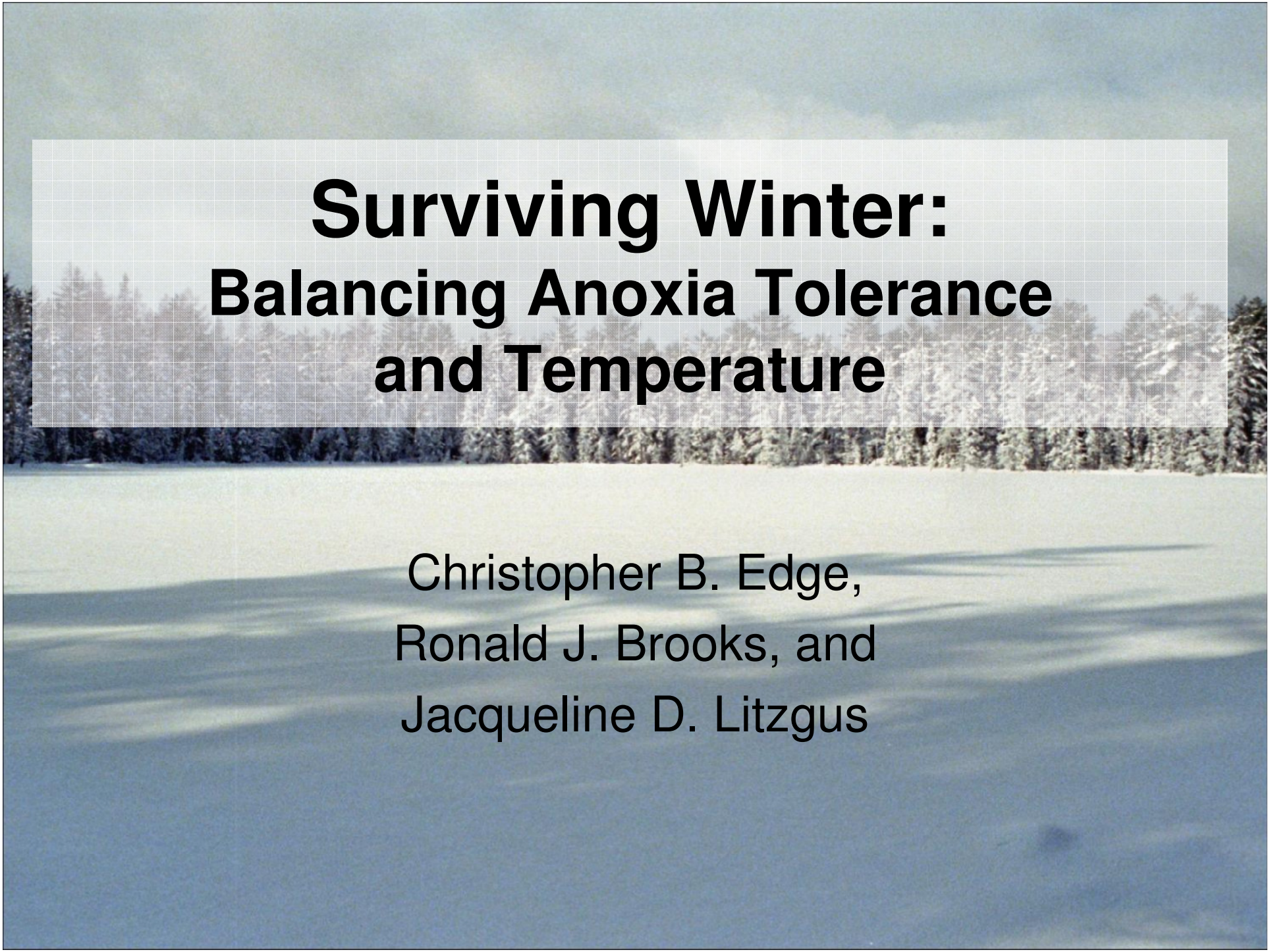


Surviving Winter:
Balancing Anoxia Tolerance and Temperature

Christopher B. Edge,
Ronald J. Brooks, and
Jacqueline D. Litzgus

Turtle Conservation

- Typically focused on
  - Summer habitat
  - Nest sites
  - Additive mortality
- Limited attention to overwintering locations
- Core habitats

Winter

- Risk of freezing and predation
- Ice cover
- Air temperature (-40°C to +10°C)

Ectotherms

- Unable to feed (Temperature)
- Mobility reduced
- Energy from reserves accumulated during the previous active season

