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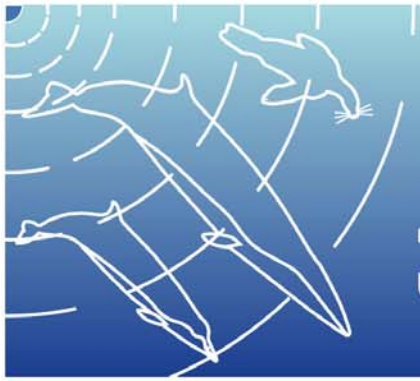

**Policy on Sound and Marine Mammals:**
An International Workshop

**U.S. Marine Mammal Commission - Joint Nature Conservation Committee, U.K.**

28-30 September 2004 - London, England

# Mitigating the Potentially Harmful Effects on Sound on Marine Mammals

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Southwest Fisheries Science Center
NOAA Fisheries


Marine Mammal Commission London Workshop, 28-30 Sep 2004

*with thanks to Bob Gisiner, Office of Naval Research

# Mitigation Goal

Mitigation – Minimizing the potentially negative effect of anthropogenic sound on marine mammals.

# Mitigation Methods

Sound Sources:

1. Military sonar
2. Airguns
3. Shipping
4. Fixed sources (e.g. pile-driving)

# Mitigation Methods

1. Modification or removal of the sound source.
2. Avoiding marine mammal habitat.
3. Ramp-up or soft-start procedures.
4. Detection* and modification of activities.
   *Detection methods, a lengthy digression.
5. Sound screening.
6. Aversive alarms.

# Mitigation Methods

## 1. Removal or modification of sound source.

**Removal**?

- Principle noise sources (military sonar, airguns for seismic surveys, and surface ships) are all critical. Alternatives are not readily available.

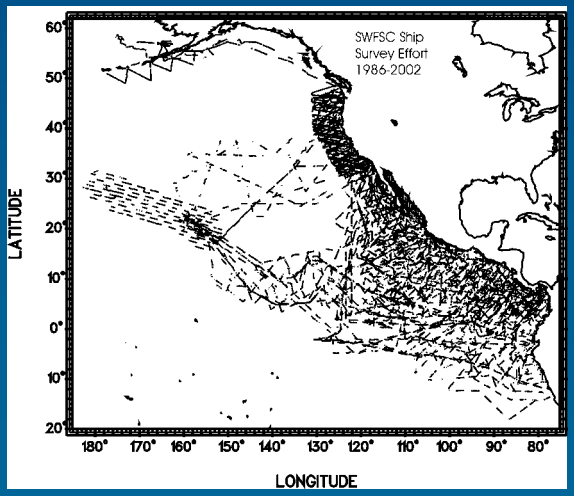
**Modification**?

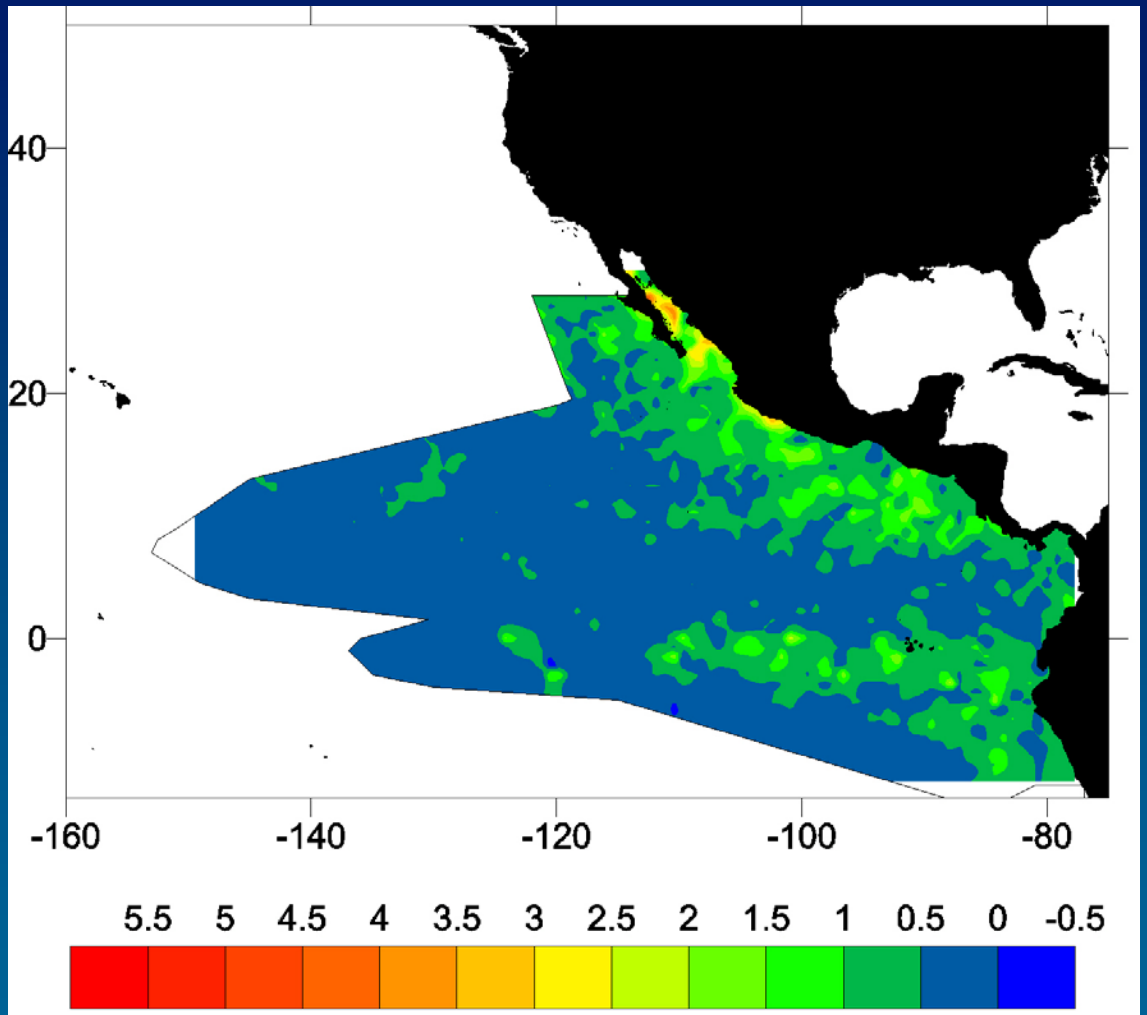
- Change training and testing of military sonar?
  - Train at lower SL.
  - Train and test only in specific ranges.
  - Increase use simulators.
- Alter signal characteristics to reduce effects?
  - Some changes may alter system performance.
- Quieter surface ships.

