

# A freshwater recirculating culture system for experimental hatchery populations of steelhead

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# Freshwater Recirculation at Manchester Research Station

- Salmonid research at Manchester conducted over entire lifecycle
- Freshwater is limiting (~ 50 gpm well water)
  - Fish culture of juveniles
  - Maturation of adults
  - Operation of laboratories
- Designed, constructed, and tested a freshwater recirculating culture system for steelhead research
  - Uses 5-15 gpm makeup
  - Provides up to 120 gpm
  - Twenty 6' diameter tanks
  - Mechanical, biological, and UV filtration
  - Chilling capability
  - Automation
  - Water quality monitoring
  - Alarms
  - Backup generator
  - Effluent ozonated



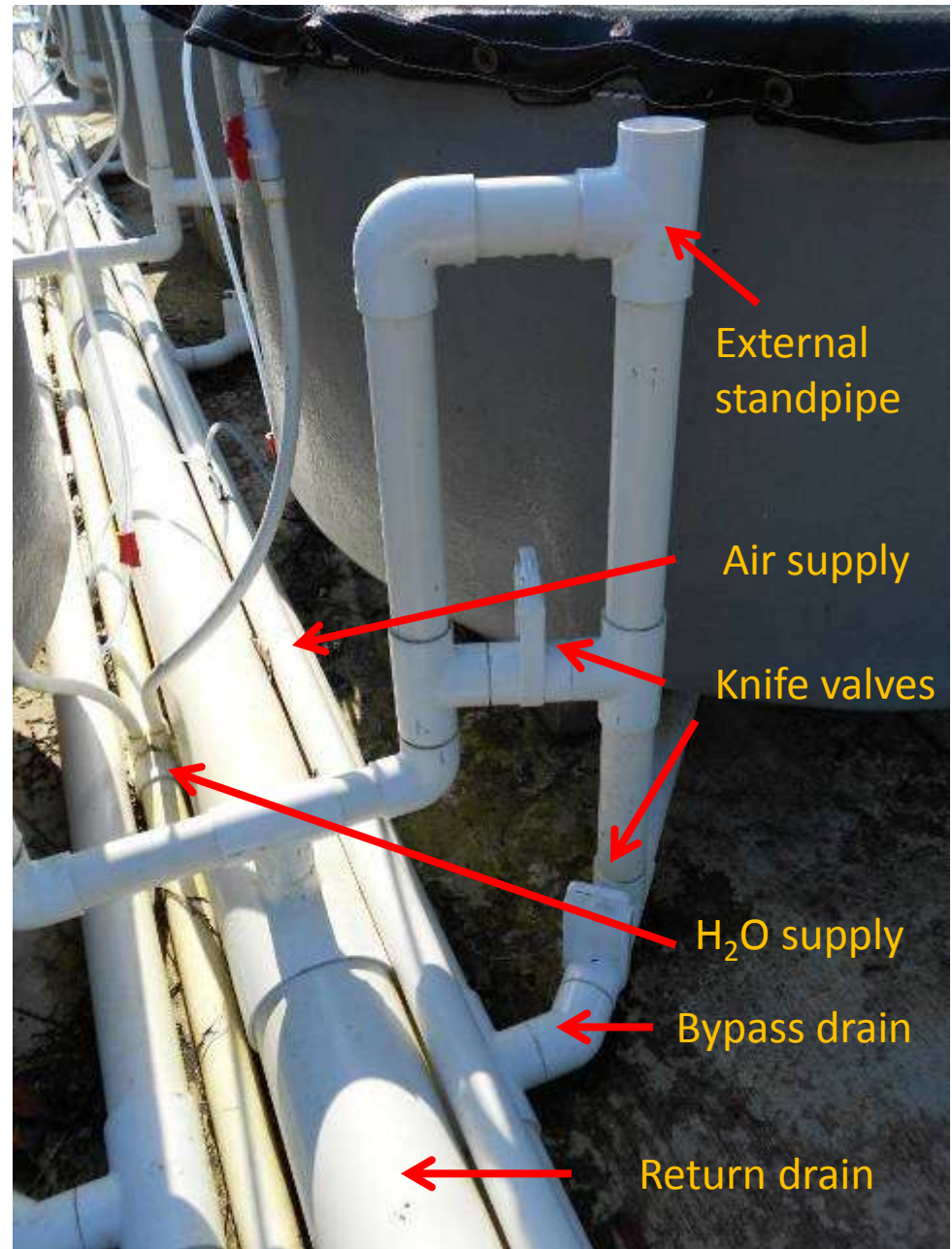
# Fish Culture System Overview





## Features of rearing vessels and water supply

- 6 foot diameter circular tanks
  - Shade cloth covers with screened feeding port
- Treated water supply line with ball valves to each tank
  - Option to supply tanks with saltwater
- Air supply line connected to 1HP blower
  - Air stone with rolling valves
- External standpipe with knife valves
  - Return to recirculation sump
  - Lower water level
  - Drain waste to bypass



## Features of water treatment system

- Backflush reservoir (900 gal) and makeup water input
  - Overflow to recirc sump (1250 gal)
- 3HP pump with variable frequency drive
- 2 - 130 gpm sand filters
- 2 - 130 gpm biofilters
- 2 - 550 Watt UV sterilizers (170 gpm)
- 5HP chiller – 60 gpm
- 1HP regenerative blower
- Electrical and control panel
- Automated backflush (2X /day)
- Alarm control panel with autodialer
- Water quality telemetry unit
  - Netronix node
  - Hydrolab DataSonde 4a
- 2 Heath tray incubator stacks



## System controls and alarms

- Control volume of water delivered with variable frequency drive for main 3 HP pump
- Automated backflush of sand and biofilters PLC
- Low system pressure and water level sensors
- Alert conditions delivered with a sensaphone and autodialer connected to a cell phone



