Fish Transport

AERIAL STOCKING OF SMOLT SALMON

AERIAL STOCKING

Live Fish Transport

- Good water quality is key!
- Key factors determining a successful transport
  - Oxygen
  - Carbon Dioxide
  - Water temperature
  - Ammonia
  - pH
  - Size of fish

FRED manual 70-73

FHM 348-366

Water Quality

- Transport systems are typically recirculating aquaculture systems and are subject to the same environmental issues.
- Oxygen
  - Typically administered by oxygen cylinders
  - Oxygen should be about 12 – 15ppm prior to loading
  - D.O. levels will drop initially – why?
  - Hyperoxygenation is possible

Oxygen

- Bottled oxygen flow to the diffusers is controlled with regulators, flow should be 3-4 liters/min. – adjust as necessary though
- Higher flows result in larger bubble size - why is this a problem?
- Most ceramic stones need to be protected from freezing when wet. Need to handle with care.

Cramer Decker 0-15 LPM Oxygen Flowmeter

$31.52

View Product

amazon

Lots of different ways to deliver oxygen/air

Sweetwater® Air Diffusers, Flat Ceramic, Plastic Base
Part #Sweetwater DYPFP

Point Four Micro Bubble Diffusers (MBD)
Part #1DMBDC100 to 1DMBDC120

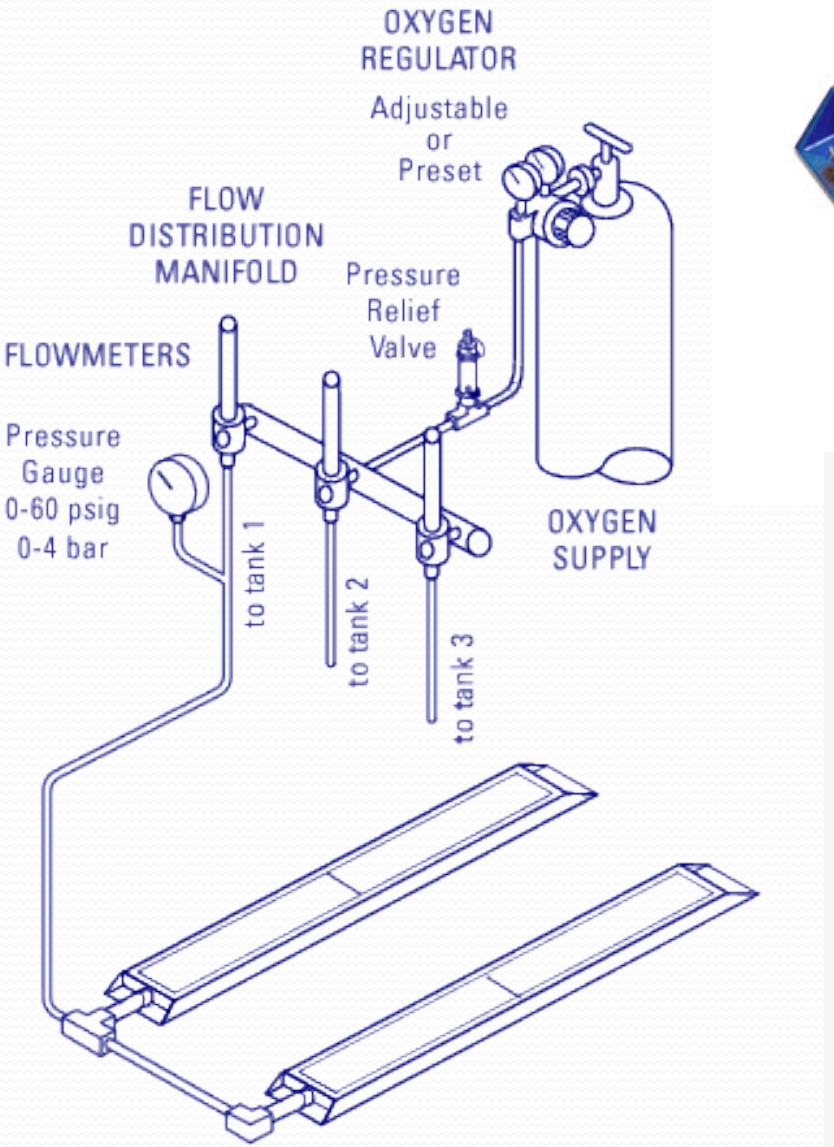
Sweetwater® Air Diffuser, 6" L x 1.5" W, 1/2" NPT, PE
Part #ALR15