Turtle Strategies

- Anoxia intolerance
  - Spiny Softshell Turtle (*Apalone spinifera*)
  - Map Turtle (*Graptemys geographica*)
  - Uncommon Musk Turtle (*Sternotherus odoratus*)
  - Wood Turtle (*Glyptemys insculpta*)
- Anoxia tolerance
  - Painted Turtle (*Chrysemys picta*)
  - Uncommon Snapping Turtle (*Chelydra serpentina*)
  - Spotted Turtle (*Clemmys guttata*)
  - Bog Turtle (*Glyptemys muhlenbergii*)
  - **Blanding's turtle (*Emydoidea blandingii*)?**

Ultsch 2006

Anoxia Intolerance

- Well oxygenated water
- O_2 uptake via extrapulmonary means
  - Buccopharyngeal pumping, integument, and cloaca
- Habitat selection occurs (Ultsch 2006)

Anoxia Tolerance

- Can overwinter in most habitats
  - Eutrophic wetlands
- Bury in substrate
- Don't rely on O_2

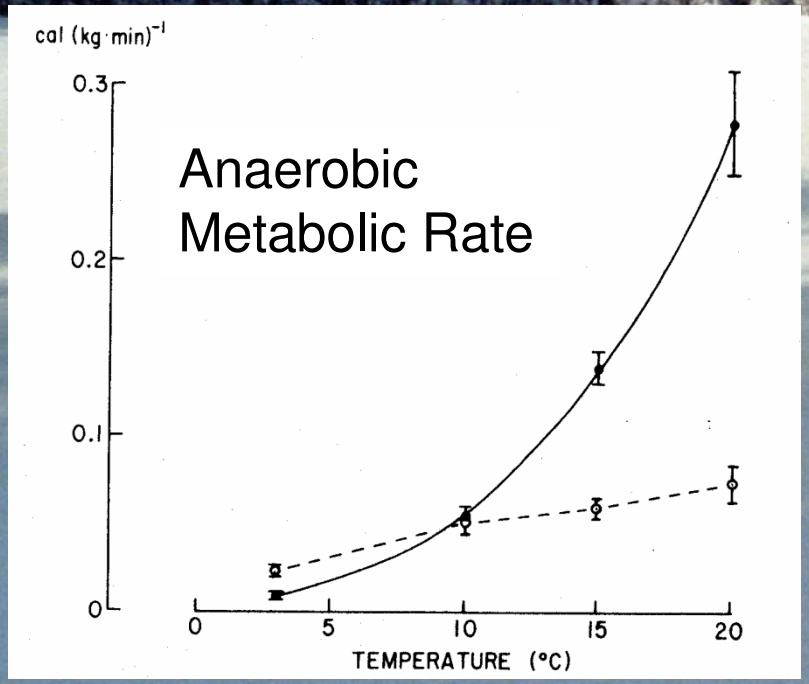
Anaerobic By-Products

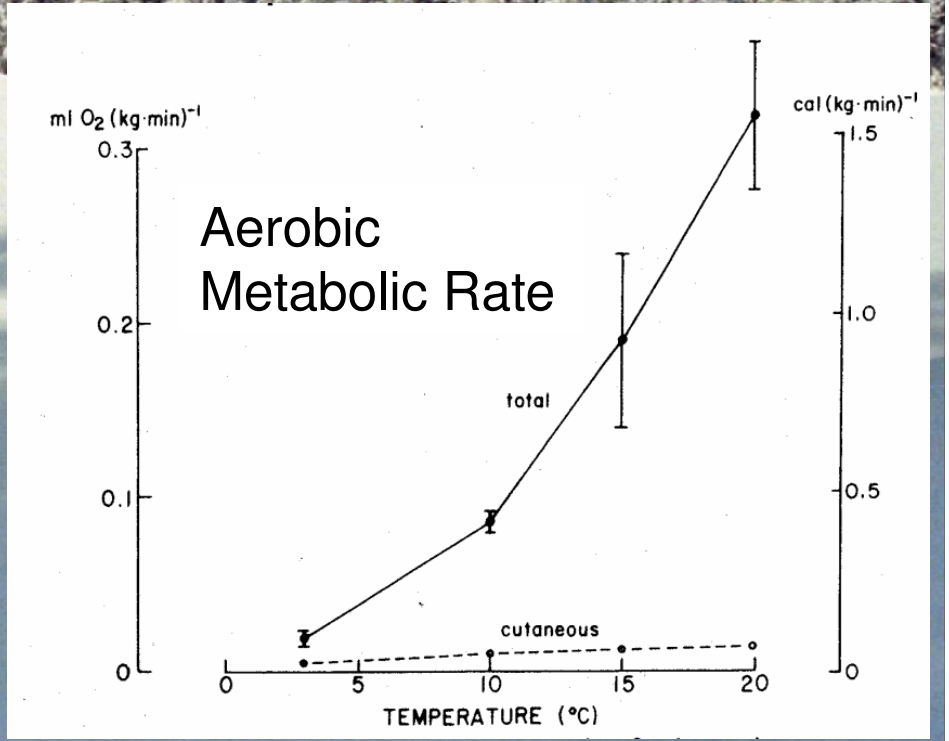
- Buildup of Lactic acid
  - Muscle cramping
- Lower extracellular pH
  - Metabolic acidosis
- Higher levels of CO_2
  - Respiratory acidosis

