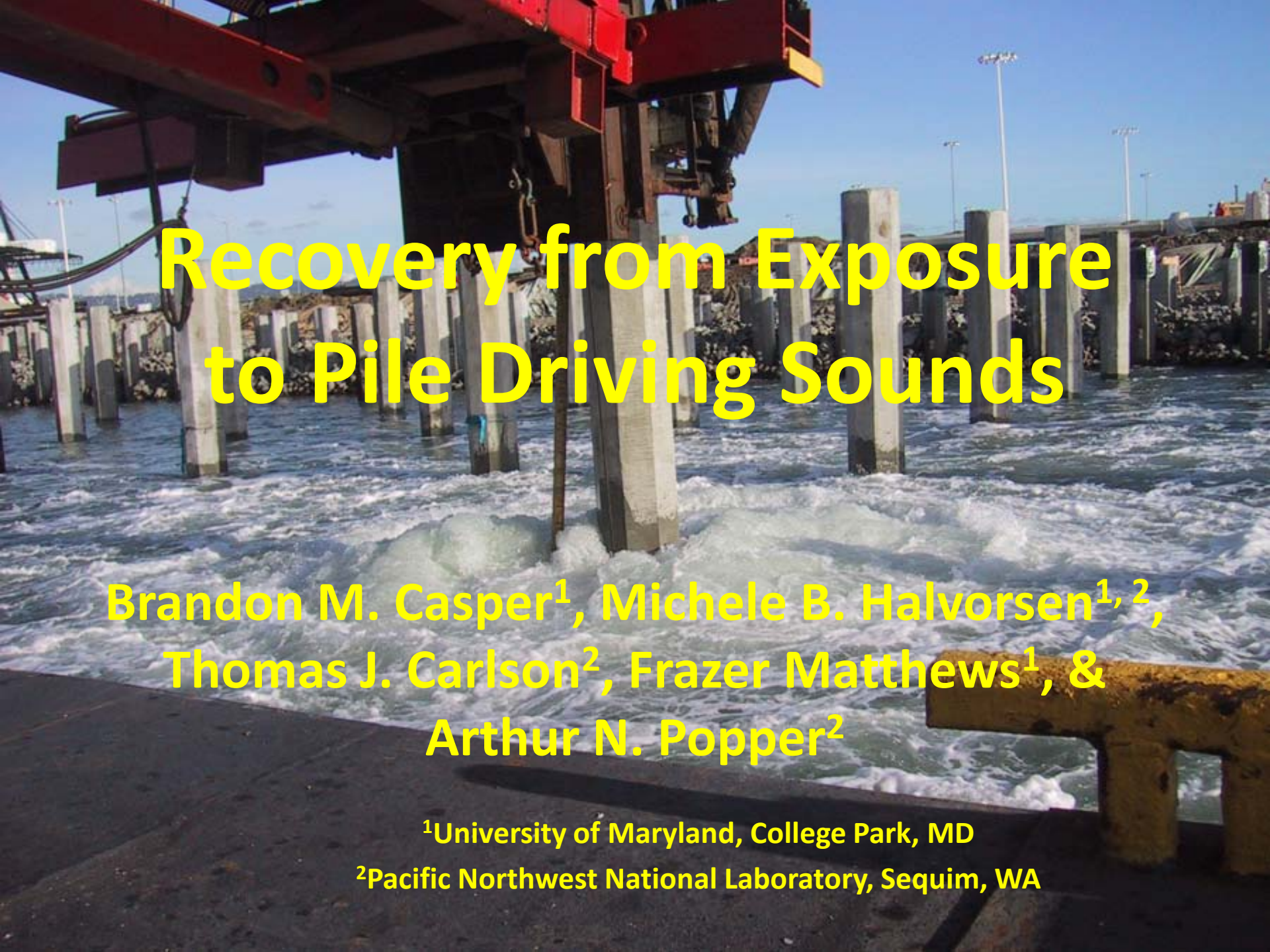

Recovery from Exposure to Pile Driving Sounds

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Background & Purpose

- Dr. Halvorsen discussed overall thrust of project and methodology
- We used the same approach with two other questions:
  - Will fish recover from physiological effects and barotrauma over time?
  - Are results in other species comparable to those for Chinook salmon? (Or, how much can we extrapolate salmon results?)