Bulk Air Diffusers, 1", 120/Pk, .05 cfm
Part #AA1

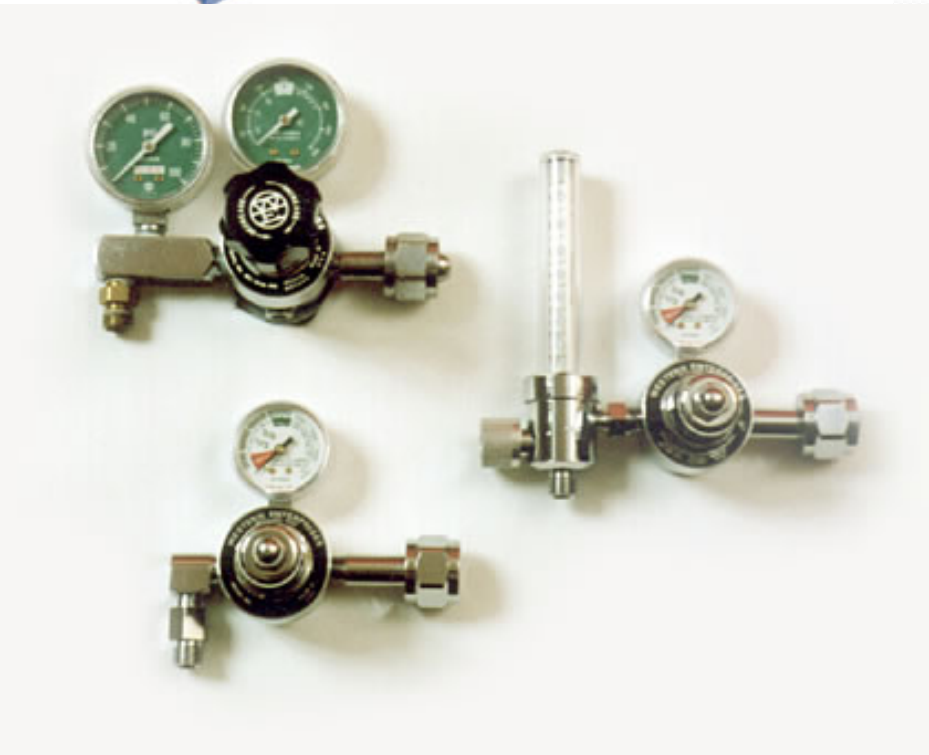
Ceramic Cylinder Air Diffuser
Part #DYCHP 4"-12"

Small Pond Diffuser Manifold
Part #ALP4

High-Efficiency Diffuser Tubing, 1" O.D., Per Foot


OXYGEN
REGULATOR
Adjustable
or
Preset
FLOW
DISTRIBUTION
MANIFOLD
Pressure
Relief
Valve
FLOWMETERS
Pressure
Gauge
0-60 psig
0-4 bar
to tank 1
to tank 2
to tank 3
OXYGEN
SUPPLY
MICROBUBBLE DIFFUSERS MBD


Point Four
Point Four
Point Four



Typical record keeping for transports

4/11/97					
Chinook	CL to NB	140,000 @ 23.3gms			
Loading	start @ 9:30 finished @ 11:30				
Time	**Temp.**	**O2 mg/l**	**CO2mg/l**	**pH**	**O2 flow**
8	4.5	8.9	20	7.9	3
12:30	4.2	10.4	32	6.8	
1:30		10.8	28		
2:30		10.6	20	6.7	
3:30		12.12			
4:30		12.9	22	6.6	2.5
5:30		13.9			
6:30		14.4	24		2
7:30		15.2		6.3	
8:30		15.9	18	6.3	1.5
10:00		16.4			
12PM		17.1			1
2AM		17	20	6	

Carbon Dioxide again

- CO_2 is generated by fish as a result of metabolism and is excreted through the gills. Any increased ventilation due to stress results in increased CO_2 being excreted into the water.
- In transport systems CO_2 needs to be controlled. This is easily accomplished by using a packed column or an aeration system .
- As CO_2 increases the water becomes more acidic and pH is lowered.
- Increased CO_2 concentration in the blood lowers blood pH and reduces the ability of hemoglobin to bind oxygen.
- As pH lowers, the harmful effects of free CO_2 are enhanced
- A level of 2mg/L exists in equilibrium with normal atmospheric pressure. 7mg/L is normal at pH 6.9 and 20mg/L is considered a critical threshold for salmonids.

Carbon Dioxide

- What's wrong with taking in too much carbon dioxide?

