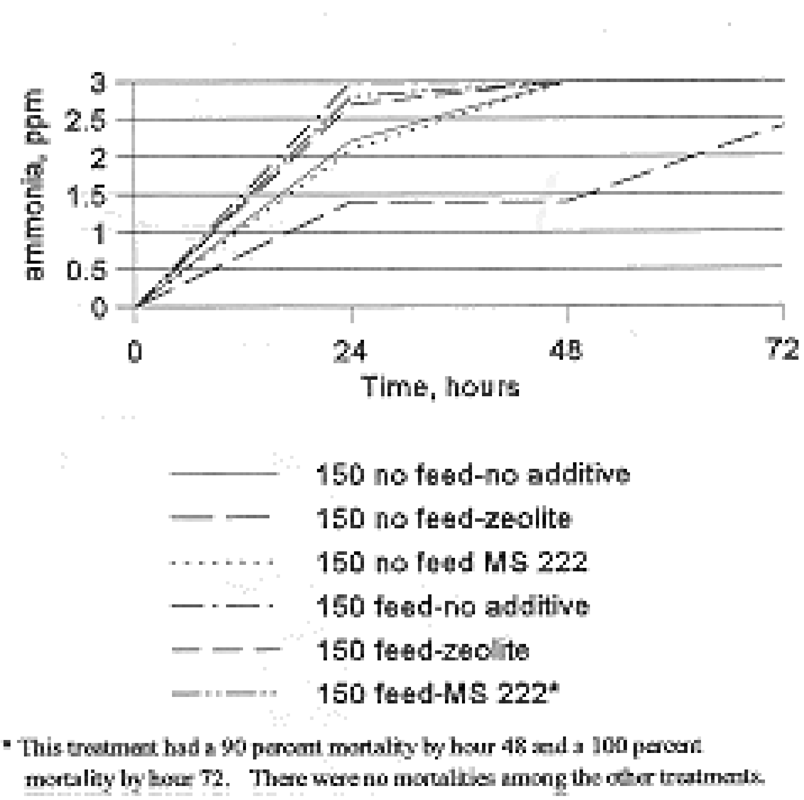
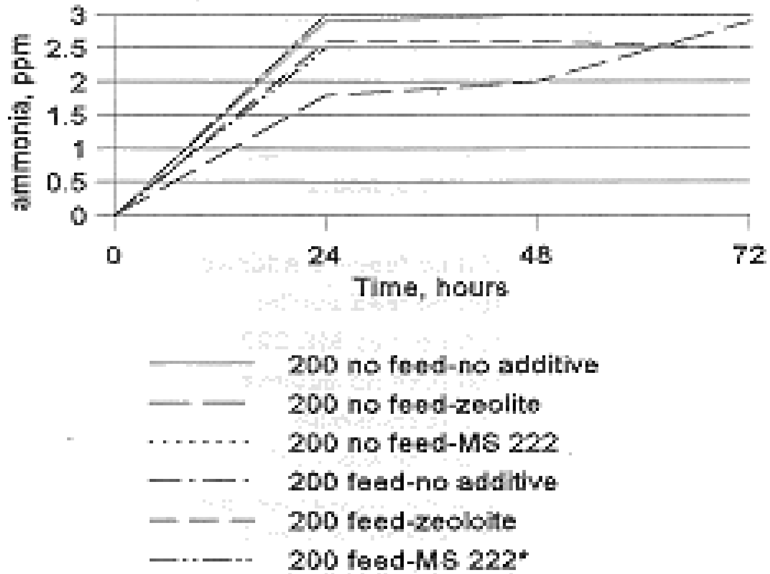


Figure 9. Ammonia concentrations over time for fish packed with various additives.



* This treatment had a 50 percent mortality by hour 48. and a 100 percent mortality by hour 72. There were no mortalities among the other treatments.

Figure 10. Changes in total ammonia nitrogen concentrations in bags packed for a 48 hour transit time.

Receiving Fish

Most farms that ship fish will also be receiving fish, either to resell or to add to their broodstock line. Appropriate care and handling of in incoming shipments of fish is another critical function to a successful farm or transship operation.

Arriving shipments should be inspected immediately, particularly those that have been shipped over long distances or those which have been subject to delays. Fish that are densely packed in bags that have taken longer than expected to arrive may be suffering from exposure to accumulations of ammonia, thermal shock, or other problems. A quick assessment of the condition of the arriving fish can limit losses in such cases.