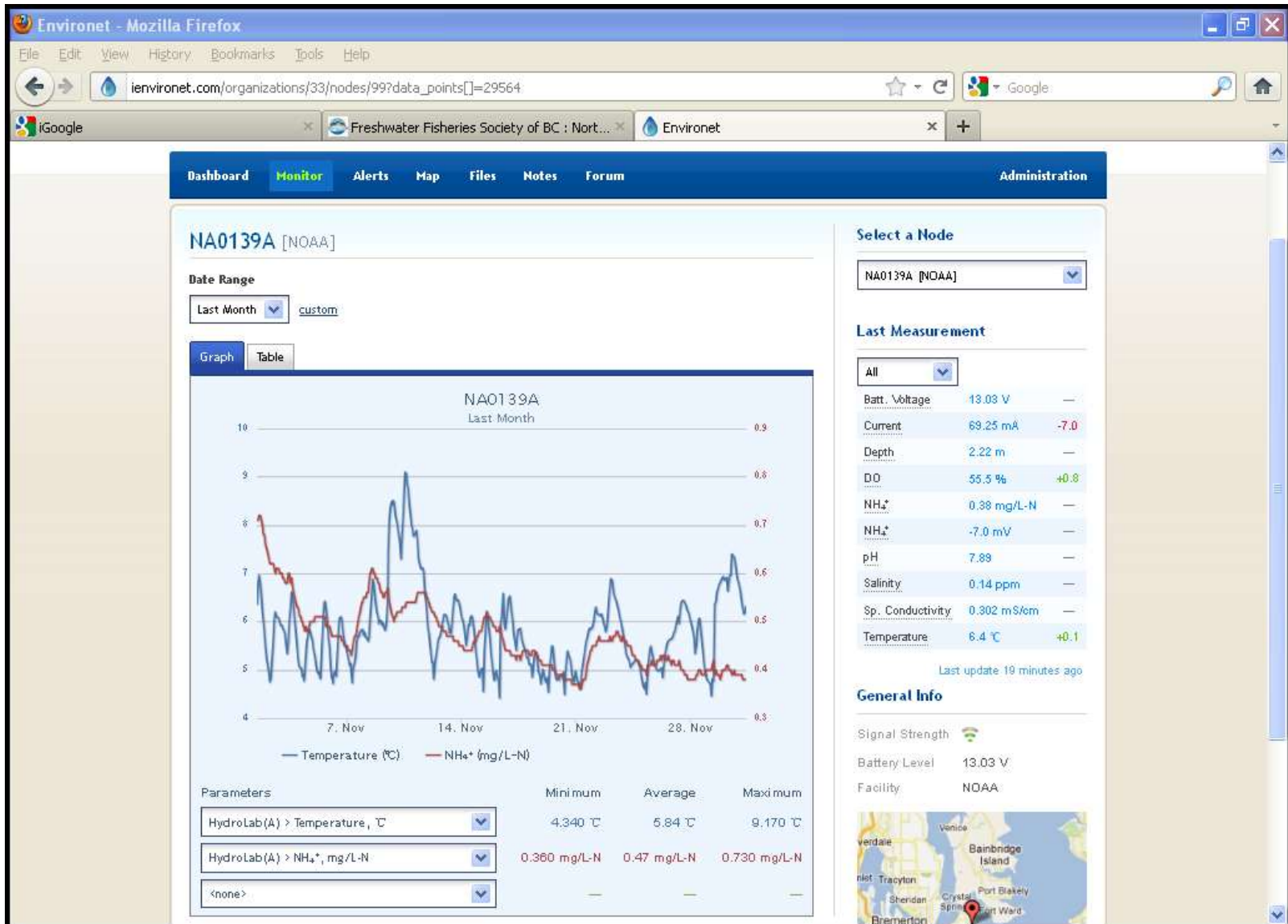


## Water quality monitoring

- Water quality parameters measured hourly with a Hydrolab Datasonde 4a (Hach corporation)
  - Temperature ( $^{\circ}\text{C}$ )
  - Dissolved  $\text{O}_2$  (% Saturation)
  - Ammonium ion (mg/L)
  - pH (units)
  - Specific conductivity (mS/cm)
- Multiprobe placed in the recirc sump to measure water returning from tanks (worse case scenario)
- Data logging and telemetry performed by RN-500 node (netronix corporation)
  - Water proof housing
  - Thiamis ICU
  - GSM and GPS antennas
  - 18 Ah battery and charger
  - DC or AC power
  - Monthly service charge
  - Environet interface