Ammonia

- The major source of ammonia is fish metabolism
- In a completely closed recirculating transport system it is not possible to rid the water of ammonia without chemical addition
- The harmful effects of ammonia are controlled by regulating pH. Lower pH levels minimize the concentration of toxic unionized ammonia (NH3)
- Ammonia in aquaculture systems is measured as total ammonia, the sum of the concentrations of NH4 and NH3. Table are available that yield values for NH3 under a given pH, temperature and salinity.
- Fasting fish and reducing overall stress will greatly reduce ammonia production

Chemicals » Hauling Tank Water Conditioners » **SureHaul**

Reduces stress and mortality caused by fish hauling and holding. Sure-Haul™ also reduces the accumulation of ammonia, nitrate and prevents foam buildup caused by hauling tank crowding. Safe for use on all freshwater fish, it has a low regulatory status and is safe for use on food fish. Ideal for fish transport, bait tanks, minnow farms and fishing/bass tournaments. One 5-gallon bucket (50 lbs) treats 1,600 gallons (6,056 liters) of water. The concentrated formula includes the same ingredients, except the salt, and saves in shipping costs. Simply mix one gallon with 50 lbs of non-iodized salt (purchased locally) to treat 1,920 gallons (7,267 liters). Not a dechlorinator.

Ammonia

Up

Ammonia toxicity is thought to be one of the main causes of unexplained losses in fish hatcheries. Different species of fish can tolerate different levels of ammonia but in any event, less is better. Rainbow trout fry can tolerate up to about 0.2 mg./l while Hybrid striped bass can handle 1.2 mg./l. The effects of ammonia toxicity include reduced growth rates, gill hyperplasia (enlarging), decreased tolerance to low dissolved oxygen levels and decreased resistance to disease.

Ammonia exists in two forms in the water : NH_3 **(this is called unionized ammonia)**

NH_4^+ **(this is called ionized ammonia)**

Together, these two forms of ammonia are called *TAN* which means total ammonia nitrogen

Unionized ammonia (NH_3) is the form of ammonia which is toxic to fish and must be checked regularly in a recirculating fish hatchery. Ammonia is produced when fish consume feed and is released through feces (about 20%) and through the gills and urine (about 80%). Biofiltration is used to reduce the amount of total ammonia in the system but toxic ammonia (NH_3) can be at higher than acceptable levels even when the biofilters are functioning properly. The two factors which affect the amount of toxic ammonia is in your system other than the total ammonia itself is the water temperature and the pH. I'm not sure why temperature has an effect on the amount of NH_3 in the water but I can explain how pH affects it.

The **pH** of water (**p**otential of **H**ydrogen) is a measure of the amount of hydrogen ions (H^+) which are present in the water. The lower the pH is, the more hydrogen (H^+) ions there are in the water. As we mentioned before, NH_3 is toxic ammonia and NH_4^+ is non-toxic. From this, then, it becomes apparent that the more H^+ ions there are, the more available they become to combine with NH_3 to change it to NH_4^+. The affect pH has on the level of toxic ammonia in the system is profound as the following table demonstrates.

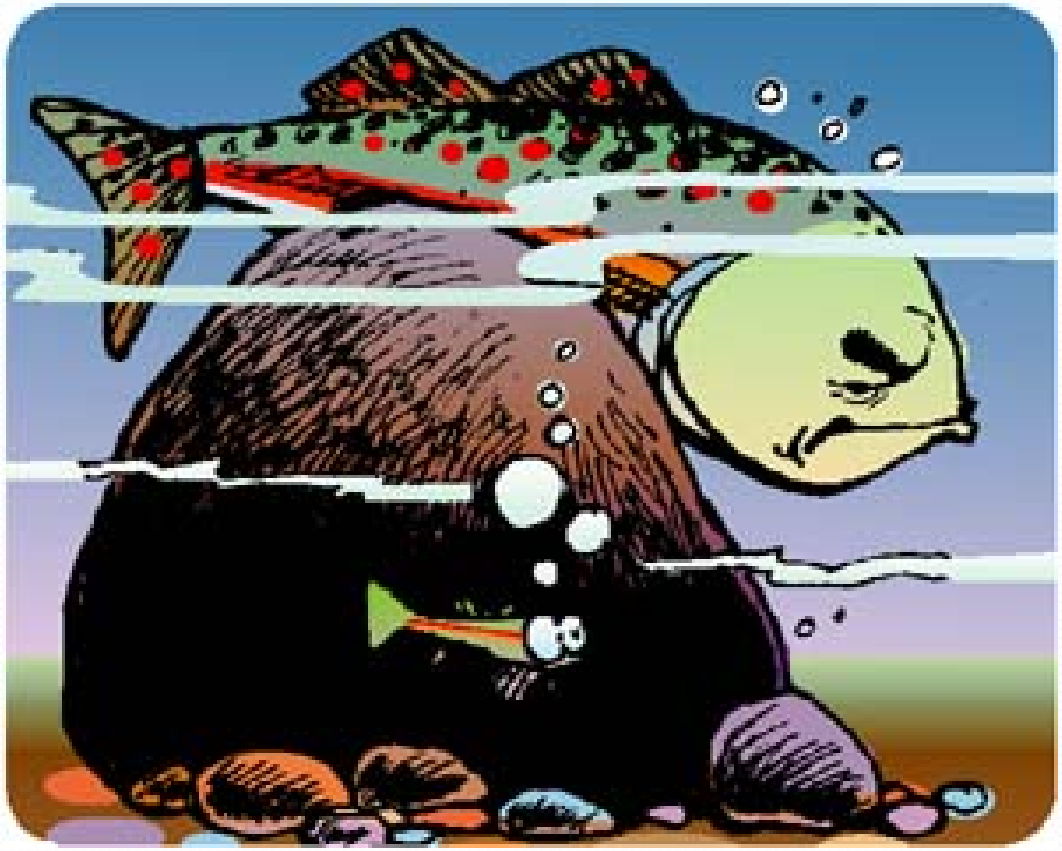
The numbers in red indicate the lethal level for Salmonids. **Note that at a pH of 7.4 and a total ammonia concentration of 5 parts per million, you have more toxic ammonia in your system than if you were at a pH of 6.5 with a total ammonia concentration of 40 parts per million.**