Glucose → Pyruvate Acid → ATP + **Lactic Acid**

Metabolism

- Positively correlated with temperature
- Low temperatures reduce metabolic rate





Herbert and Jackson 1985

Hypothesis

1. Suppress metabolic rate
2. Reduce the risk of acidosis

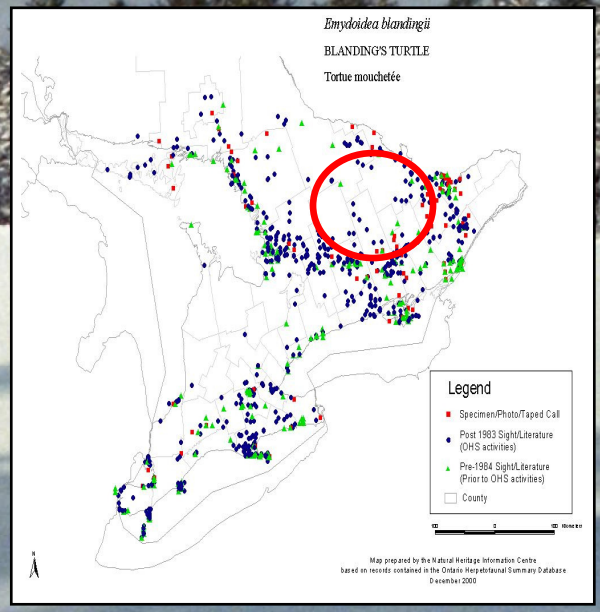
Select sites with low temperatures irrespective of oxygen level.

Blanding's Turtle

- Threatened species
- Semi aquatic
- Little known about overwintering ecology
- Anoxia tolerant?

Methods

- Algonquin Provincial Park
- 7 individuals (5F; 2M)
  - 5 Bog/Fen
  - 2 Pond/Marsh
- 30 random stations
  - 15 Bog/Fen
  - 15 Pond/Marsh
- From 6 December 2006 to 11 April 2007



Turtle Locations

- iButtons attached to radiotagged turtles in fall
- Locations marked with GPS and confirmed via telemetry

Random Sites

- Brick tethered to structure
- iButton attached to brick
    - 2cm above substrate
- Marked with a stake/buoy