# Mitigation Methods

## 2. Avoiding Marine Mammal Habitat.

Ferguson *et al*. (in prep.). Predicted density field for all dolphin species pooled in the eastern tropical Pacific based on 1986-96 data.



# Mitigation Methods

## 2. Avoiding Marine Mammal Habitat.

Identification of beaked whale "hotspots" (MacLeod *et al*. 2002)

- Slope waters & seamounts / Gulf of California & Bahamas
- Hotspots have tended to be where people study beaked whales
- Many other, unidentified hotspots may exist

Quantifying habitat features (density modeling)

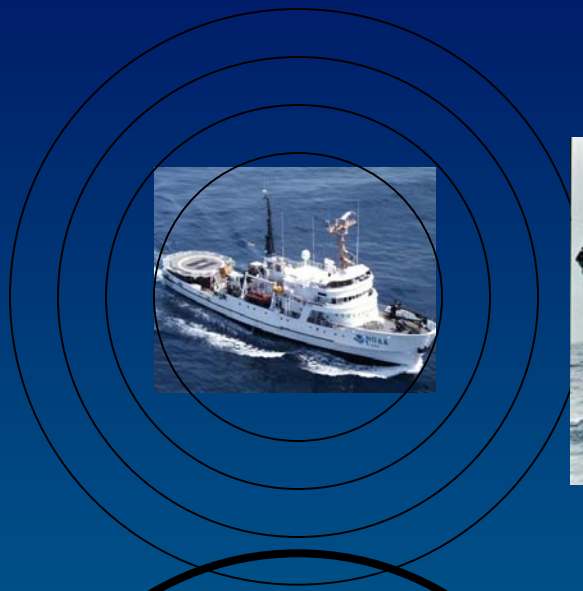
- Many un-surveyed areas
- Extrapolation to un-surveyed areas is risky
- Research on habitat mapping is still at a very early stage of development (but getting more support now).

Benefits may be limited

- Geophysical studies may be interested in specific areas
- Marine mammals are distributed in virtually all waters
- Densities may only vary by a factor of 10X

# Mitigation Methods

## 3. Ramp-up (or soft-start) Procedures




# Mitigation Methods

## 3. Ramp-up (or soft-start) Procedures

A widely used method (Seismic industry, academic, NATO military testing, UK military).

Success presumes that animals will respond appropriately to low sound levels by moving away from the sound source.

Potential Problems:

1) Marine mammal response to ramp-up is unknown.
2) Most known beaked whale stranding events occurred when ships have been in a sustained use period.
3) Effectiveness of this method is untested.