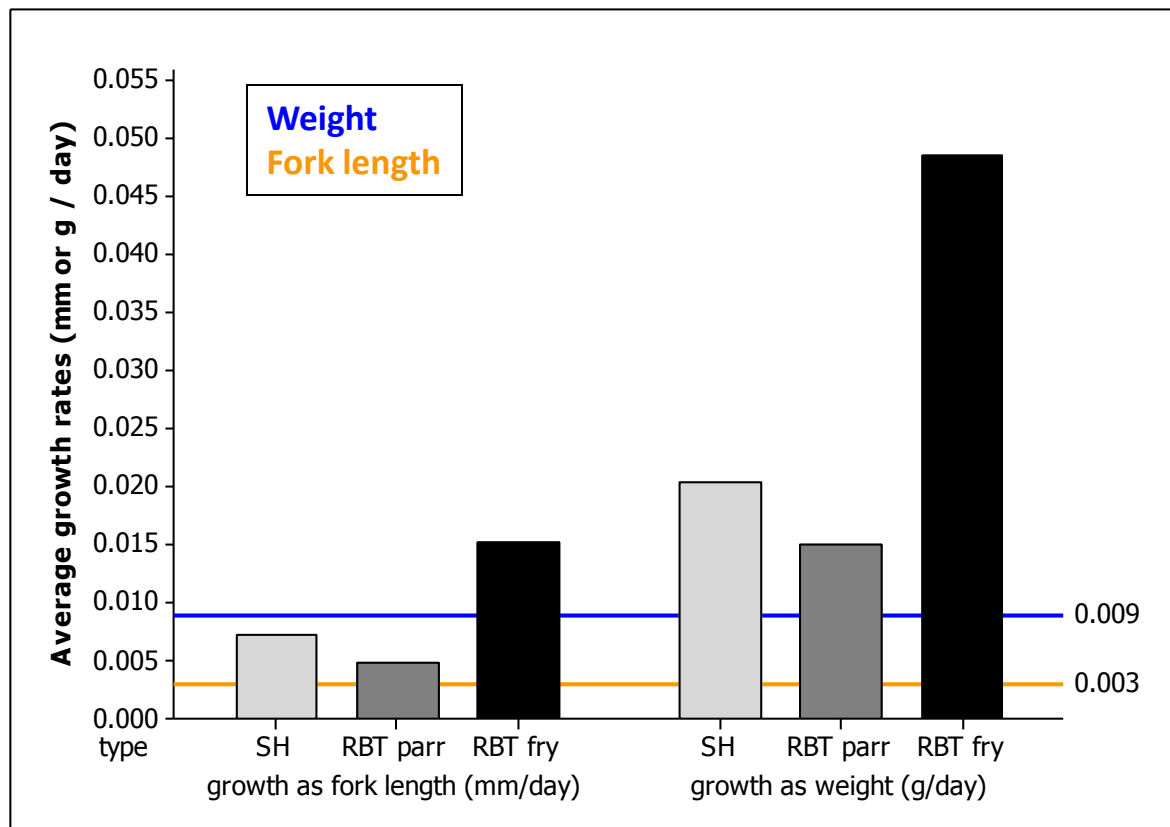
# Environet interface