Recovery from Exposure

- Exposed Chinook salmon to pile driving at two different SEL_{cum}
- Necropsy on fish at day 0 as baseline (and to replicate the results Dr. Halvorsen reported)
- Additional exposed fish examined on days 2, 5, and 10 post exposure
- Also kept careful track of feeding and tank "behavior"
- Had control fish that were treated identically to the exposed animals, but without sound

Results

- No mortality – all fish survived the full 10 days post exposure
- All fish resumed feeding almost as soon as they were returned to home tank
- Tank behavior (which has nothing to do with how fish would behave in the wild) was no different than with the control fish
- Fish generally showed recovery from all physiological effects

Conclusions

- Unless a fish dies immediately post exposure, it may survive all effects from pile driving at the sound levels used
- The 10-day post exposure paradigm shows that animals are healing from physiological effects
- No new effects showed up post-exposure, indicating that there were no unobserved effects on day 0 that manifest themselves later

What Do the Results Mean?

- Are these results applicable to animals in the wild?
  - Answer: **No** and **Yes**!
- **No**: animals in the wild are subject to harsher conditions than in our experiments. Therefore:
  - even if the fish have small physiological effects, they may have lower fitness than unexposed animals; and
  - lower fitness may also lead to increased predation or less ability to find food, etc.

What Do the Results Mean? (cont.)

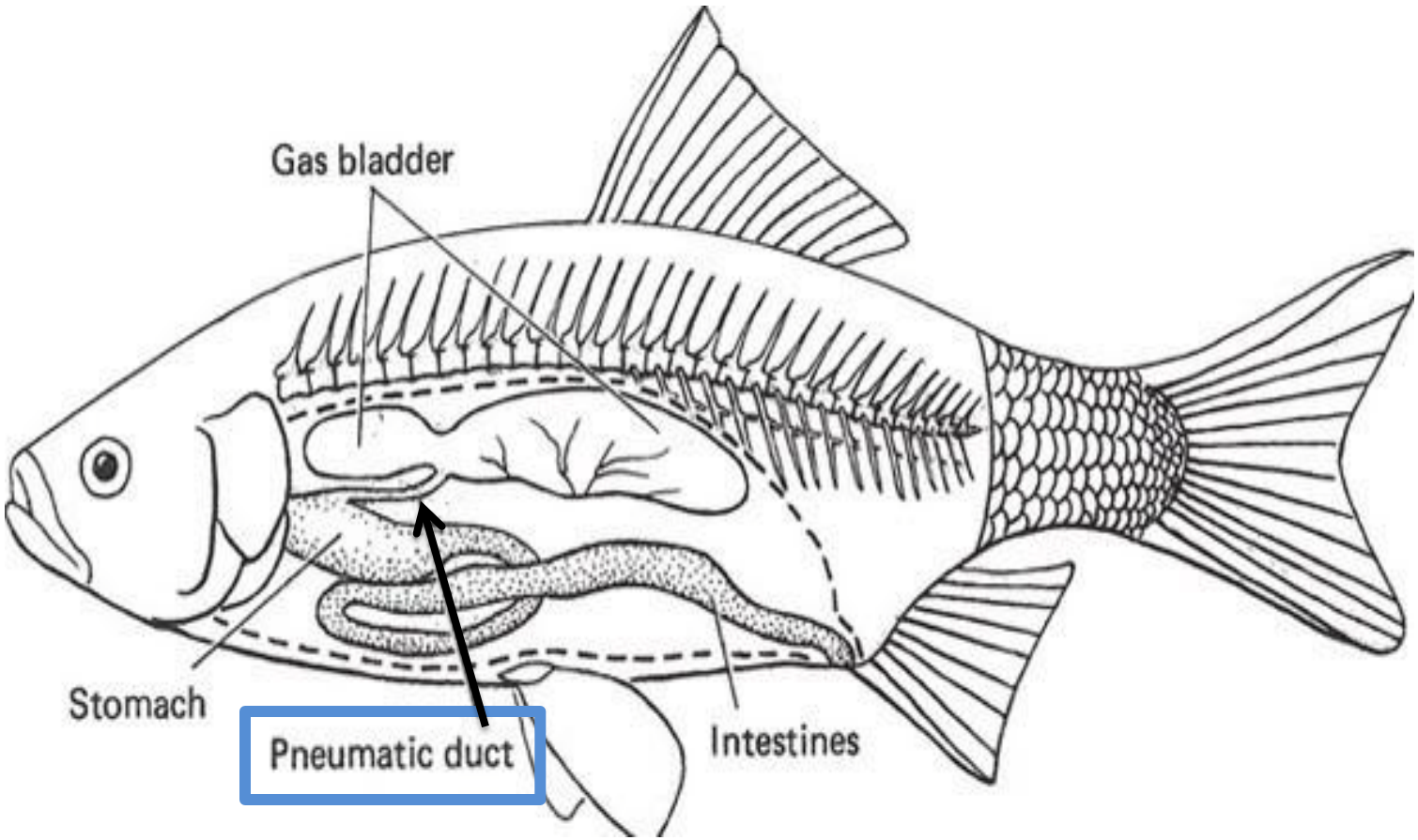
- **Yes**: results show that fish *could* recover if not exposed to harsh conditions
- Therefore, physiological effects from pile driving do not necessarily mean that animals will die.
- Moreover, the fact that the fish eat immediately post-exposure suggests that this may also happen in the wild!

