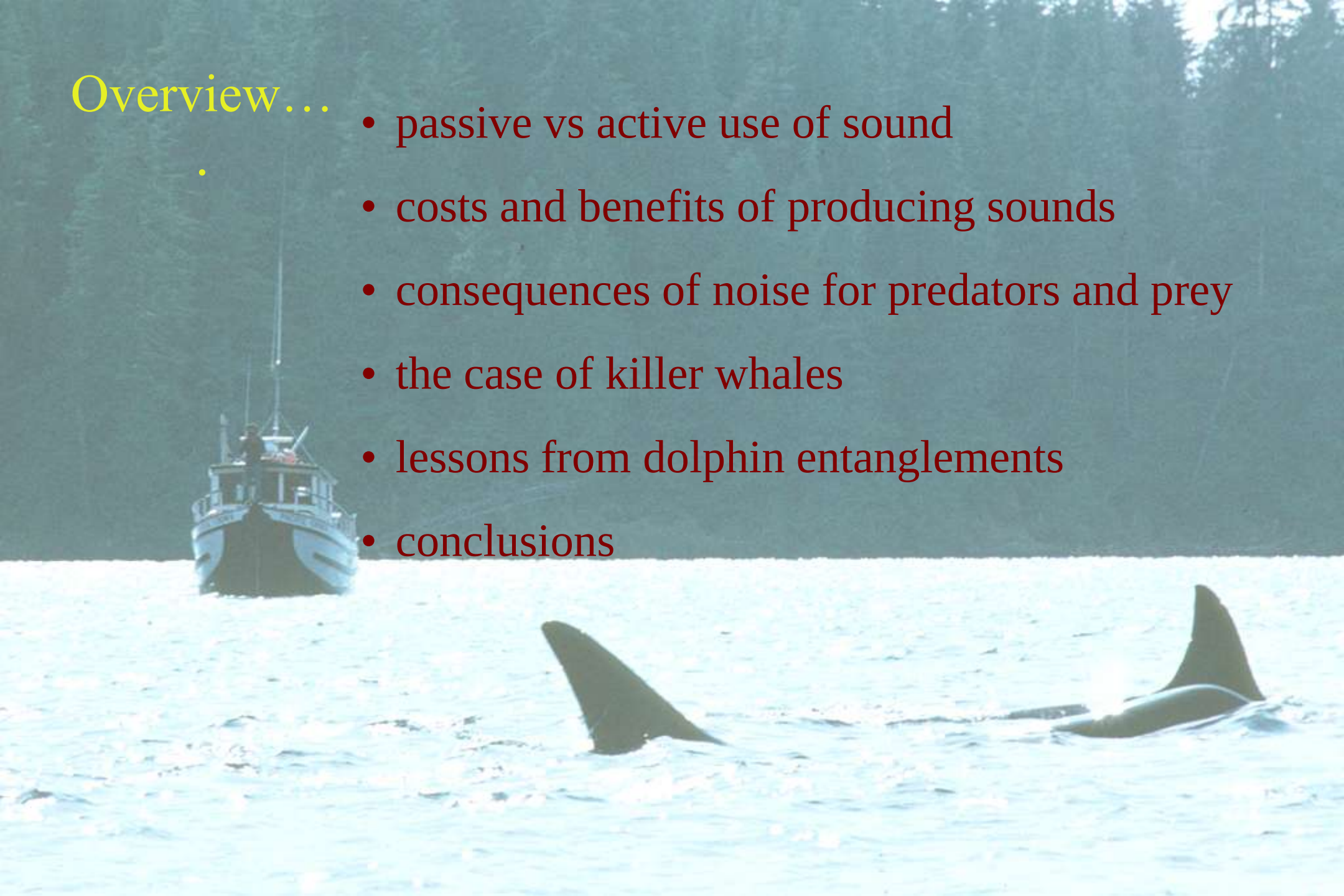
Ecological Constraints on Sound Production in Marine Animals: the Importance of Listening

Lance Barrett-Lennard

Vancouver Aquarium

University of British Columbia



Overview…

- passive vs active use of sound
- costs and benefits of producing sounds
- consequences of noise for predators and prey
- the case of killer whales
- lessons from dolphin entanglements
- conclusions

Active sound use

Sound produced by the actions of an individual & used by it for:

- social communication
  - contact and status
  - group cohesion
  - mediating interactions
  - territorial defence
- inter-group/species communication
  - intimidation of rivals/predators
  - competition avoidance
  - territorial defence
- hunting/foraging
  - prey detection/localization (short to med.-range echolocation)
  - prey manipulation
- orientation and navigation
  - object detection (long-range echolocation)

Passive sound use

Use of externally-produced sounds detected by listening

- detection of predators / rivals by:
  - hearing vocal sounds
  - hearing incidental sounds
  - hearing alarm calls
- hunting and foraging by hearing:
  - prey's vocal sounds
  - prey's incidental sounds
  - disruption of sound fields
  - echos of sounds from other sources
- orientation and navigation by:
  - orientation by reference to consistent sounds
  - assessing reverberation and resonance of external sounds
  - use of acoustic signposts

