

Problems for South Branch fishes in 2006

Steven Foster - U.S. Army Corps of Engineers

Andrew Johnson - WV DEP

Oxygen Affinity

- The ability of hemoglobin to take up oxygen
- High oxygen affinity means the hemoglobin has a strong attraction for oxygen and will readily take it up
- As hemoglobin enters gills it will saturate based on the conditions of the water surrounding the gills

Oxygen Affinity

- 4 major factors for oxygen affinity
 - Organic Phosphates
 - Partial pressure of carbon dioxide
 - pH
 - Temperature

Oxygen Affinity

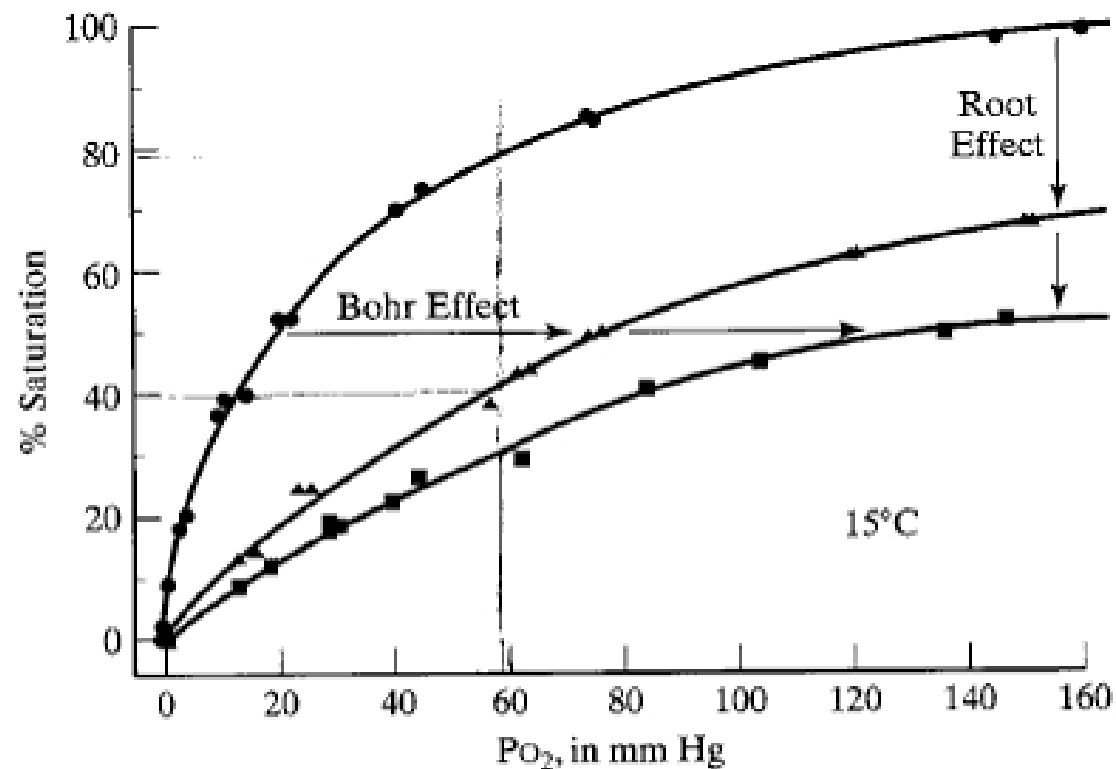


FIGURE 4.5 Blood oxygen equilibrium curves for winter flounder (*Pseudopleuronectes americanus*) blood equilibrated to three levels of P_{CO_2} at 15°C: <1 mm Hg (●; mean pH, 8.02), 8 mm Hg (▲; mean pH, 7.48), and 24 mm Hg (■; mean pH, 7.17). Modified from Hayden et al. (1975).