# Mitigation Methods

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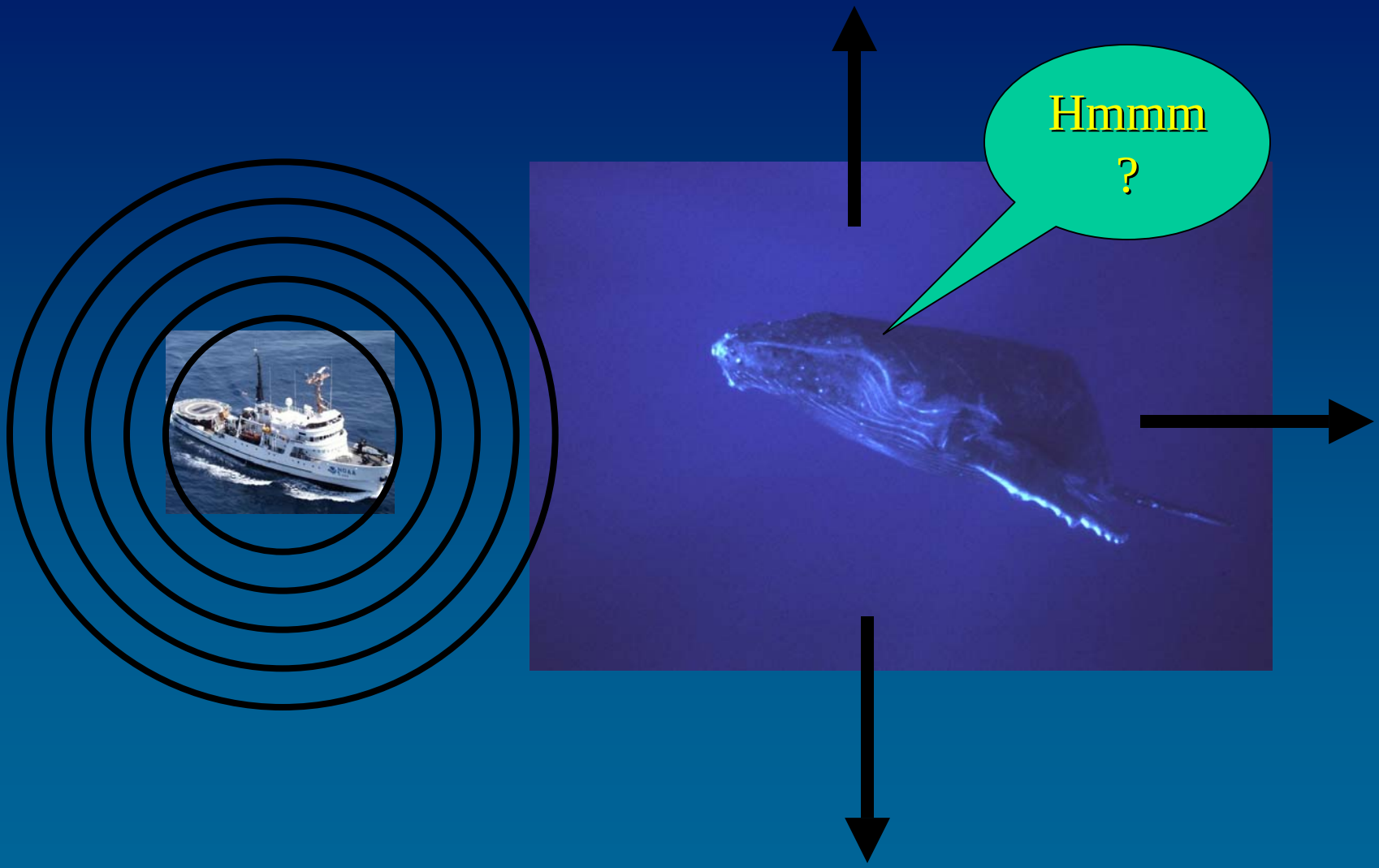

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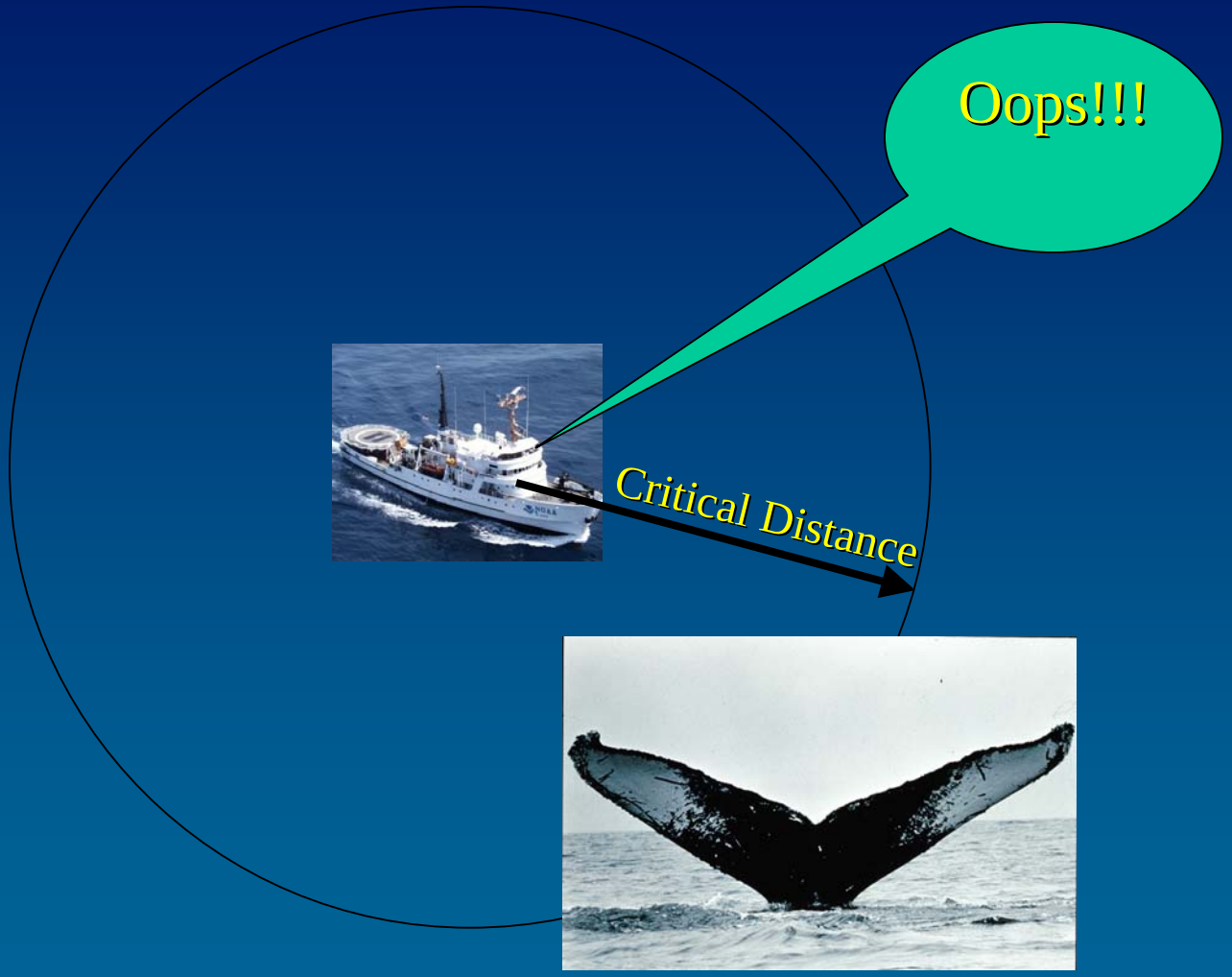
# Mitigation Methods