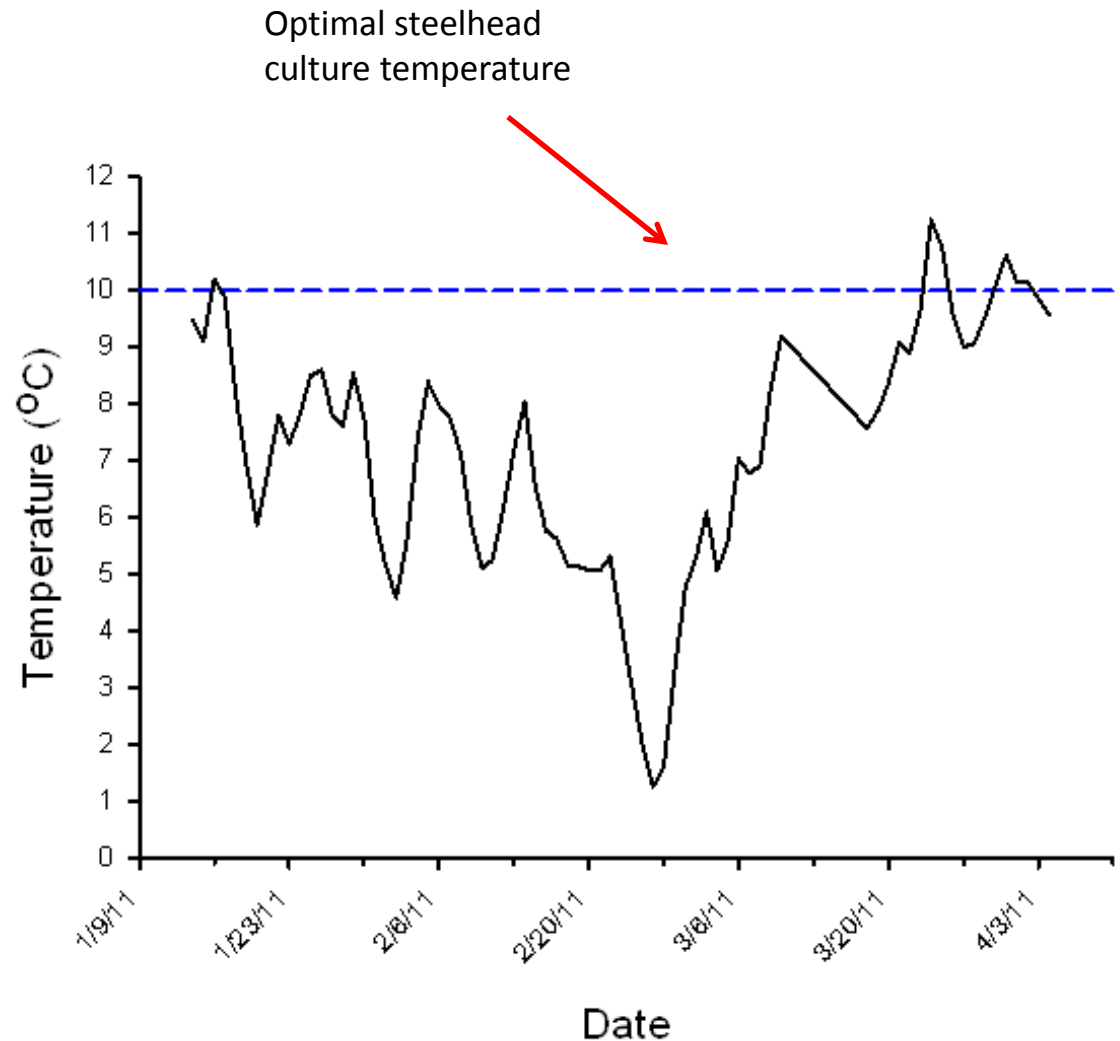
## Testing system performance: fish growth