Costs and benefits of active sound use

Costs

- energy expended in sound production
- attracting predators
- attracting rivals
- alerting prey

Benefits

- detecting prey with echolocation
- navigating with echolocation
- mediation of social interactions
- attracting mates
- manipulating prey
- intimidating rivals
- territorial defence

Consequences of increased noise for predators

- passive listening impaired
  - ➢ more difficult to locate prey
  - ➢ more difficult to navigate and orient silently
- own swimming sounds masked
- communication impaired
- more difficult to avoid competition

Consequences of increased noise for prey

- passive listening impaired
  - ➢ more difficult to detect predators
  - ➢ more difficult to navigate and orient silently
- acoustically screened from predators
- communication impaired

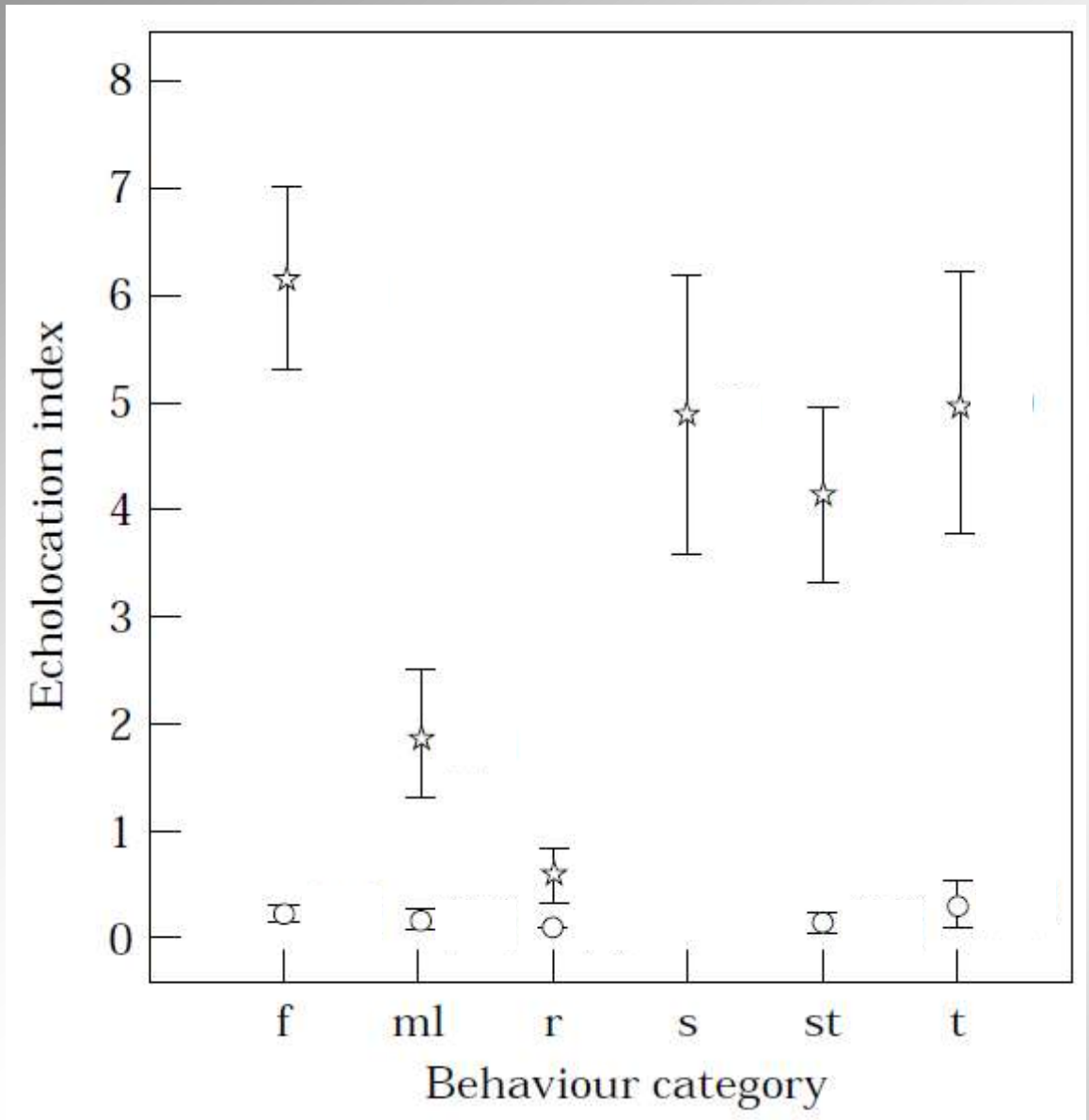
Does noise change the relationship between predators and prey?