## 4. Detection and modification of activity.




Critical Distance
200 m – 2 km

Critical Threshold
~180 dB

# Mitigation Methods

## 4. Detection and modification of activity.

Widely used method in seismic surveys and Navy operations.

1. In seismic research, modifications typically involve powering down to one airgun and/or change in vessel course
2. In Navy ship-shock tests, detonation is aborted until the critical area is clear.

Success Presumes:

1. High probability of detecting animals.
2. Modified activity will prevent damage to animals.

Potential Problems:

1. Visual detection probability may be low for some species.
2. Alternative detection methods are untested.

# Detecting Marine Mammals

## Visual Detection on Ship Surveys


25X “Big-eye” binoculars

7X handheld binoculars
& naked eyes

ESW – Effective Strip Width, 1/f(0)

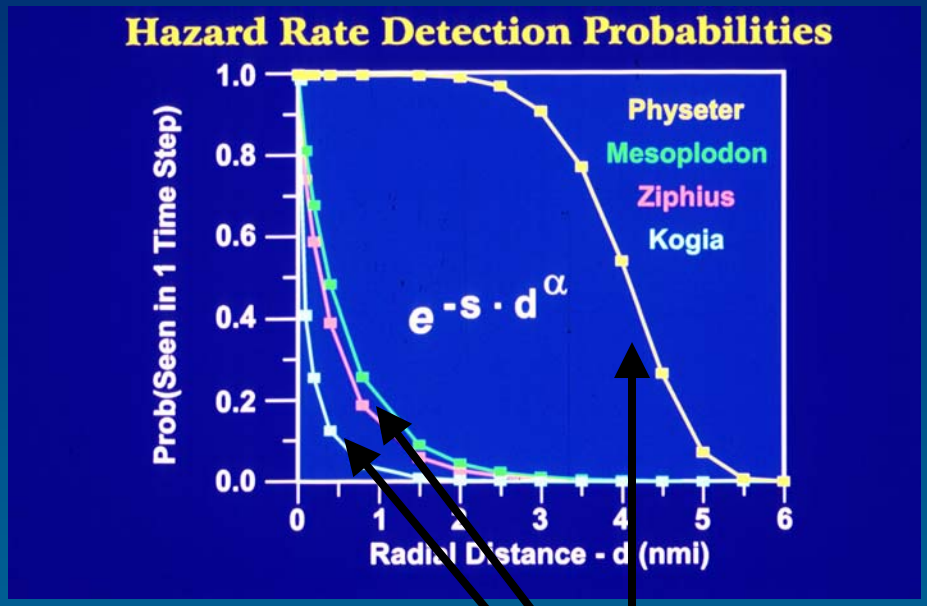
TDP – Track-line Detection Prob., g(0)

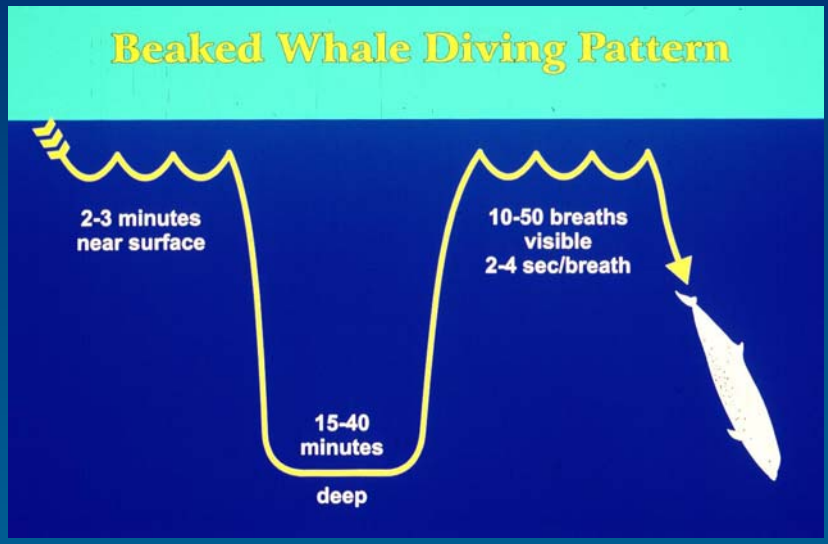
# Detecting Marine Mammals

## Visual Detection on Ship Surveys

ESW – Effective Strip Width

TDP – Track-line Detection Prob.



