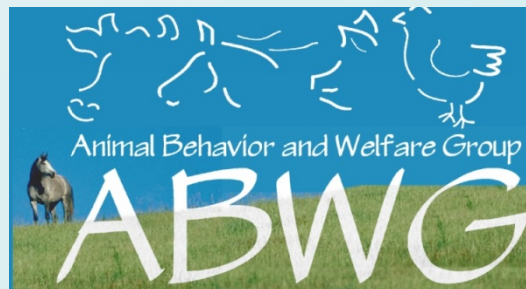




Aquaculture Welfare Assessment

Comparing Open Net Pens for Salmon with
Land-Based Raceways for Trout

Animal Welfare Judging Competition 2008



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Facility Basics – Salmon

- Pacific Ocean, off coast of Washington, USA
- Stocking density: 30 kg/m³
- Personnel: Former fishermen with high school degrees
 - 5 years experience with aquaculture
 - 20 years of fishing experience



Facility Basics – Trout

- Inland raceway system located in U.K.
- Stocking density: 45 kg/m³
- Personnel: Technicians have bachelor degrees in biology or fisheries
 - They have been working at the farm for 3 years



Grading & Grouping - Salmon

- Mechanically graded five times until the fish are 80 g (2.8 oz)
- Fish are then placed into ocean pens



Grading & Grouping - Trout

- Fish are boxed graded when moved to a clean tank
- After fish reach 8 in (20 cm), they are sorted by approximating size visually



Water Quality - Salmon

- Average summer water temperature: 55°F (12°C)
- Average winter water temperature: 50°F (10°C)
- Located in protected bay to avoid storm damage



Water Quality - Trout

- Average summer water temperature: 50°F (10°C)
- Average winter water temperature: 30°F (-1°C)
- Water is from a natural spring and has physical filtration systems
- Cascading raceways help maintain oxygen levels



Nutrition - Salmon

- Salmon pellet nutrient information: 48% protein, 11% fat, 3% fiber and 12% ash
- Additional vitamins are provided when water is $< 50^{\circ}\text{F}$ ($<10^{\circ}\text{C}$)
- Fish are fed 2-3 times per day
- Food is scattered using a machine operated by an employee



Nutrition - Trout

- Trout pellet nutrient information: 40% protein, 10% fat, 3% fiber and 12% ash
- Fed via automatic feeder 5 times a day



Measures of Fin Erosion

Salmon

- Dorsal fin erosion scored at 3 or higher (on a scale of 0-5) in 25% of fish
- Most erosion and other bodily wounds are found on the smaller fish in the pen



Photo Courtesy of M. Faisal

Trout

- Pelvic fin erosion scored at a 2 (on a 0-5 scale) on 10% of fish
- Caudal fin erosion scored at 1 (on a 0-5 scale) on <5% of fish



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Handling

Salmon

- Salmon are handled when graded (5x) and immediately before slaughter
 - Grading is done mechanically



Trout

- Trout are handled when moved periodically to larger tanks as fish grow
- Trout are also handled when vaccinations are given



Return to Feeding after Stress - Salmon

- Rough weather produces cage noise which alters fish behavior
 - Fish do not feed for 2-3 days after a storm
- Fish do not feed for 2 days after being graded



Return to Feeding after Stress - Trout

- Trout will not feed for 1 day after being moved to a new tank
- Trout will not feed for 1 day after handling



Parasitism/Disease - Salmon

- Sea lice infection peaks in late spring with 20% of stock infected
 - Treatment for sea lice— Dichlorvos baths
 - 8% of salmon infested with sea lice develop another health problem (e.g., secondary infection)
- Rate of viral disease:
 - Viral hemorrhagic septicemia = 9% of stock
 - Infectious pancreatic necrosis virus = 7% of stock
 - Swim bladder sarcoma virus = 3% of stock

Parasitism/Disease - Trout

- Vaccinations against *Flavobacterium* and IHNV are provided to juveniles
 - During vaccination, fish are handled with wet gloves and/or braile lining of net
- Whirling disease observed in <2% of adult trout
- Large Bacterial Kidney Disease outbreak 2 years ago in which half of stock was lost
- Government mandated inspections are performed twice a year