In order to implement a successful receiving program you must first have a working knowledge of what changes are taking place, chemically and physically, inside the shipping bag during the transport period. Once a bag has water, fish and oxygen sealed inside it, certain chemical changes take place due to the metabolism of the fish. When fish breathe, they absorb oxygen and excrete other gases and metabolites, primarily carbon dioxide (CO_2) and nitrogen in the form of ammonia. Total ammonia nitrogen for the purposes of this manual, consists of two forms of nitrogen that exist in a pH and temperature dependent equilibrium of unionized ammonia (NH_3) and the ammonium ion

(NH_4). The un-ionized form (NH_3) is toxic to fish while the ammonium ion (NH_4) is not toxic to fish (Boyd, 1979). The proportion of NH_4 (non toxic) to NH_3 (toxic) increases with decreasing pH and decreases with increasing pH (Boyd 1979). The percentage of NH_3 also rises with increasing temperatures - so conditions with both relatively high pH and elevated temperature are especially dangerous. Since NH_3 cannot be measured directly, several tables have been created based on an equilibrium formula that predict the relative percentages of unionized ammonia at different temperatures and pH. Table 5 was created for the aquaculture industry and reproduced from Boyd 1979.

Table 5. Percentage un-ionized ammonia in solution at different pH values and temperatures. (reproduced from Boyd 1979).

Temperature (Centigrade)									
pH	**16**	**1.8**	**20**	**22**	**24**	**26**	**28**	**30**	**32**
7.0	0.30	0.34	0.40	0.46	0.52	0.60	0.70	0.81	0.95
7.2	0.47	0.54	0.63	0.72	0.82	0.95	1.10	1.27	1.50
7.4	0.74	0.86	0.99	1.14	1.30	1.50	1.73	2.00	2.36
7.6	1.17	1.35	1.56	1.79	2.05	2.35	2.72	3.13	3.69
7.8	1.84	2.12	2.45	2.80	3.21	3.68	4.24	4.88	5.72
8.0	2.88	3.32	3.83	4-37	4.99	5.71	6.55	7.52	8.77
8.2	4.49	5.16	5.94	6.76	7.68	8.75	10.00	11.41	13.22
8.4	6.93	7.94	9.09	10.30	11.65	13.20	14.98	16.96	19.46
8.6	10.56	12.03	13.68	15.40	17.28	19.42	21.83	24.45	27.68
8.8	15.76	17.82	20.08	22.38	24.88	27.64	30.68	33.90	37.76
9.0	22.87	25.57	28.47	31.37	34.42	37.71	41.23	44.84	49.02
9.2	31.97	35.25	38.69	42.01	45.41	48.96	52.65	56.30	60.38
9.4	42.68	46.32	50.00	53.45	56.86	60.33	63.79	67.12	70.72
9.6	54.14	57.77	61.31	64.54	67.63	70.67	73.63	76.39	79.29
9.8	65.17	68.43	71.53	74.25	76.81	79.25	81.57	83.68	85.85
10.0	74.78	77.46	79.92	82.05	84.00	85.82	87.52	89.05	90.58
10.2	82.45	84.48	86.32	87.87	89.27	90.56	91.75	92.80	93.84

Generally when a bag offish reaches its final destination it has been in transit for 24 to 48 hours. During this period of time there has been enough carbon dioxide produced to reduce the pH of the water down to 6.5 - 7.0. As you can see from Table 5, using a temperature of 24°C and a pH of 7.0, the toxic fraction is only 0.52 percent. If the total ammonia nitrogen reading is10.0 parts per million (ppm) then the toxic fraction is only 0.052 ppm. (0.0052 x 10.0 = 0.052 ppm). This amount of toxic ammonia (NH_3) is well within the tolerable limits for long term exposure to most species without doing any serious physiological damage to the fish (Post, 1987). However, if the pH in that same bag of fish is 10.0 and the temperature is 24 C the un-ionized toxic fraction of ammonia from the chart above is 84.0 percent, or 8.4 ppm (0.84 x 10.0 = 8.4 ppm). At this level severe stress, physiological damage and even death may occur at exposure times as short as 30 minutes or less (Post, 1987).

It is critically important when receiving fish to be aware of the temperature and pH differences between the water in the shipping bag and the receiving water. The recommended method for acclimating fish is to float the sealed bag in the tank or pond that is to receive them for a period of at least five minutes per degree of temperature difference or until the temperature of the bag is within two degrees of the receiving water. The bag should be kept out of direct sunlight to avoid photic shock to the fish and elevated water temperatures in the bag from a greenhouse effect. At this point in the receiving procedure un-iodized salt may be added to reduce stress. Fish should also be inspected under the microscope for any parasites or disease and the proper treatment applied. When the bag is unsealed, the fish can be dipped out and placed directly into the receiving water. Generally, water in shipping bags is discarded rather than introduced into the culture system as a means of limiting possible introductions of pathogens, anesthetics, etc.

lf the bag is unsealed prior to this, the CO_2 in the shipping water will dissipate into the atmosphere and the pH of the shipping water in the bag will begin to increase rapidly along with the toxic fraction of ammonia, potentially causing severe stress or death. Adding water to an unsealed bag may only increase stress if the water being added has a high pH and temperature. I your water naturally has a low pH and you do choose to add water to the bag, remove an amount equal to what you would replace for acclimation. This will at least reduce the total amount of nitrogen present in the shipping water.