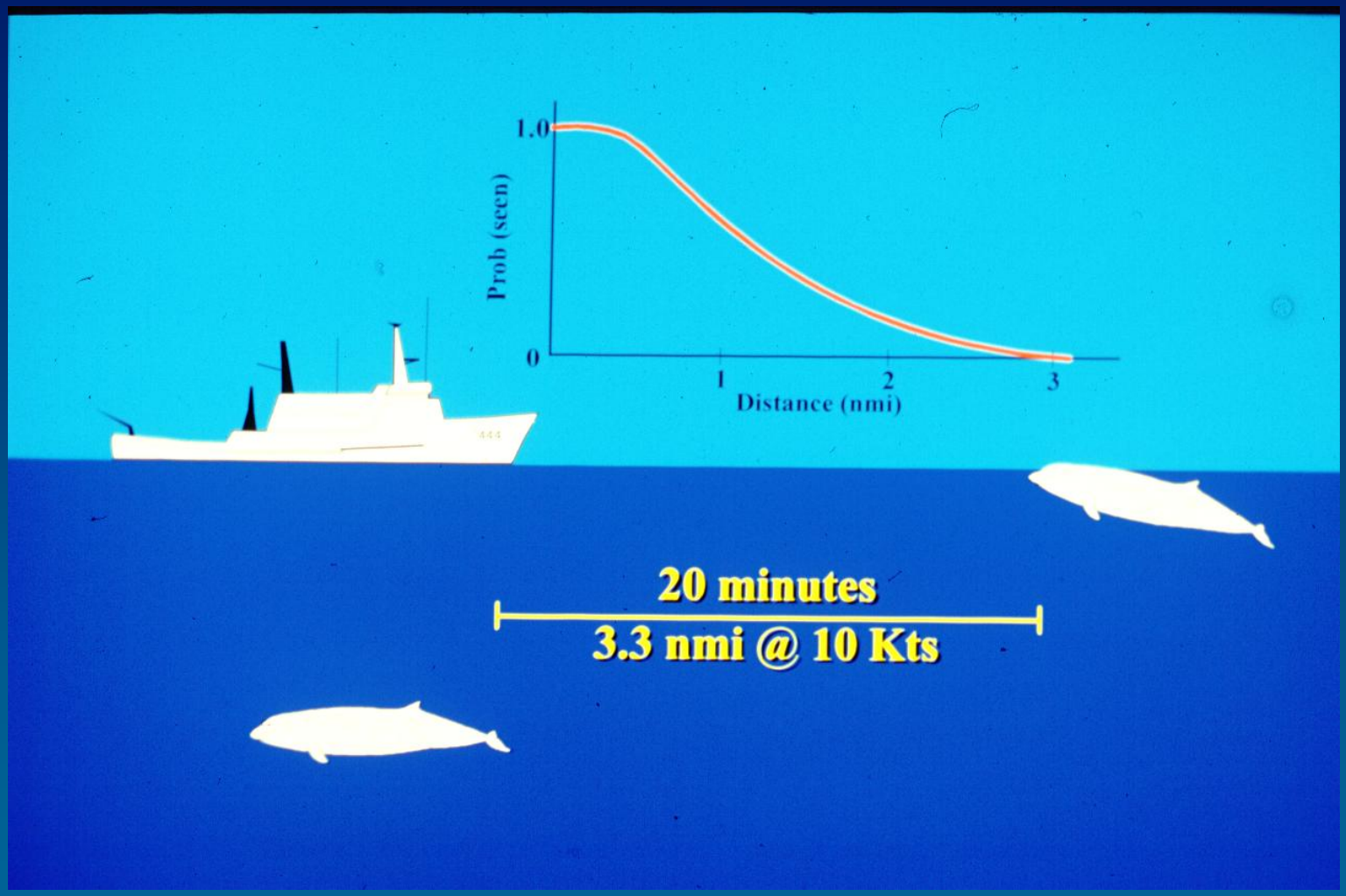

Sperm whale

Beaked whales

Dwarf & pygmy sperm whales

# Detecting Marine Mammals

## Visual Detection on Ship Surveys




**Given beaked whale dive times are >20min, many will never surface within visual range.**

# Detecting Marine Mammals

## Visual Detection on Ship Surveys

ESW – Effective Strip Width TDP – Track-line Detection Prob.

| Species | ESW km | TDP |
|---|---|---|
| Sperm whale | 2.2-4.6 | 0.87 |
| Blue whale | 2.2-3.2 | 0.90 |
| Common dolphin | 0.7-2.0 | 0.8-1.0 |
| Harbor porpoise* | 0.2-0.4 | 0.5-0.8 |
| Dwarf sperm whale* | 1.2 | 0.35 |
| Cuvier's beaked whale* | 2.7 | 0.23 |

*Suveys for these species only in calm seas

# Detecting Marine Mammals

## Visual Detection on Ship Surveys

Many “cryptic species”, like beaked whales seem to disappear when sighting conditions are less than optimal:

| Beaufort sea state | # Sightings | Sightings/ 1000km |
|---|---|---|
| **0-1** | **138** | **10.1** |
| **2** | **169** | **4.9** |
| **3** | **175** | **2.4** |
| **4** | **180** | **1.5** |
| **5** | **76** | **0.9** |