- 6 tanks stocked with ~300 fish each (1867 fish total)
  - 4 tanks domesticated rainbow trout
  - 2 tanks of hatchery steelhead
- Rations slightly exceeded satiation to maximize growth rates
- Calculated average instantaneous growth rate (fork length & mass) over 147 days
- Compared growth rates to 13 year average for hatchery steelhead at Winthrop National Fish Hatchery
- Growth exceeded rates at WNFH
  - Length ( $n = 6$ ,  $T = 4.9$ ,  $p = 0.002$ )
  - Weight ( $n = 6$ ,  $T = 3.9$ ,  $p = 0.006$ )



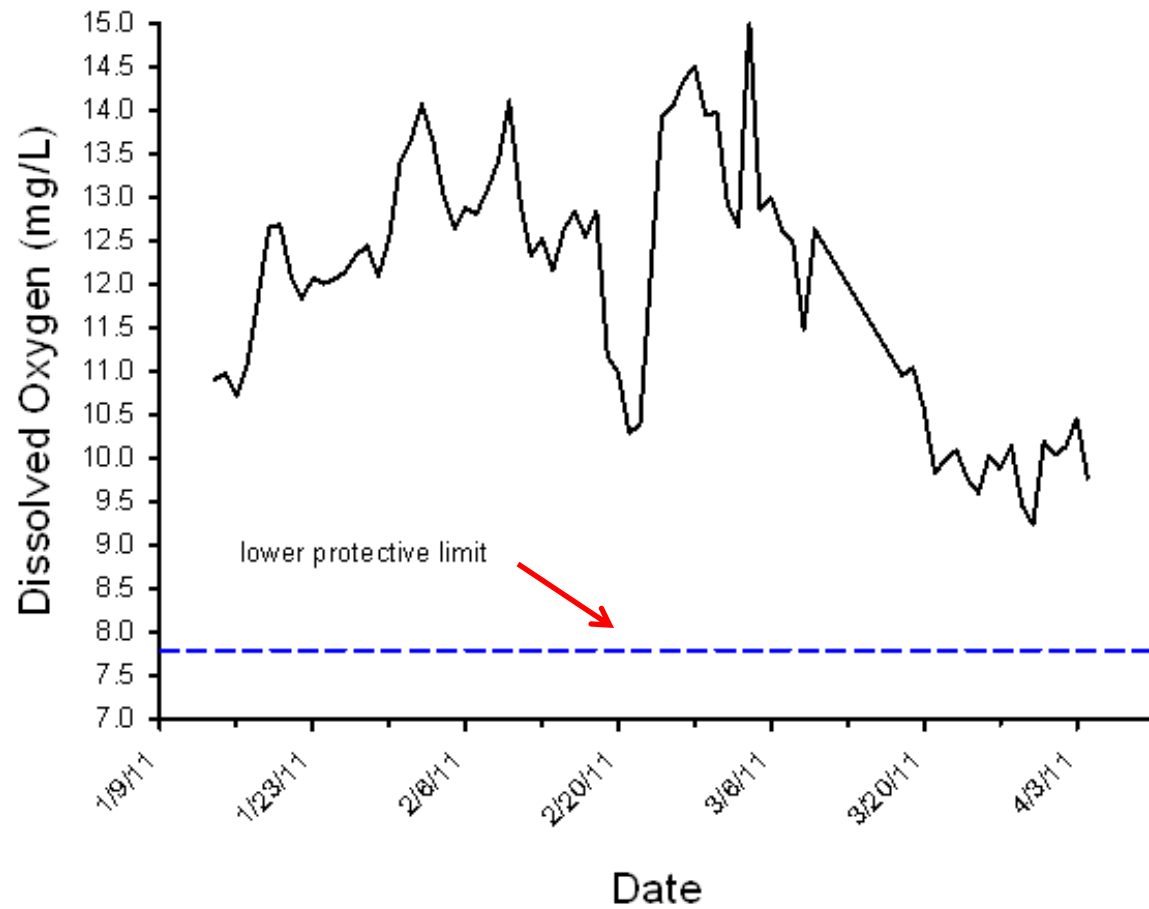
## Testing system performance: water temperature