Summary and Conclusions

Even the most effectively run ornamental fish production operation is likely to fail if insufficient attention is paid to fish packing and shipping procedures. To some extent, this can b summarized as a matter of minimizing risks at every step of the packing and transport process, without going to the costly excess of shipping underpacked bags. Packing methods should take into account the species being shipped and the expected time in transit. Concentrating sales in easily reached destinations, and adherence to established packing methods, materials, and densities described in this manual will contribute to the consistent delivery offish in excellent condition. We recommend the use of an effectively designed packing room, with harvests prepared appropriately in anticipation of shipping deadlines.

Literature Cited

Boyd, C.E. 1979. Water quality in warmwater fishponds. Auburn University / Craftmaster Printers Auburn, AL. 359 pp.

Herwig, N. 1979. Handbook of drugs and chemicals used in the treatment of fish diseases Charles Thomas Publishers, Springfield, IL. 272 pp.

Post, G. 1987. Textbook of fish health. TFH Publications, Inc., Ltd., Neptune City, NJ. 288 pp.

Appendix 1

List of suppliers in the Aquaculture industry.

Listing in this appendix does not constitute a recommendation for, or a guarantee of, any of the products or services that the listed manufactures, suppliers or organizations may provide. For a more comprehensive listing consult your local extension agent or the buyers guide or directory editions of one of the industry related publications.

Chemical Products

Argent Chemical Laboratories 8702 152nd Ave. N.E. Redmond, WA Phone: (206) 885-3777 Fax: (206) 885-2112	Chemicals, therapeutics, specialty feeds, laboratory equipment, books and manuals
Brewer Environmental Industries Inc 311 Pacific Honolulu, HI 96718 Phone: (808) 532-7400	Herbicides, insecticides, fertilizer, agriculture products
Chemaqua P.O. Box 2457 Oxnard, CA 93033 Phone: (805) 486-5319 Fax: (808) 486-2491	Therapeutics, water conditioning products
Crescent Research Chemical 4331 E. Western Star Blvd. Phoenix, AZ 85044 Phone: (602) 893-9234 Fax: (602) 244-0522	Therapeutics, bacterial cultures, water conditioning products, CPE, HCG, LHRH, test kits, meters
Fritz Chemical Company Aquaculture Division P.O. Drawer 17040 Dallas TX 75217	Therapeutics, water conditioning products
Hawaiian Fertilizer Sales, Inc 91-155 C Leowaena Street Waipahu, HI 96797 Home: 808 677-8779	Fertilizer, herbicides, agriculture products

Netting Products

Memphis Net and Twine Co., Inc
2481 Matthews Ave.
P.O. Box 8331
Memphis, TN 38108
Phone: (901) 458-2656
Fax: (901) 458-1601

Seines, dip nets, gill nets, floats, lead, aprons, knives, rope, baskets, commercial fishing supplies

Nylon Net Co.
615 East Bodley
P.O. Box 592
Memphis, TN 3810
Phone: (901) 774-1500
Fax: (901) 775-5374

Seines, dip nets, gill nets, floats, lead, aprons, knives, rope, baskets, commercial fishing supplies

Tenax Corporation
4800 E. Monument St.
Baltimore, MD 21205-3042
Phone: (410) 522-7000
Fax: (410) 522-7015

Plastic netting, liner

Fish Graders

Commerce Welding and Manufacturing Co.
2200 Evanston
Dallas, TX 75208
Phone: (214) 748-8824
Fax: (214) 761-9283

Aluminum interchangeable bar graders

Magic Valley Heli-Arc and Mfg.
P.O. Box 511
198 Freightway St.
Twin Falls, ID 83301
Phone: (208) 733-0503
Fax: (208) 733-0544

Aluminum adjustable bar grader

Shipping Bags

Diverse Sales and Distribution
935 Dillingham Blvd.
Honolulu, HI 96817
Phone: (808) 848-4852

Plastic bags

Koolau Distributors Inc 1344 Mookaula Honolulu, M 96817 Phone: (808) 848-1626	Plastic bags

Shipping Boxes

Pacific Allied Products, Ltd. 91-110 Kaomi Loop Rd. Kapolei, HI 96707 Home: (808) 682-2038	Styrofoam boxes and sheet material, corrugated outer boxes
Unisource 91-210 Hanua Wahiawa, HI 96786 Home: (808) 673-1300	Corrugated foam core boxes

Heat Packs

Grabber Warmers
205 Mason Circle
Concord, CA 94520
Phone: (510) 680-0777
Fax: (510) 827-1161
Telefax: (800) 990-9276

Cold Packs

J & W Products, Inc.
2931 Koapaka St.
Honolulu, HI 96819
Home: (808) 833-0755