# Detecting Beaked Whales

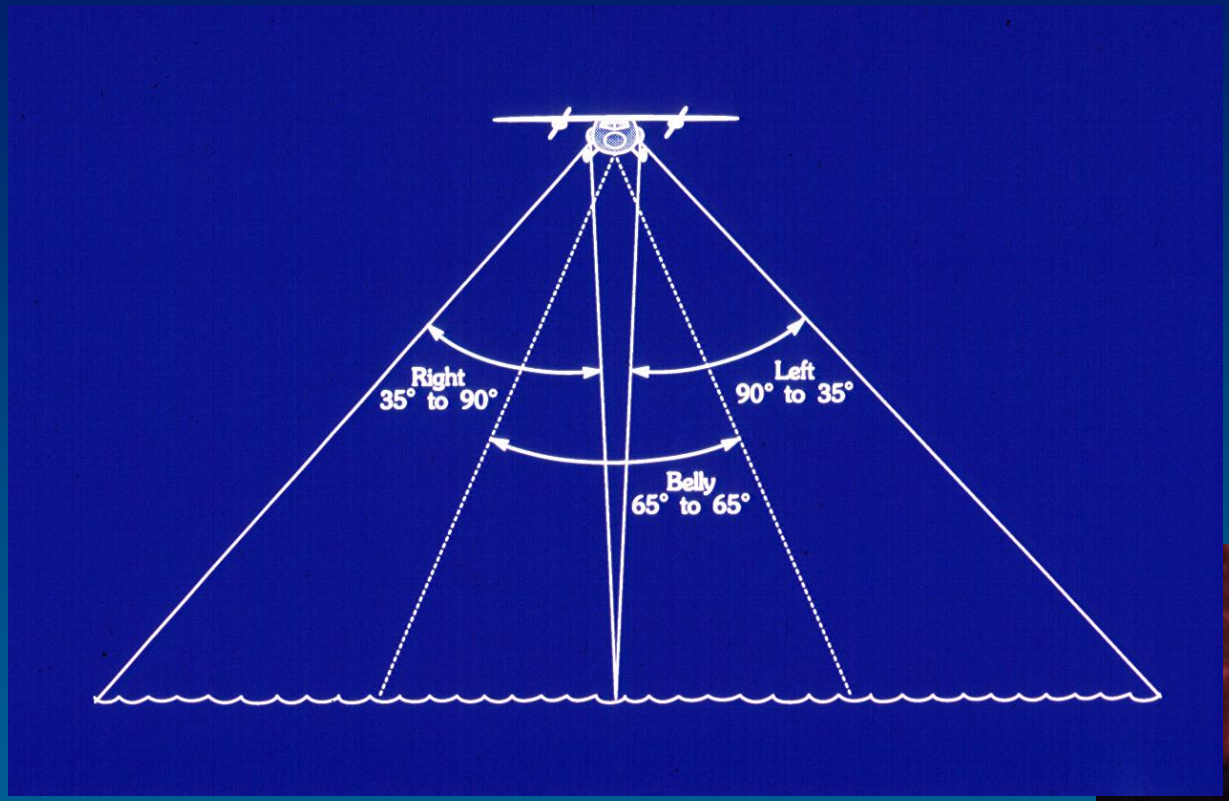
## Visual Detection from Ships

| Mitigation Surveys | TDP = 0.2-0.5<br>Line-transect Surveys | Δ |
|---|---|---|
| 1 observer | 3 observers | 2X |
| 7X binoculars & NVD | 25X & 7X binoculars | 3X |
| Daytime and night | Daytime | 2X |
| Any sea state condition | Beaufort 0-2 | 2-4X |
| Observer experience | Observer experience | 0-2X |
| | Overall | 24-96X |

Therefore, ….. TDP = g(0) < 0.01-0.02 for mitigation surveys.

# Detecting Marine Mammals

## Visual Detection on Aerial Surveys




# New Technologies for Detecting Marine Mammals

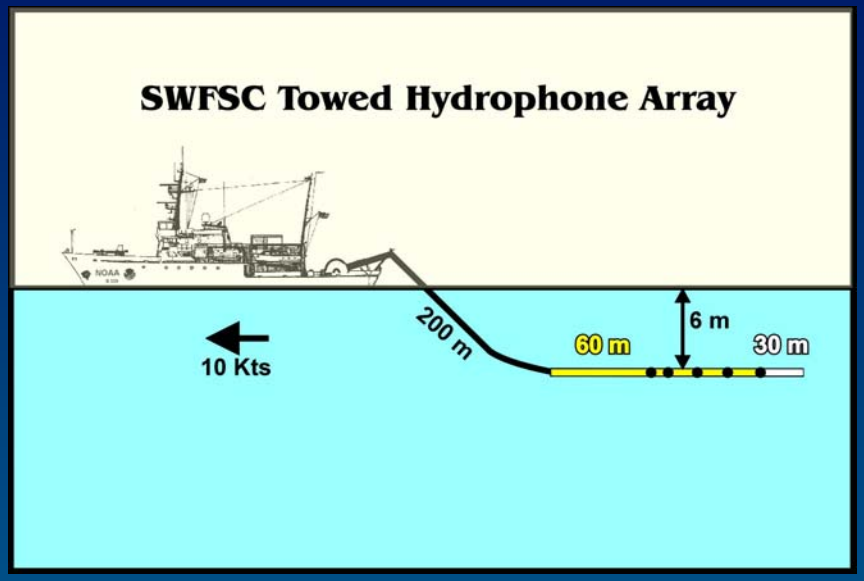
- Passive Acoustic Detection – detecting submerged marine mammals from the sounds that they make.