Total	ph										
Ammonia	6.5	6.6	6.7	6.8	6.9	7	7.1	7.2	7.3	7.4	7.5
(ppm)											
5	0.0047	0.0059	0.0074	0.0093	0.0117	0.0147	0.0185	0.0233	0.0293	0.0368	0.0463
6	0.0056	0.0070	0.0089	0.0112	0.0140	0.0176	0.0222	0.0280	0.0352	0.0442	0.0555

Temperature

- Cold water allows higher densities than warm water
- For a given size fish transport density can be increased with a 1 degree C drop and decreased with a 1 degree rise by about 10%.
- A 10 degree C difference between transport and receiving water is usually easily tolerated by fish, however tempering for as long is practical is always beneficial.

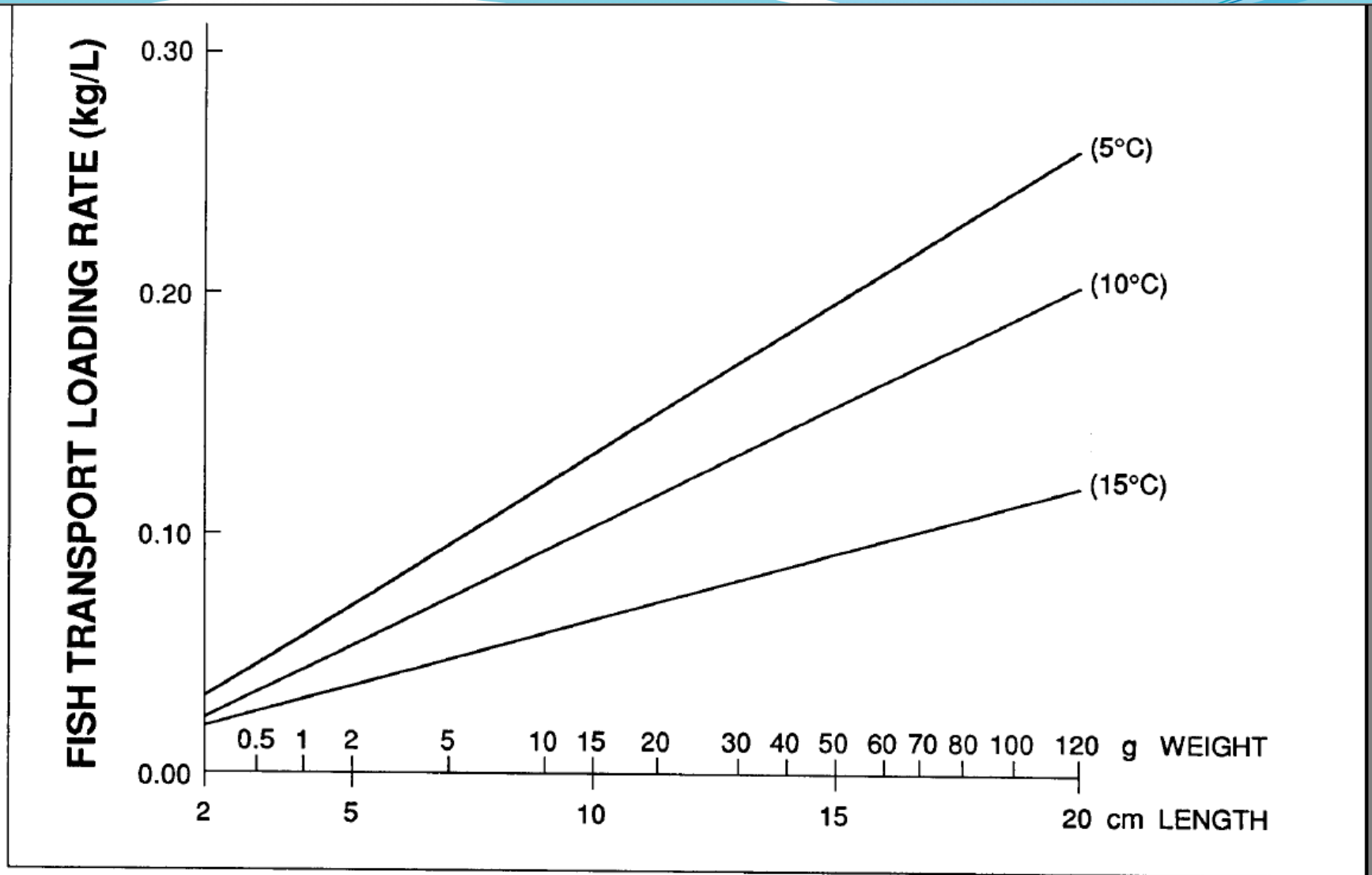
Size of Fish



Big fish have lower metabolic rates than smaller fish and can be transported at higher density.

Size of Fish

Fingerlings	.06 -.24kg/liter
Smolts	.24 -.36kg/liter
Adults	.1kg/liter (light loading)



levels, but should always be below 200% saturation. It must be remembered that salmonid metabolic rates have a wide range of variation and that changes in environmental parameters or disturbance of fish can

Safe theoretical loading curves for juvenile salmonids as proposed by Websters in 1981. *It is wise to test all procedures before committing valuable production to a transport method. This may take the form of a mock transport trip at the hatchery.*

Transport densities

		No. of Fish	Ind. Weight	Total Weight (kgs)	Transport lbs / gal.	Kg/L
Trip #1	NP #1	259,716	0.608	157.91	1.74	0.21
Trip #2	NP #1	259,716	0.608	157.91	1.74	0.21
Trip #3	NP #2	285,421	0.61	174.11	1.92	0.23
Trip #4	NP #3	286,088	0.6	171.65	1.89	0.23
Trip #5	NP #4	285,275	0.6	171.17	1.88	0.23
Trip #6	NP #5	284,449	0.61	173.51	1.91	0.23
Trip #7	NP #6	284,510	0.59	167.86	1.85	0.22
	Totals	1,945,175	0.60	1,174.11	1.88	
	2002 Transports to Neck Lake June 5					
		No. of Fish	Ind. Weight	Total Weight (kgs)	Transport lbs / gal.	Kg/L
Trip #1	NP #1	285,000	0.49	139.65	1.54	0.18
Trip #2	NP #2	285,000	0.5	142.50	1.57	0.19
Trip #3	NP #3	285,000	0.49	139.65	1.54	0.18