- Water quality measurements were made inside one of the stocked circular tanks
- During the test period, average daily water temperatures rarely exceeded optimal temperature for steelhead growth (10 °C, Pauley et al. 1986)
- The temperature control during severe cold weather is inadequate because the system lacks heating capability



## Testing system performance: dissolved oxygen

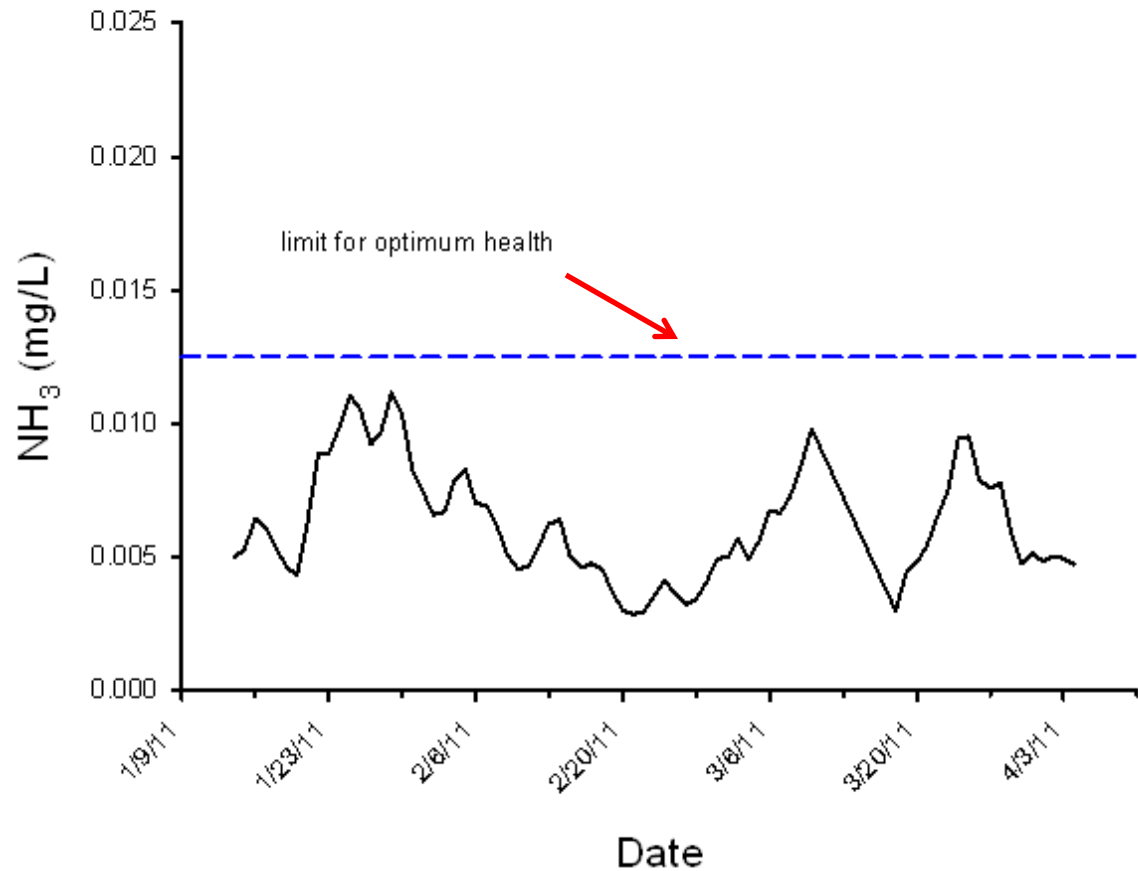
- Dissolved oxygen levels never fell below the lower protective limit for salmonid culture (7.8 mg/L Davis, 1975)





## Testing system performance: Ammonia concentration

- The concentration of unionized ammonia ( $\text{NH}_3$ ) was calculated from the measured ammonium ion ( $\text{NH}_4^+$ ) concentration, temperature, pH, and conductivity using a spreadsheet developed by Colt, 2001
- The calculated ammonia concentration never exceeded the upper limit for optimum salmonid health (0.0125 mg/L) proposed by Piper et al., 1982