- Active Acoustic Detection – detecting submerged marine mammals using SONAR.

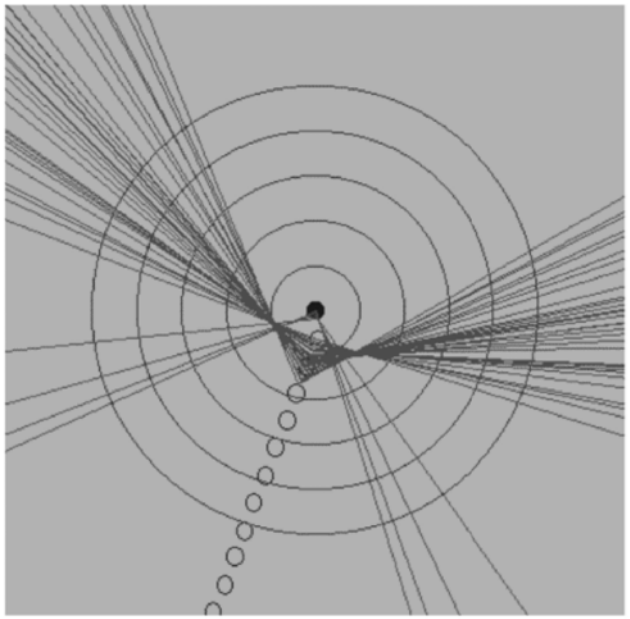
- X-Band Radar, multi-spectral imaging, infrared imaging – detecting marine mammals at the surface.

# Detecting Marine Mammals

## Passive Acoustic Detection- Towed Hydrophones




ISHMAEL & WhalTrak
Software for localization



<u>All Species</u>

vocalizations are voluntary

<u>Beaked Whales</u>

don't know their vocalizations

poor experience with surface detection

<u>Baleen Whales</u>

low-frequency sounds are masked by flow noise

# Detecting Beaked Whales

## Active Acoustic Detection

### Potential Benefits:

Improved probability of detection close to sound sources of concern.

Day/night, all weather.

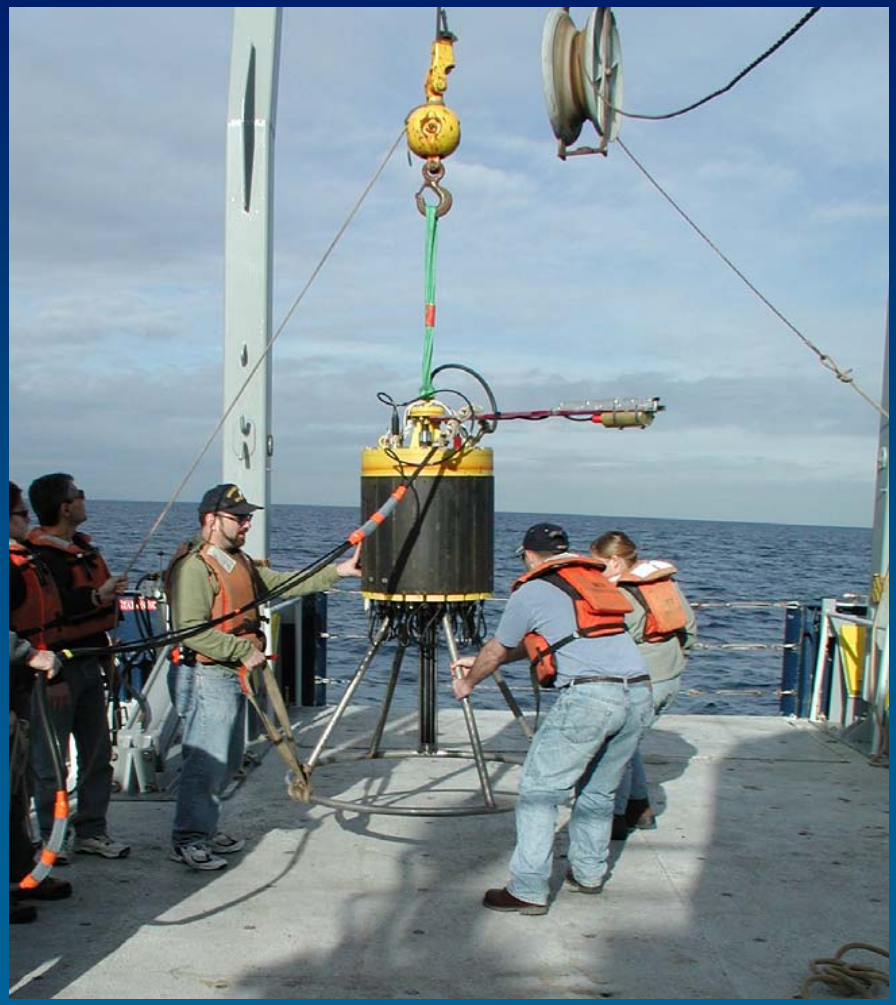
Finds quiet, low visibility animals.

### Potential Problems:

Presently hard to tell different species of marine mammals apart.

Can give high false-alarm rates (can't tell marine mammals from similar "targets").

Concern about the effect of sonar itself on species of interest or other species.



Slide courtesy of Bob Gisiner

# Mitigation Methods

## 4. Detection and modification of activity.

Widely used method in seismic surveys and Navy operations.