Trip #4	NP #4	285,000	0.45	128.25	1.41	0.17
Trip #5	NP #5	285,000	0.46	131.10	1.44	0.17
Trip #6	NP #6	285,000	0.44	125.40	1.38	0.17
	Totals	1,710,000	0.47	806.55	1.41	
	Total cost of transport ($)		5,757.00			
	Cost per fish ($):		0.0034			
	Cost per kg ($):		7.14			

Columbia River Smolt Barges

- D =.05kg/l
- Flow through pumping
- Ld = .5kg/liter/min
- R = 6
- Avg. barge capacity
  - 34,000 kg

Columbia River fish transport barge
- 300 miles in two days
- fish technician onboard to monitor water quality
- May/June
- up to 100,000 fish/day are handled
- 15 to 20 million salmon/steelhead per year

Saving salmon

Corps fish programs target survival

Above, Doug Marsh, a research fisheries biologist for the National Oceanic and Atmospheric Administration Fisheries, examines one of the juvenile salmon to be transported. Below, Floyd Hunt, maintenance worker, fills a barge's holding tank with smolts to be transported below Bonneville Dam.

Story and photos by Gina Schwartz

During April and May, river flows and water temperatures rise in lower Snake River tributaries, spurring smolts into their downstream run to the Pacific Ocean. Walla Walla District fish facilities went into high gear to give protected fish species a safer ride to the sea.

Using specially-equipped barges to carry migrating juvenile salmon and steelhead around dams on the lower Snake and Columbia rivers, the U.S. Army Corps of Engineers works with many state and federal agencies to transport and study salmon. District fish facilities operate daily during the spring run to tag and transport as many fish as possible.

Lower Granite Lock and Dam's fish facility transports the most fish in the District.

"Granite is the first dam on the Snake River that these fish encounter, so we see the most here," said Mike Hulter, fish facility manager at the dam. "Juvenile fish that go through the dam's bypass systems can be routed either directly back into the river below the dam, or to the fish facility for loading into transport barges."