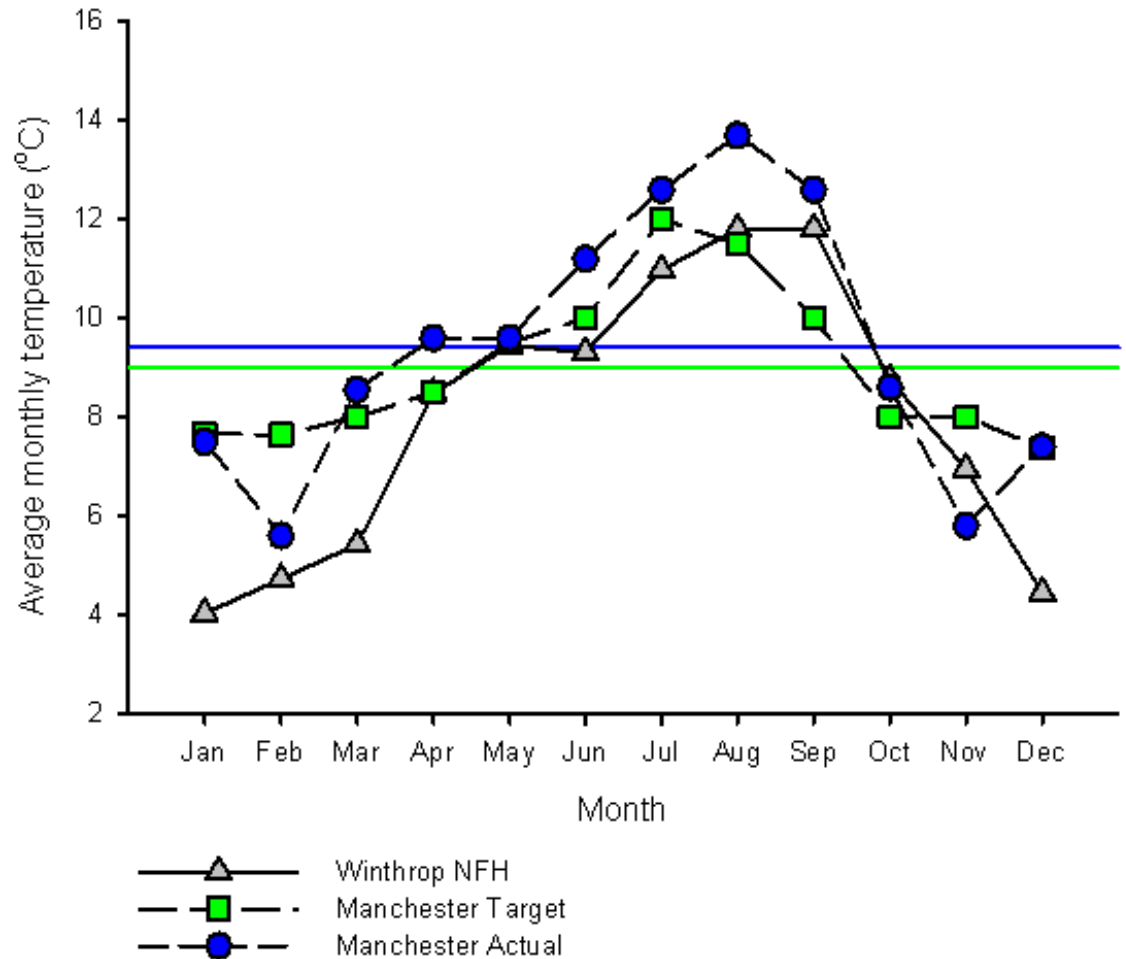
## Rearing of experimental steelhead populations

- Winthrop National Fish Hatchery is transitioning to local (Methow River) steelhead broodstock
  - Spawn timing and cold culture temperatures necessitate a 2 year rearing strategy for local stock
  - WNFH continues to raise yearling smolts from broodstock collected in the Columbia River (Wells Hatchery)
- Conducting behavioral and physiological experiments at Manchester Research Station to assess factors affecting growth, smoltification, and precocial maturation in steelhead raised using 1- and 2-year rearing strategies



## Temperature profile for Methow River Steelhead Project

- No temperature control in individual tanks
- S1 and S2 steelhead have different temperature profiles at WNFH
- We averaged the two WNFH profiles and developed a temperature profile for Manchester based on our makeup water temperature and environmental conditions
- Temperature based growth model
- Targets achieved in winter and spring, but not summer
  - Install a roof over the tanks to provide shade





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