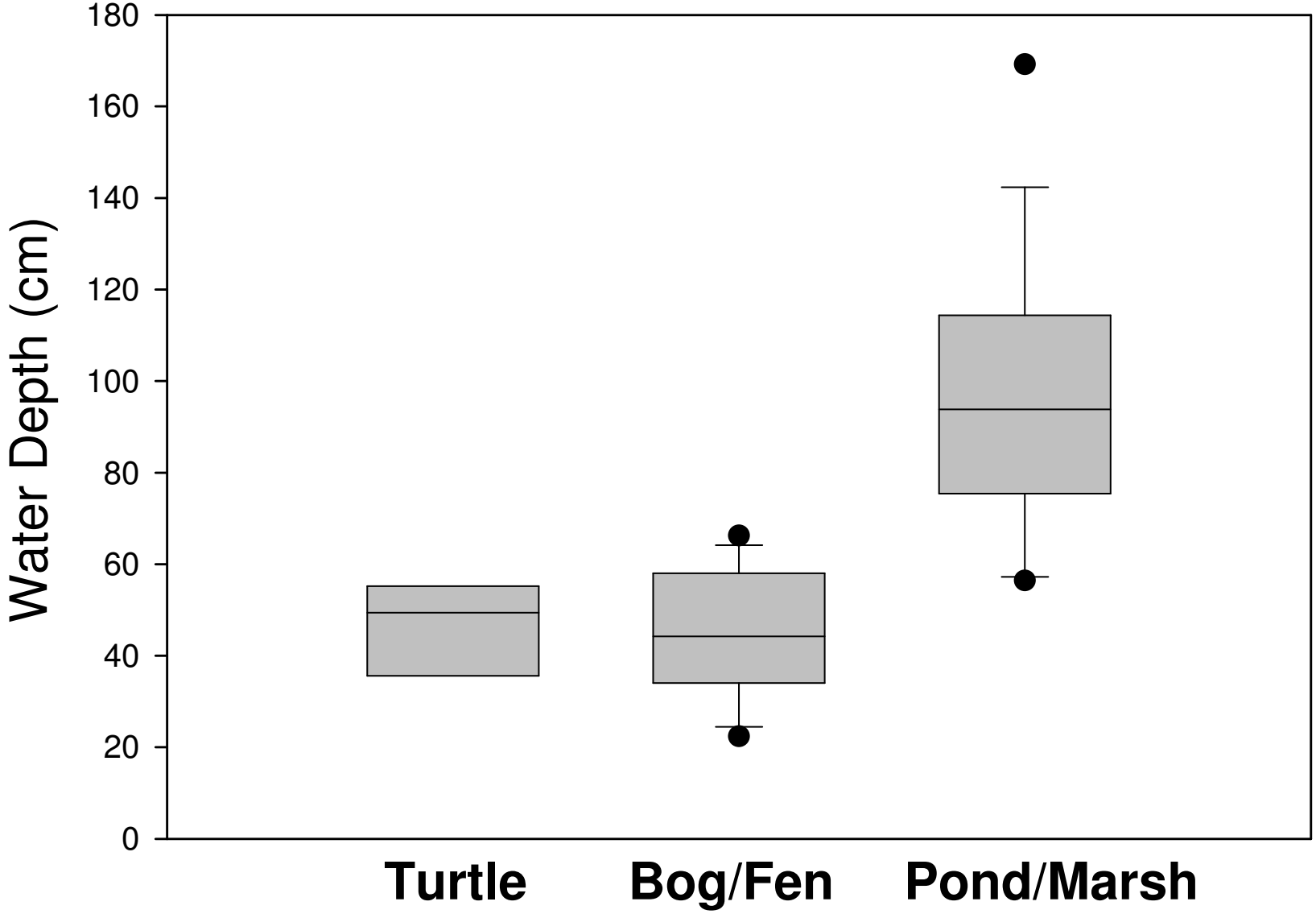
Variables

- Temperature
  - iButton datalogers 180min interval
  - Average of 7 day periods
  - 6 December 2006 to 11 Apr 2007
- Dissolved Oxygen
  - YSI DO 200
  - Monthly samples (Jan, Feb, Mar)
- Water Depth
  - Mean of five measurements

Water Depth

- Difference between turtles and random sites ($F_{1,33}$=4.084; p=0.0515)
- Pond/Marsh deeper than Bog/Fen ($F_{1,33}$=3.609; p=0.066)
- Interaction is significant ($F_{1,33}$=4.779; p=0.0360)