Are Results Comparable in Other Species?

- Can we extrapolate results from Chinook salmon to other species
  - Impossible to test every fish species (>30,000)
  - The methodology is so complex, and takes so long, that even a few species are hard to test
  - Thus, need to select other species with considerable care so that they are "representative" of other "types" of fish

Species Selection

- Chinook salmon are physostomus – swim bladder connected to gut by pneumatic duct



http://mbff.proboards.com/index.cgi?board=general&action=print&thread=2558

Species Selection (cont.)

- To fill swim bladder gulp air
- Can constantly adjust volume as needed (as long as can get to the surface)
- Other condition is physoclistous swim bladder
  - Not open to the outside
  - Uses glands to input and remove gas
  - Takes longer to adjust volume of swim bladder
  - Means that as pressure changes there is no loss of gas to compensate

Selection of New Species

- Physoclists
- Also different body shape than Chinook salmon
- Important that the species meet certain experimental criteria:
  - Sufficient numbers available
  - Right size for HICI-FT
  - Sustainable in lab
  - Easily handled

Hybrid Striped Bass

http://www.tnfishing.net/striped_bass.html

Chinook Salmon

http://dnr.wi.gov/fish/species/trout/identification_salmon.html

Hybrid Striped Bass (cont.)

- Thus:
  - Hybrid striped bass are physoclists
  - Different body shape than Chinook salmon
  - Represent body shapes found in many percoid fishes
  - To date have collected data on hybrid striped bass, including recovery

Procedure

- Similar to that of Chinook salmon
- Purpose to find onset of physiological effects (not the extent of injuries)
- Examine day 0, 2, 5, 10, 15

Results

- Kinds of injuries observed
  - Herniated swim bladder
  - Hemorrhaging & bruising of swim bladder by gas gland
  - Rupture of swim bladder
  - No other tissue damage observed

Overall Results and Conclusions

- No mortality!
- Fish fed and swam normally immediately post exposure
- Onset of physiological injury in hybrid striped bass starts with herniation and minor hemorrhaging of swim bladder
  - Since fish swam normally, herniation does not appear to affect swimming behavior (in tanks)
  - Herniation recovers within 10 days
- No other injuries (as like those Chinook salmon)

Overall Results and Conclusions (cont.)

- Why the difference between Chinook salmon and hybrid striped bass?
  - hybrid striped bass swim bladder cannot release gas in response to rapid pressure changes
  - Therefore, unlike Chinook salmon, gas expands and causes herniation

http://www.piclist.com/techref/other/pond/TilapiaRaising.htm

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http://www.hodgesandhodges.com/services/pile-driving.php