HANDLING AND LOADING

Importance of Distribution	Final Phase of Production Handling great numbers in a short period of time Large amount of fish in a small amount of water Mortality enroute and post stocking
Conditions to consider before transporting fish	Fish in good and healthy condition Fish are not smolting Do not stress fish during loading Starve fish for 48-72 hours Use high-quality water Use functioning life support system Have the distribution vehicle in good mechanical condition
Handling and Loading Stress	Stress can be severe and result in immediate or delayed mortality. Fish become hyperactive. There is increased oxygen consumption and greater excretion of metabolic products. First hour after loading is most critical. Oxygen consumption is elevated for 30-60 minutes after loading later it declines. If insufficient oxygen is present during this adjustment period, fish may develop an oxygen debt.
Tempering	Temper the water in the tank with receiving site water to acclimate the fish for: temperature water chemistry gas levels
Stress Reduction	Add O_2 Take off of feed Add ice Aerate tank Recirculate water Use anti-foam Provide an air scoop

TRANSPORTATION EQUIPMENT

Methods of Transportation	Styrofoam Containers Through the Mail, etc. Boats and Barges Airplanes and Helicopters Trucks
Truck Features	Size Automatic transmission vs straight drive Diesel vs gas Cab-over vs conventional Gooseneck trailer and pickup truck
Tank Design Materials	Fiberglass, aluminum, and wood are most commonly used. Stainless steel, glass, galvanized iron, sheet metal, etc. are sometimes used.
Tank Insulation	Purpose Types of insulation styrofoam, fiberglass, urethane, and corkboard advantages of styrofoam and urethane K factor: compare various insulating materials
Compartments	Constructed to meet distribution needs Advantages of different numbers of compartments Size of tank or compartments
Shape of Tank	Rectangular - most commonly used Elliptical - trend in recent years
Advantages of Elliptical	Better mixing and circulation of water as size of tank increases polyurethane insulation Few structural members and no sharp corners Rapid ejection of fish Ease of removing fish with a dip net Mass production Conforms to truck chassis and holds center of gravity towards the area of greatest strength Light weight

CIRCULATION SYSTEM

Circulation System Influences and Need	Tank Shape Water Circulation Pattern Aeration Types
Description of Circulation Systems	Suction lines, perforated screens Overhead spray Introduction of oxygen Self-priming pumps Close-coupled pumps vs flexible coupled 7°F vs 3°F per hour
Pipes	Piping material is black or galvanized steel, aluminum, or plastic Water friction excess of pipe fittings Pipe diameter Use of generators and electrical pumps or aerators
Advantage of using aerators and supplemental oxygenation	Reduced temperature increase (1°F compared to 2.5°F). Aerators and oxygen can operate independently back-up system advantage with small fish Fewer maintenance problems Cheaper Take up less space and are lighter
Aeration	Provides oxygen and reduce carbon dioxide; maintain pH and suppress toxic levels of dissolved ammonia and carbon dioxide.
Methods of Aeration	Spraying devices Baffles Screens Venturi units Agitators Air blowers Fresh-flo aerators

WATER QUALITY

Oxygen	Most important single factor in transporting fish.
Ability to use oxygen depends on a number of factors	Tolerance to stress Water temperature pH Carbon dioxide Metabolic products such as ammonia
Insufficient oxygen	will stress or kill fish. It causes hypoxia and the build up of k lactic acid will cause delay mortality.
Oxygen requirement	Sufficient oxygen suppresses harmful effects of ammonium and carbon dioxide DO greater than 7.0 ppm, but less than saturation minimum of 6 ppm Effects of handling and loading stress on oxygen consumption requires additional oxygen especially during first hour of hauling (This statement may not be correct) Use of chemicals to increase oxygen concentration and utilization of antifoam (25 *ml* per 100 gallons of water)
Temperature	Insulation in the tank helps to maintain the required temperature. Ice is simple to use to lower the water temperature. It may be difficult to find and if large pieces are used they could damage the hauling tank.
Refrigeration units	Expensive to purchase and operate Require careful maintenance Large units are more practical than small units
Temperature Monitoring	Temperature should be continuously monitored. Electric thermometers are readily available and inexpensive. They provide monitoring of temperatures from inside truck cab. 1 degree rise in temperature could reduce fish load by 5.6%

WATER QUALITY

Ammonia

- Main metabolic product
- Could reach 10 ppm
- Depends on fish load and length of trip
- Exposure to 11 to 12 ppm for 6 hours and longer causes adverse effects
- Temperature and time of last feeding are important factors in regulating ammonia excretion
- the lower the water temperature the less ammonia excreted
- starve fish for 48 to 72 hours
- starve large fish longer than small fish

Carbon Dioxide

- Product of fish and bacterial respiration
- Acidifies water
- Reduces oxygen-carrying capacity of fish blood
- Fish may die even if oxygen levels seem adequate
- Trout tolerate 15.0 ppm; become distressed at 25.0 ppm
- Carbon dioxide gradually increases in distribution tanks
- Air scoops help
- Tight lids can result in $C0_2$ build up
- Aeration of water will reduce concentrations of dissolved CO_2 if the there is adequate ventilation
- Antifoam will help
- Buffers can be used to control pH (Trishydroxymethlminomethane)