Barges carry the fish past the remaining dams for release downstream of Bonneville Lock and Dam. Throughout the two-day, almost 300-mile trip, a District biological technician rides along on the barge, checking water quality in the tanks, and adjusting water flow as needed.

"The first day, I check the tanks every two hours. After that, every four," said Suzette Frazier, a "barge rider." "I sleep a little bit between my checks until we get them to the release point."

The Corps runs the Juvenile Fish Transportation Program in cooperation with National Oceanic and Atmospheric Administration Fisheries.

NOAA Fisheries runs tagging operations at the District's fish facilities. A tiny microchip, about the size of a grain of rice, is inserted into the abdomen of an anesthetized fish.

Information about the fish is recorded and linked to the tag number: species, size, weight, body condition and whether the fish is released or barged downstream. During the last week of May, Lower Granite's facility processed about 100,000 fish daily for barge transport. Typically, 15 to 20 million salmon and steelhead are transported from District dams each year.

To obtain a better, scientific understanding about salmon, the Corps sponsors many studies to help improve passage conditions for fish at the dams and through the river system.

For example, at Lower Granite this year, the Corps funded studies to gather data about bats, spawned-out steelhead that are returning to the ocean, and the downstream migration of juvenile salmon once released past the dams.

Fish passage facilities and operations on the river have been developed and refined based on results of various studies. These include adult fish ladders, fish bypasses with turbine intake screens and the smolt barging program.

Above, Suzette Frazier, biological technician and "barge rider," adds oil to one of four engines that run pumps to keep water flowing in the holding tanks on the barge transporting smolts downstream. Barge riders tend the fish around the clock during the two-day trip downstream. Right, the tug boat, Mary Jane II, steers a barge full of young salmon and steelhead away from the fish facility dock at Lower Granite Lock and Dam on the lower Snake River. The fish take a nearly 300-mile trip downstream and are released just past Bonneville Lock and Dam on the Columbia River.

Biological technicians, Suzette Frazier, left, and Carla Hurlbert exchange information before the fish barge starts its journey downstream.

Oregon State University biology students place small transmitters into juvenile salmon to collect migration data for a Corps-funded study.

- Any transfer/transport of fish should be considered a STRESSUL event.
- Simply arriving at your destination with live fish may in itself be a cause for celebration !
- Post -transport mortality can be severe. A stressful transport will predispose your fish to attack by a pathogen.
- Given good water quality and a given tank size the amount of biomass you can transport will vary depending on the size of the fish and water temperature.

Techniques to Mitigate Stress

- Handling and crowding during loading
  - Results in stress causing increased metabolic rates and oxygen consumption. Transport water should be saturated with oxygen prior to loading.
  - If possible maintain a flow through tank while loading.
- Use of anesthetics to calm fish during transport.
  - Use of anesthetics during transport is not common.
  - Any of the compounds commonly used such as MS222 will work and should only be used to produce a relaxed state does not affect equilibrium.
  - Addition of salts has a sedative effect
- Fish should be fasted 48 – 72 hours prior to transport.
  - Longer periods may be recommended in cold water
  - The standard metabolic rate of rainbow trout typically does not begin to decline until about 48 hours without food (Wedemeyer 1996)
  - Rainbow trout studies (Phillips & Brockway 1954) determined that after 60hrs of fasting oxygen consumption reduced 25% and ammonia excretion was reduced 50%

- Addition of minerals
  - When fish are stressed during transport by loading and handling ventilation rates increase dramatically. As more water is passed over the gills the normal osmotic influx of water through the gills rises and increases urine production resulting in a loss of chloride ions. Loss of these ions can become life threatening and often the mortality is noticed after the transport is complete.
  - Stress and mortality are reduced by simply adding minerals that allow the fish to restore the osmotic balance by taking in chloride ions. This can be accomplished by the addition of :
    - NaCl - .1 –1%
    - $CaCl_2$ – 50ppm
    - Sea salts - .5%
    - Sea Water @ 10 – 15ppt
    - Check salinity with a meter

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Chemicals » Water Conditioners » **Defoamer**

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Our defoamer is a high-quality, 5 percent food grade, silicone-based product that will instantly eliminate surface foam in tanks, ponds, hauling tanks, etc. Use sparingly, as one teaspoon treats 100 gallons or more. This is a great price on a high-quality defoamer. Made in USA.

Chemicals » FDA-Approved Medications » **Tricaine-S**

This is an FDA-approved, ANAD #200-226, high-grade brand of MS-222 (tricaine methanesulfonate), which is an anesthetic/tranquilizer of fish and other cold-blooded aquatic organisms. When used properly, it induces a temporary state of immobilization that is rapidly reversed when the animal is placed back in clean water. It is commonly used when handling fish during manual spawning (stripping), tagging, measuring, weighing and surgical operations. It is a great sedative for transporting, sorting and grading fish.