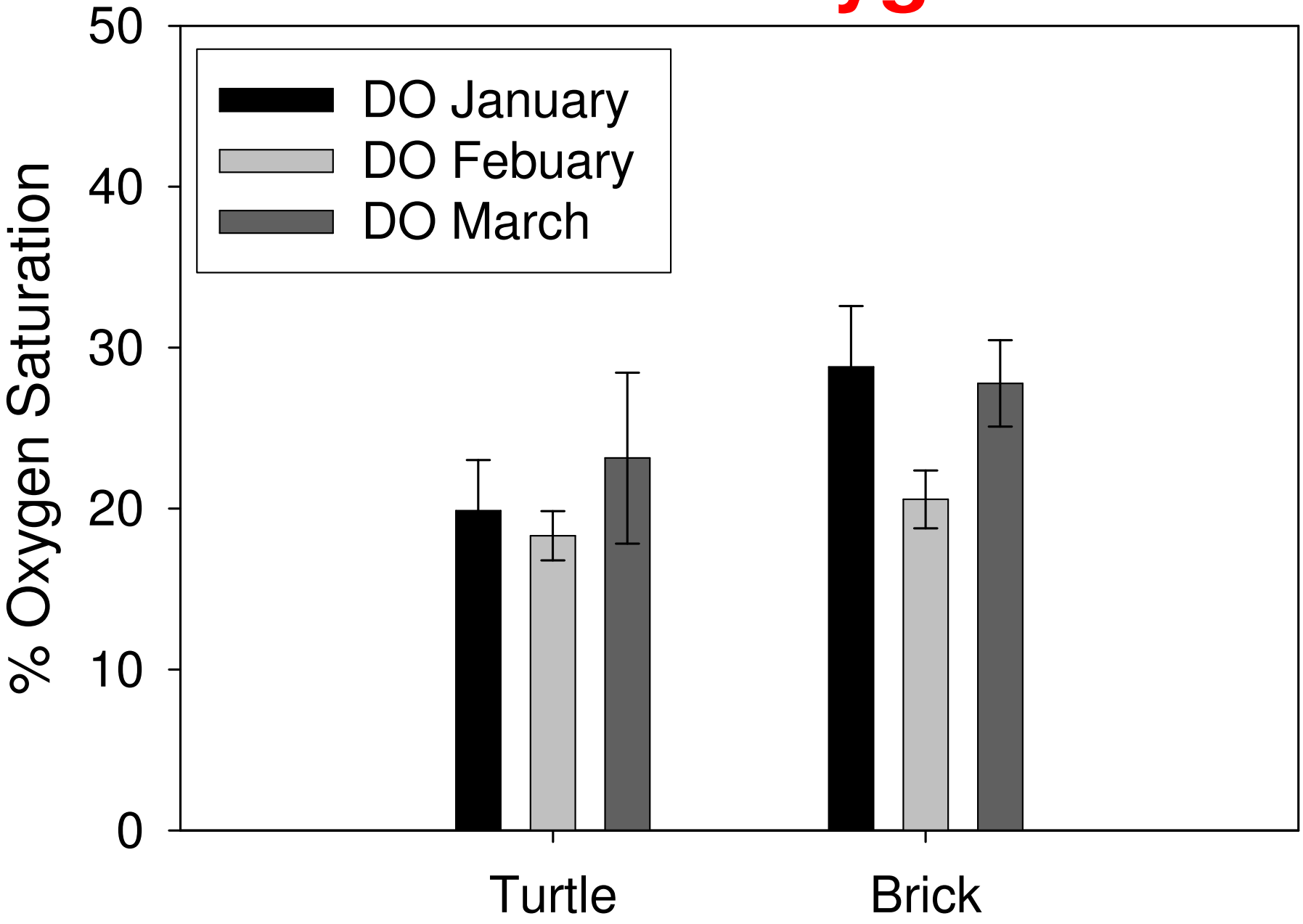
Select shallow habitats



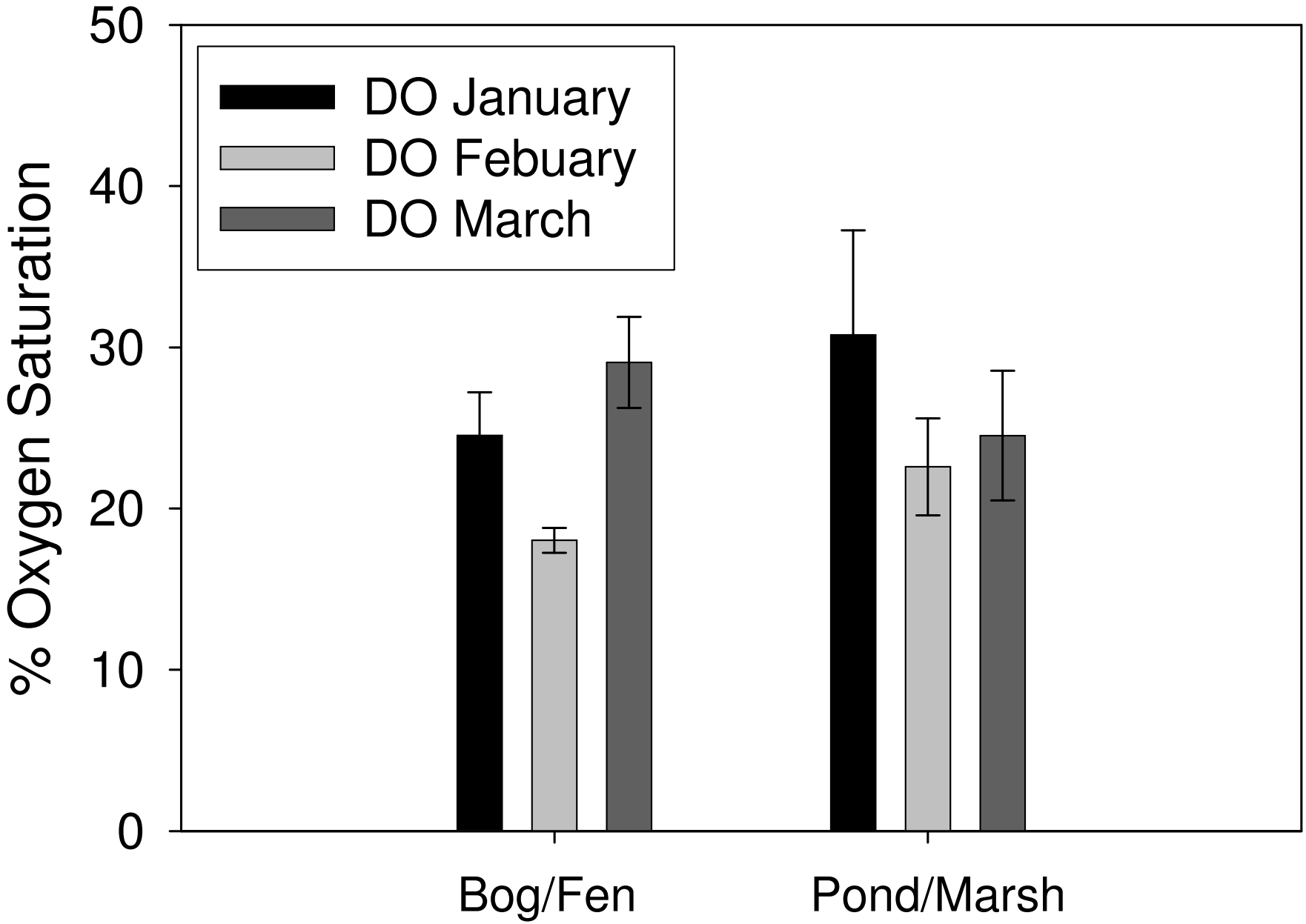
Dissolved Oxygen

- No difference between random sites and turtles ($F_{3,30}$=0.377; p=0.770)
- No difference between Bog/Fen and Pond/Marsh ($F_{3,23}$=2.412; p=0.927)