Carrying Capacity Depends upon

- Efficiency of aerating system
- Duration of haul
- Water Temperature
- Fish size
- Fish species

Fish Size is Important

- Carrying capacity is directly proportionate to length
- Fewer pounds of small fish per gallon of water than large fish
  - ***From Piper et al***
  - 100 lbs. - 2 inch
  - 200 lbs. - 4 inch
  - 300 lbs. - 6 inch
- Carrying capacities vary widely among hatcheries
- Loading densities should be calculated by water displacement method
- Can haul 2.5 to 3.5 pounds of eight to eleven inch rainbow trout per gallon of water for 8 to 10 hours under ideal conditions.

Feed

Feed Deprivation before transport

Chuck's ex. 2 d prior @ 59° F 8-12 in

@ 50° F · ½ x length = # days off feed

½ x 4 in = 2 days

EXERCISES

Problem 1A

How many pounds of 6" trout can be hauled in a distribution truck that is capable of hauling 1,000 lbs of 10" trout?

$$\frac{1}{6^3 \times 0.0004} = 11.574$$

500 lb 5" trout
600 lb 6" trout
1000 lb 10" trout

$$\frac{1}{(\text{length})^3 (\text{condition factor})} = W$$

Problem 1B

How many (number of fish) 6" trout can be hauled if the average condition factor of the fish is 4000×10^{-7}?

600 lb 6" trout

600 lbs × 11.494 fish/lb = 6,896.4 fish

Temp change metabolic Rate

1° F = 5.6%

6000 50° F 6,500 fish on board

need to haul 6000 fish

~~1200~~ 1200 fish excess

$\frac{1200 \text{ more fish}}{6800 \text{ fish}} = 17.6\%$

~~50 + 0.176 = 68° F~~

~~41.2° F~~

$\frac{17.6\%}{5.6\%} = 3.14°$ 46.9° F

EXERCISES

Problem 1A

How many pounds of 6" trout can be hauled in a distribution truck that is capable of hauling 1,000 lbs of 10" trout?

$\frac{1000 \text{ lbs}}{10 \text{ inches}} = \frac{x \text{ lbs}}{6 \text{ inches}}$ OR

$\frac{6 \text{ inches}}{10 \text{ inches}} \times 1000 \text{ lbs} =$ **600 lbs of 6 inch fish**

Problem 1B

How many (number of fish) 6" trout can be hauled if the average condition factor of the fish is 4000×10^{-7}?

6 inch fish = 11.574 fish/lb

11.574 fish/lb x 600 lbs = **6,944 fish**

Feed Size

Real cold H_2O

go down a pellet size

more protein + highly digestable

Photoperiod

fish will grow differently depending on the photoperiod as well as temp

fish will grow much faster than you think in Feb Mar Apr - do not short on food

EXERCISES

Problem 2A

If a truck can haul 900 lbs of 4" trout, how many pounds of 9" trout will it haul?

900 lbs - 4" trout

2025 lbs - 9" trout

Problem 2B

How many pounds of 9" trout can be hauled if we lower the water temperature 10°F by adding ice to the truck in 2A?

2025 lbs

10 x 5.6 = 56%

2025 x 0.56 = 1134 + 2025 = 3159 lbs

Problem 2C

Using the truck from 2A we loan our truck to Mescalero, New Mexico. They find that for each hour the truck is driven across the desert, it will warm the water 1°F. If they have a 6 hour trip, how many pounds of 4" fish can they haul (we could haul 900 lbs. of 4" fish)?

6 x 5.6% = 33.6%

900 lbs 4" fish

900 x 0.336 = 302

900 - 302 = 598 lbs

EXERCISES

Problem 2A

If a truck can haul 900 lbs of 4" trout, how many pounds of 9" trout will it haul?

$$\frac{900 \text{ lbs}}{4 \text{ inches}} = \frac{x \text{ lbs}}{9 \text{ inches}} \quad \text{OR}$$

$$\frac{9 \text{ inches}}{4 \text{ inches}} \times 900 \text{ lbs} = \textbf{2,025 lbs of 9 inch fish}$$

Problem 2B

How many pounds of 9" trout can be hauled if we lower the water temperature 10°F by adding ice to the truck in 2A?

10°F x 5.6 %/°F = 10 x 0.056 = 0.56 (56%) increase
0.56 x 2025 lbs = 1134 lbs increase
2025 lbs + 1134 lbs = **3,159 lbs**

Problem 2C

Using the truck from 2A we loan our truck to Mescalero, New Mexico. They find that for each hour the truck is driven across the desert, it will warm the water 1°F. If they have a 6 hour trip, how many pounds of 4" fish can they haul (we could haul 900 lbs. of 4" fish)?

6°F x 5.6%/°F = 6 x 0.056 = 0.336 (33.6%) decrease
900 lbs x 0.336 = 302 lbs decrease
900 lbs - 302 lbs = **598 lbs**