- noise increases the ability of acoustically cryptic prey to hide from from passive-listening predators, thereby decreasing predation rates
- noise inhibits the ability of passive-listening predators to feed

In balance, noise is likely to be more harmful to passive-listening predators than prey

The killer whale case

- in the NW Pacific, fish-eating resident killer whales and marine mammal-eating killer whales inhabit the same waters
- since marine mammals have better hearing and more effective predator escape options than fish, sound production is more costly for transients than residents
- prediction: transients favour passive listening over echolocation

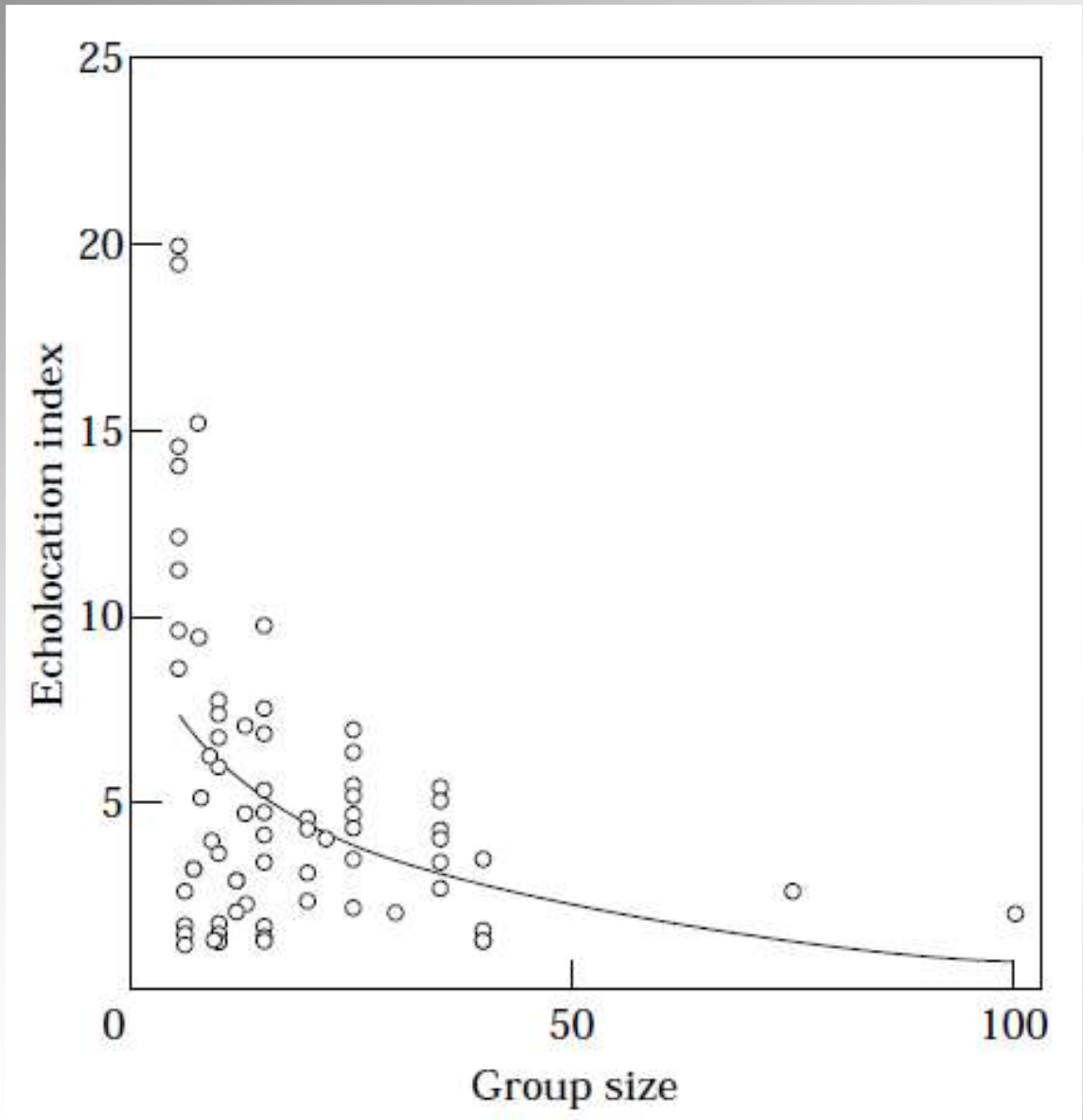


active

Fish-eating killer whales (starred) use echolocation 27 times more frequently than marine mammal-hunting transients (circles)

passive

Barrett-Lennard et al, 1996 Animal Behaviour 51:553-565.



In fish-eating resident killer whales, echolocation use per individual goes down as group size goes up. Indicates echolocation sharing?

Barrett-Lennard et al, 1996 Animal Behaviour 51:553-565.

Lessons from dolphin and porpoise entanglements in fishing nets

- To decrease the bycatch of dolphins and porpoises in nets, acoustic reflectors have been attached to nets to make them more detectable by echolocation.

- active “pingers” attached to nets more successful

conclusion: dolphins and porpoises travel with echolocation **off** much of the time

Conclusions

- one of the ways in which anthropogenic noise degrades marine habitat quality is by impairing passive listening
- this degradation has the potential to affect the nature of ecological interactions
- some species may be affected by chronic noise much more than others.

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