No selection for oxygen levels



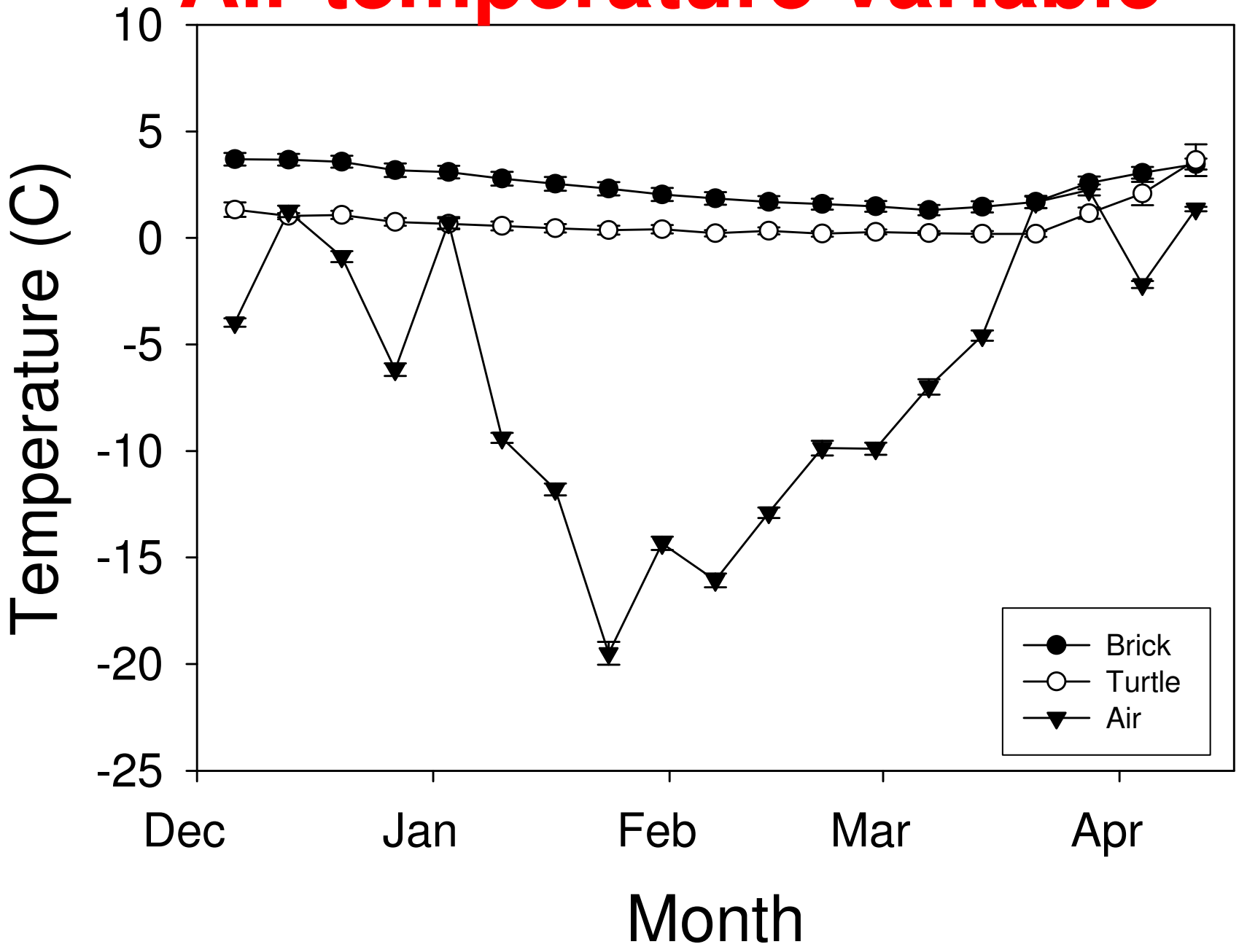
No difference between habitats



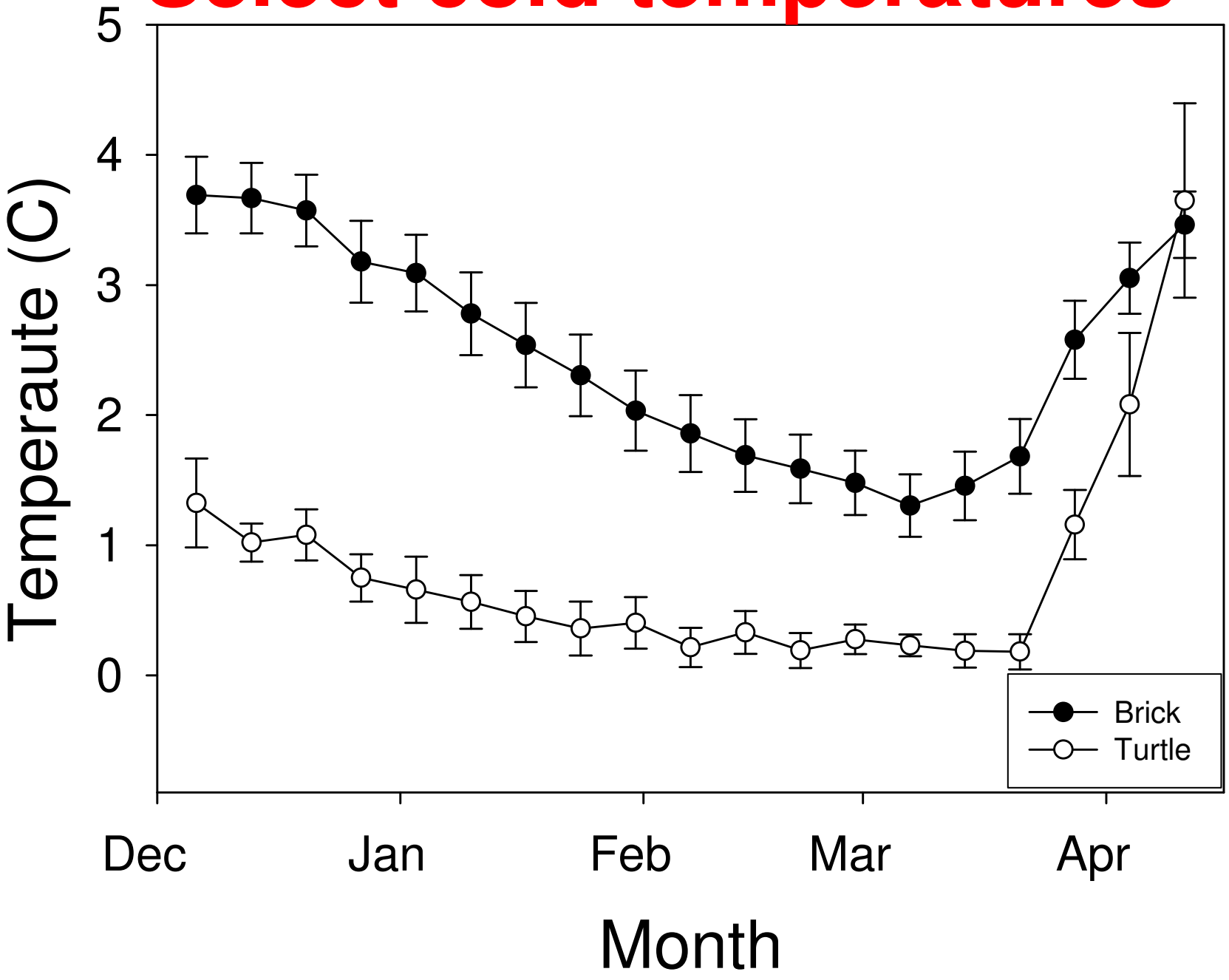
Temperature

- 15 Bog/Fen, 12 Pond/Marsh
- Turtles are at colder temperatures than random sites ($F_{19,13}$=4.174; p=0.006)
- No difference between habitat types ($F_{19,6}$=1.15; p=0.4631)

Air temperature variable

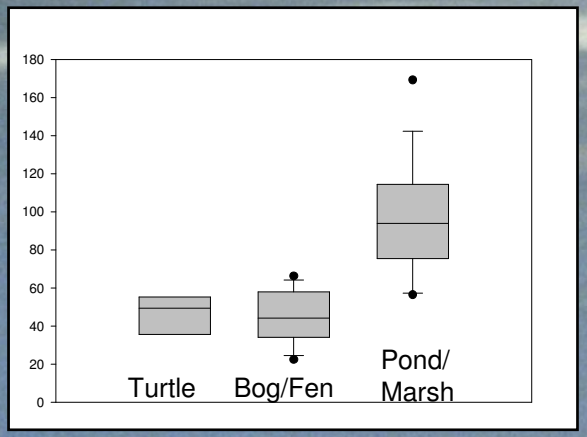


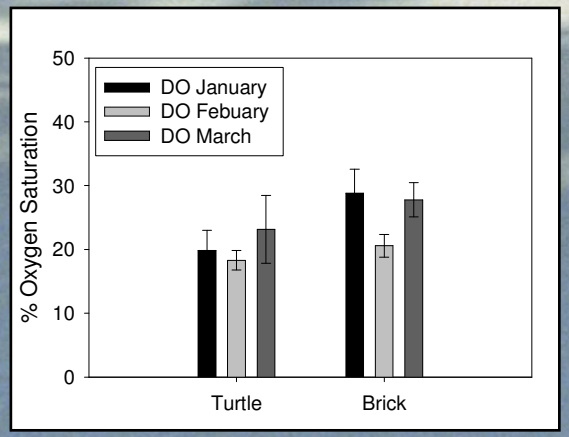
Select cold temperatures

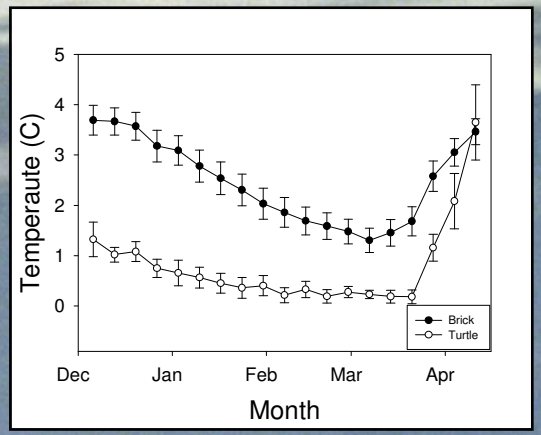


Results Summary

- Selection for shallow water
  - Or shallow habitats
- No selection for oxygen levels
- Selection for cold temperatures







Temperature

- Selection for cold temperatures
- Reduce metabolic rate
  1. Energy for reproduction and activity in spring
  2. Lower lactic acid levels in spring

Conservation

- Sites may be limited
  - Communal hibernacula
  - Offer protection for known and potential sites
- Restrict water management regimes
- Preserve wetland structure
  - Vegetation mats
  - Water flow regimes

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Questions?


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