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Oxygen Affinity

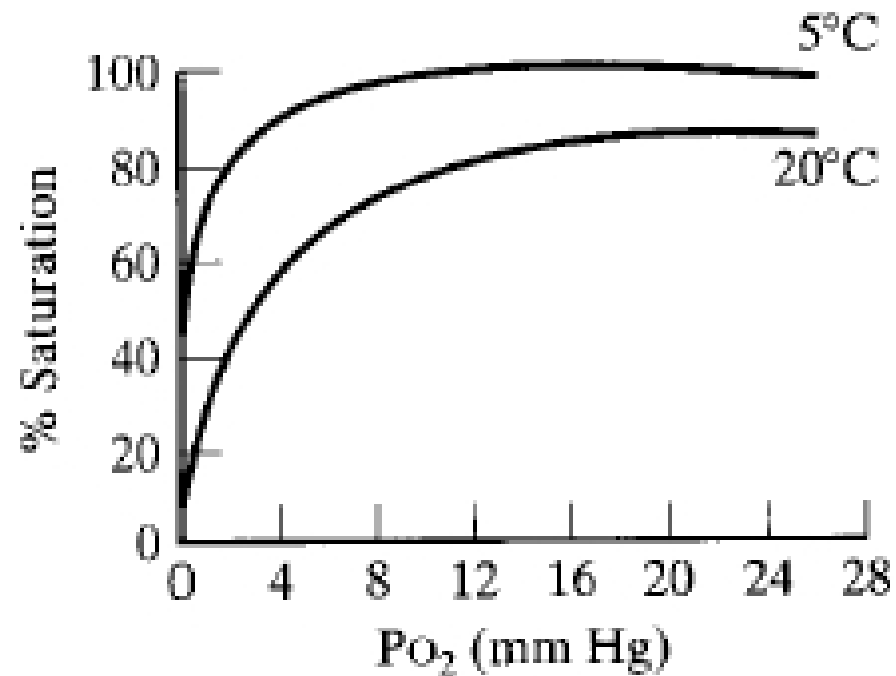


FIGURE 4.8 Oxygen equilibrium of tench (*Tinca tinca*) blood at 5°C and 20°C. Modified from Eddy (1973).

How do fish respond?

- Some are obvious. . .
 - Increase respiration
 - Move (change location)
- Hemoglobin synthesis

Hemoglobin Synthesis

- Many types of hemoglobin molecules in fish
- All types vary in their affinity to oxygen
- Several types can be present at any one time
- Different species have different combinations of hemoglobin

Hemoglobin Synthesis

- The number of hemoglobin 'types' often depends on differing habitats / environments
 - Rainbow trout have four types
 - American eel have two types
 - Goldfish have three types
- Types of hemoglobin can be synthesized from scratch or modified from existing molecules

Hemoglobin Synthesis

- Types of hemoglobin synthesis cont.
 - Goldfish adjust to temp by rearranging the α and β subunits
 - They can adjust to temp changes in three hours because of this “quick fix”
 - Certain types of hemoglobin have been shown to be more fixed
 - This has led to habitat preferences in *Catostomus* species

Spring 2006

- Redhorse and Hogsuckers most impacted
 - “Gasping” for air at the oxygen saturated air/water interface



- Death shortly after

- Similar to Rotenone survey symptoms
 - Rotenone inhibits the conversion of NADH to ATP, effectively suffocating the fish in the presence of oxygen

Spring 2006

■ Bacterial Gill Disease

- Most common in reared Salmonids
- Caused by several groups of bacteria
- Pathogenicity is increased by temperature and nutrients (James R. Winton, Fish Health Management)
- “Proliferation of lamella” and “the gill tissue had fused.”
 - Per Dr. Vicky Blazer, USGS
- Severely weakens a fish’s respiratory system



Spring 2006

- *Emergence of Aeromonas salmonicida*
 - Also, most common in reared Salmonids
 - *Causes Furunculosis*
 - *Compounds bacterial gill disease through systemic infections* (Bonnie Johnson, USFWS)
 - *Further weakens the fish*



Spring 2006

■ In an eight day period

- Taxed circulatory system
 - Approximately a 10° rise in temperature
 - Approximately 1.4 drop in pH (disregarding diurnal swings)
- Compromised respiratory system
 - Bacterial gill disease
 - Infections caused by *Aeromonas salmonicida*