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Stress Coat®

Slime coat replacement.
Stress Coat® replaces a fish's natural slime coat with a synthetic one, preventing loss of body fluids and electrolytes. This is very useful when hauling, handling or medicating fish. In addition, Stress Coat® acts as a water conditioner, neutralizing chlorine and, when used during shipping, is an economical form of protection for your investment. Not FDA-approved. Use one teaspoon (5 ml) per 10 gallons for chlorine neutralization; double for fin/scale damage. Does not neutralize chloramines.

Chemicals » Hauling Tank Water Conditioners » **SureHaul**

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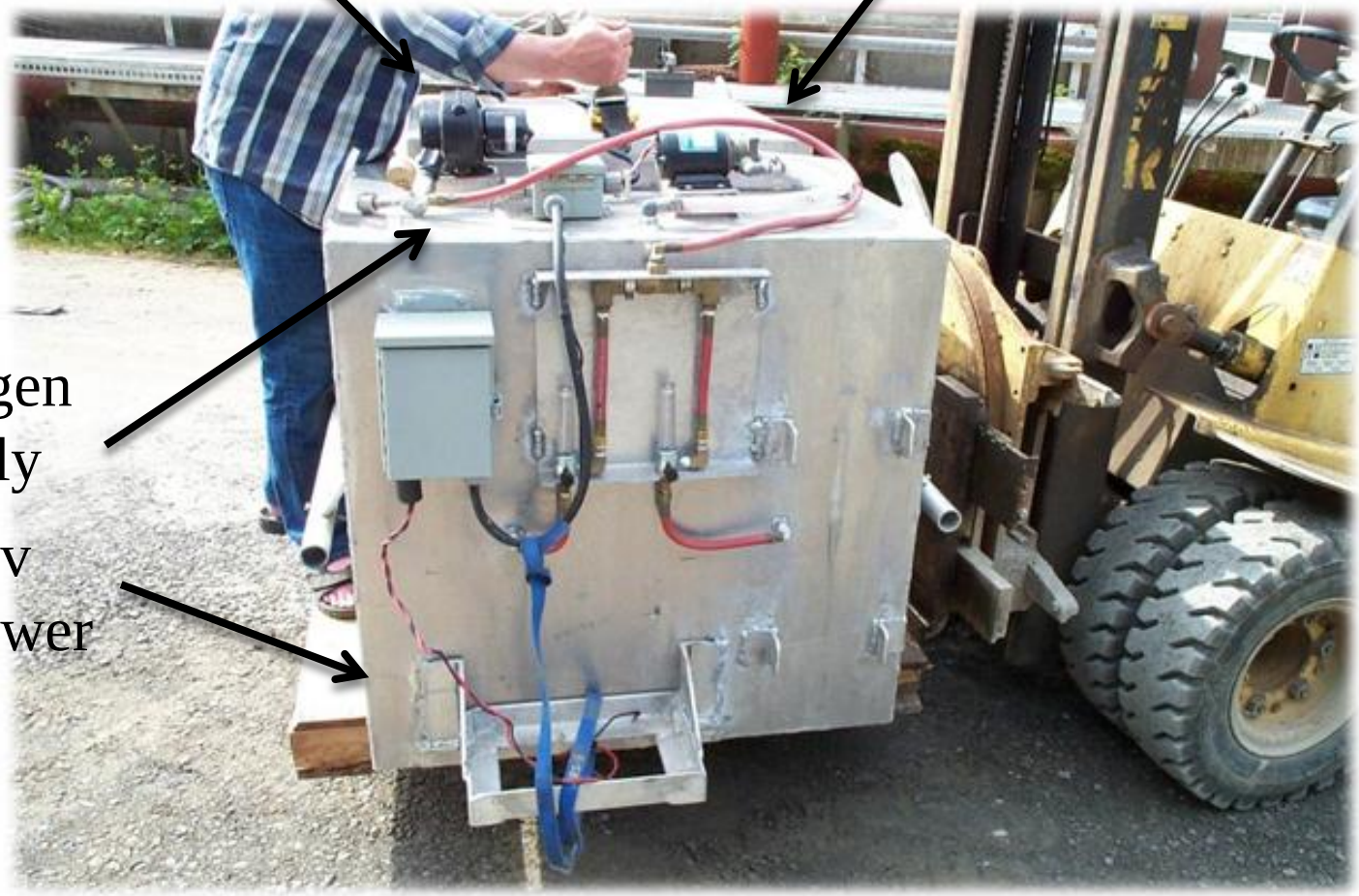
Tank Design