Overall Mortality Rate

Salmon

- 10% annually, due to rough weather and predation



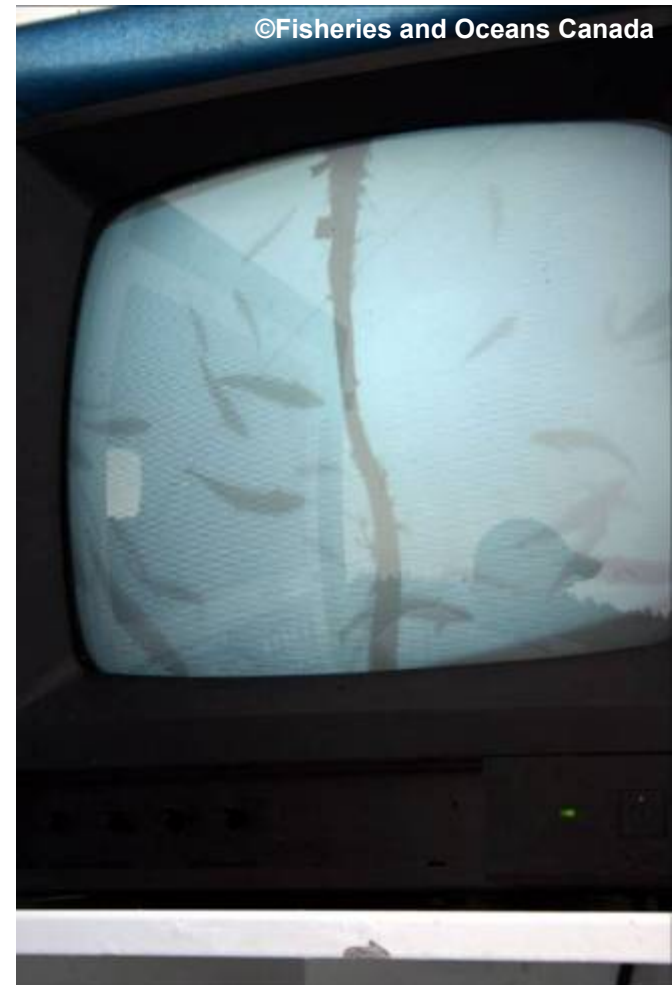
Trout

- 4% annually, primarily due to predation



Monitoring - Salmon

- Underwater cameras used to monitor the bottom of the pens
- Visual observations occur at feeding time from the boats



Monitoring - Trout

- Personnel check trout at opening of facility, specifically looking for mortalities and signs of sickness
- Additionally, checks occur throughout day at husbandry tasks are performed



Handling of Diseased Fish - Salmon

- If only a few diseased fish are observed:
 - Fish are euthanized if not suitable for consumption
- If majority of fish are infected:
 - Fish are contained in a temporary “bubble” pen with medication for specified time
 - Then all fish, water, and medication are released back into the entire pen

Handling of Diseased Fish - Trout

- Injured and diseased fish are treated in small tanks until condition is remedied



Abnormal Behavior - Salmon

- Circular shoaling behavior occurs for 5% of daylight hours
- Breaking and rolling at surface is observed when sea lice infestation is heavy

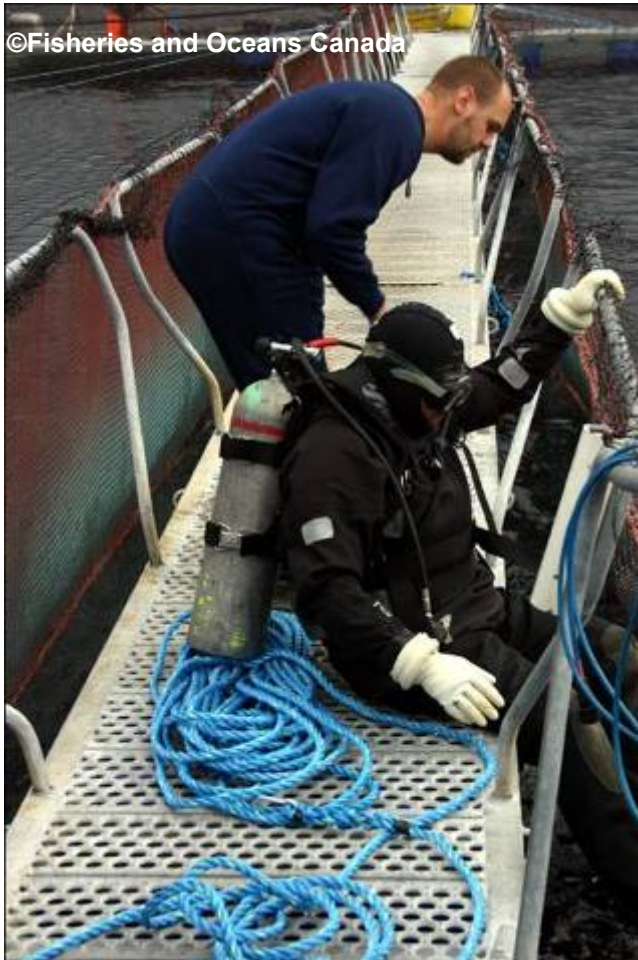


Abnormal Behavior - Trout

- Less than 2% of fish are observed swimming abnormally in raceways
- 3% of fish are observed being inactive at bottom of the tank



Predation & Escape - Salmon



- Net tears by seals occur about 1x/month
- Typically no more than 20 fish are lost before a diver can go down & repair the net
- Stress response to seal presence is unknown at this time

Predation & Escape - Trout

- An occasional fish is lost to herons and birds of prey but this is rare ($< 5/$ month)
- Escape into other water is not possible
- Approximately 10 fish/month are collected that have leapt out of the water & are not found in time to be returned to the water



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Pre-Slaughter Procedures

Salmon

- Fish are temporarily starved for 48-72 hr pre-slaughter
- Fish are enclosed in seine net and emptied onto well boat
- Well boat holding water is continually replaced with fresh salt water

Trout

- Fish are temporarily starved for 24-48 hr pre-slaughter
- Fish screw-type pumps are used to send trout into shipping trucks
- Trucks are able to chill water if trip is long and add oxygen to transport water



Physiological Response

Salmon

- Plasma cortisol during loading = 4.1 $\mu\text{g/dL}$
- Plasma cortisol during shipping = 2.2 $\mu\text{g/dL}$

Trout

- Plasma cortisol during loading = 6.3 $\mu\text{g/dL}$
- Plasma cortisol during shipping = 3.2 $\mu\text{g/dL}$

Slaughter Technique

Salmon

- Salmon are killed by immersion in CO₂ saturated water in the well boat
- Gill cutting then occurs at the processing plant on land

Trout

- Fish are lightly sedated pre-slaughter with bicarbonate-treated water in the truck
- Kill method is via electrical stunning at the processing plant