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2. In Navy ship-shock tests, detonation is aborted until the critical area is clear.

Success Presumes:

1. High probability of detecting animals.
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Potential Problems:

1. Visual detection probability may be low for some species.
2. Alternative detection methods are untested.

# Mitigation Methods

## 5. Sound Screening & 6. Aversive Alarms

Sound screening procedures, such as the use of bubble nets, are likely to be effective only for fixed sites where noise is an unwanted by-product of some other activity, such as pile-driving.

Aversive alarms:

acoustic deterrent devices (ADDs, pingers) <150 dB
acoustic harassment devices (AHDs), > 180 dB

Some hope? No beaked whales have been caught in California drift gillnet fisheries since pingers have been required 1996. 26 were caught 1991-95.

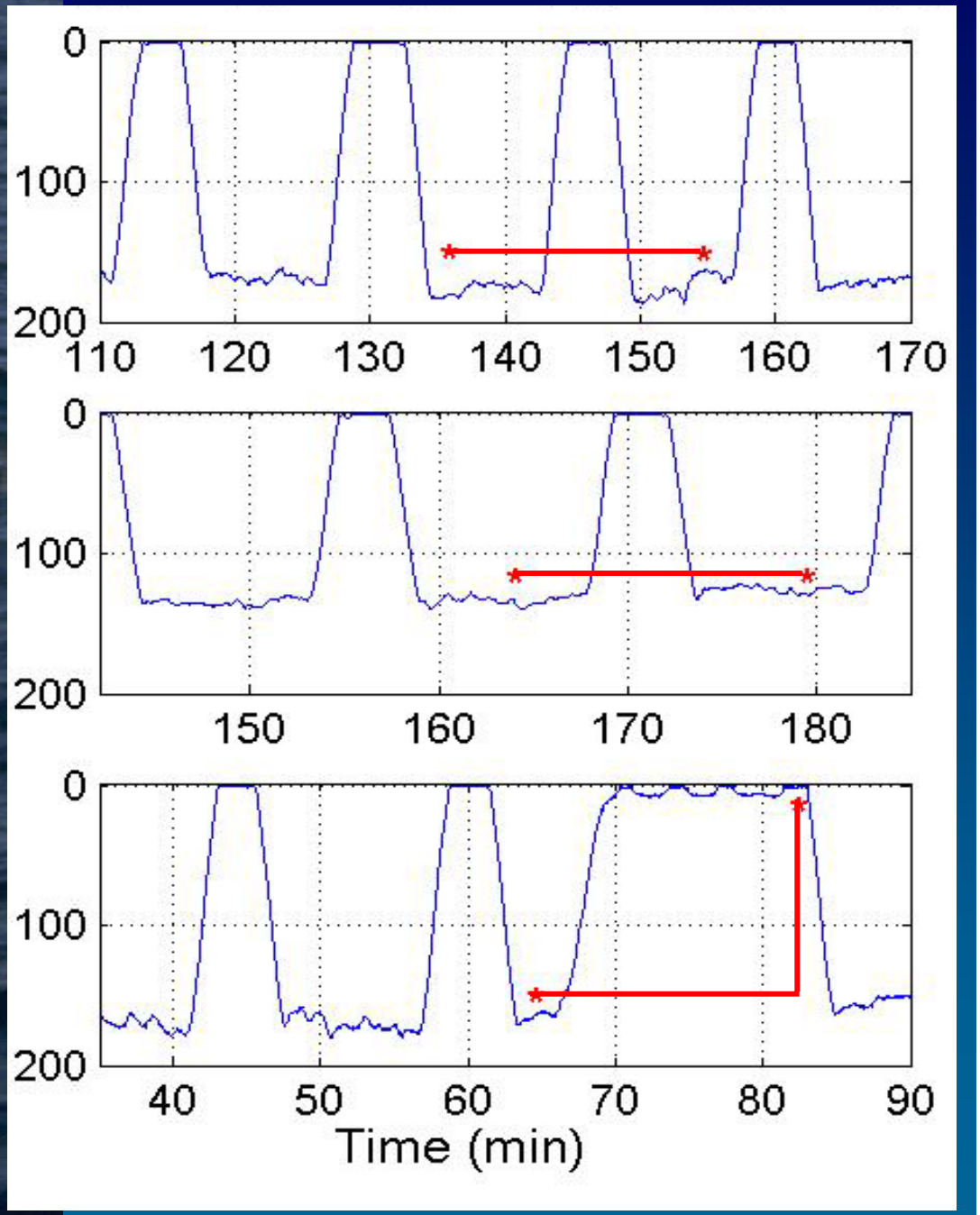
But …. will beaked whales react appropriately?

**Right whales respond to alarm sound but not vessel noise.**

**1. Natural sound**

**2. Ship noise**

**3. Alarm**




from Nowacek et al.

# Mitigation –Preventing Impacts

1. Modification or removal of the sound source.
2. Avoiding marine mammal habitat.
3. Ramp-up procedures.
4. Delay or modification of activities.
5. Visual screening.
6. Aversive alarms.

**Effectiveness is Unknown**

# Mitigation – a Re-evaluation

If currently used mitigation methods are of unknown or questionable value, are resources being used for this purpose cost-effective?

If the same resources were made available, would conservation be better served by:

1. Determining the population-level impact of sound on marine mammals
2. Determining the effectiveness of mitigation measures
3. Developing more effective mitigation measures

The End . . .

. . .The Future