Tank Design

- Construction Materials
  - Fiberglass
  - Aluminum
  - Plastic
  - Stainless steel
- Insulated or Not
- Compartments
  - Sloped to center and outlet
  - Overflow control
  - Baffles
- Size and Shape
  - Rectangular
  - Elliptical
- Circulation System (12 volt)
  - Agitator
  - Pump


Juvenile Fish
Transportation


Your
License
Dollars
at Work
MILFORD FISH HATCHERY


blower
aerator
Oxygen supply
12v power


N409PA

Neck Lake coho

Whitman chum transfers

Split fish hold

Deer Lake coho transfers

Green Lake chinook transfers

Oxygen supply and meter

Fish pump

Follow up to “Fish Transport” session:
Green Lake Chinook Transfers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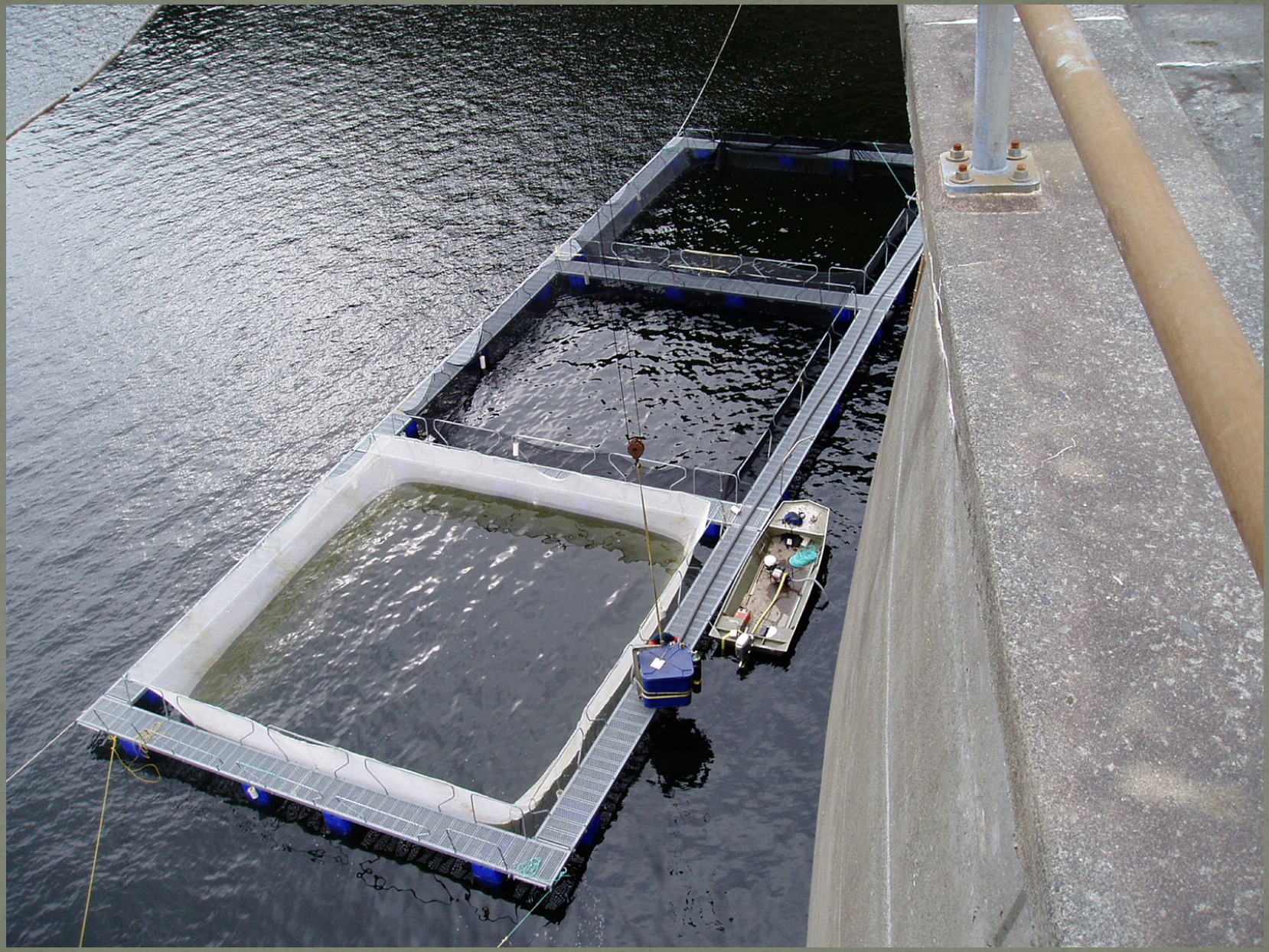

Dewatering box

Site gauges

Assignment 6

- Watch the Green Lake transfer video – (not yet posted – will send out an announcement)
- Write up a brief summary of the operation Make a
- list of some basic equipment necessary to have on hand for the operation