

Transect Surveys and Mark-recapture Techniques for Abundance and Distribution



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Why do we need abundance and distribution information?

- Trends in abundance are used to assess human impacts and to identify threatened populations.
- Absolute population size is used to assess whether known numbers of human-caused deaths (such as fisheries by-catch) are sustainable.
- Distribution data allow us to determine where human activities and whales are of most concern.
- Abundance is critical to understanding the ecosystem role of cetaceans.

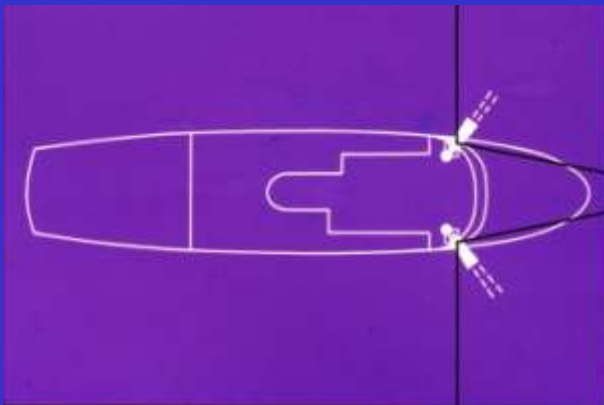
How do we estimate whale abundance?

- We kill them. No, really ... that is how they used to do it (whale kills & catch-per-unit-effort).
- Distance sampling methods (line-transect surveys from ship, boats & aircraft, towed & stationary acoustics methods).
- Shore-based counts on a migration route (gray whales, humpback whales & bowhead whales)
- Mark-recapture based on photo-identification.





Ship-based Marine Mammal Surveys





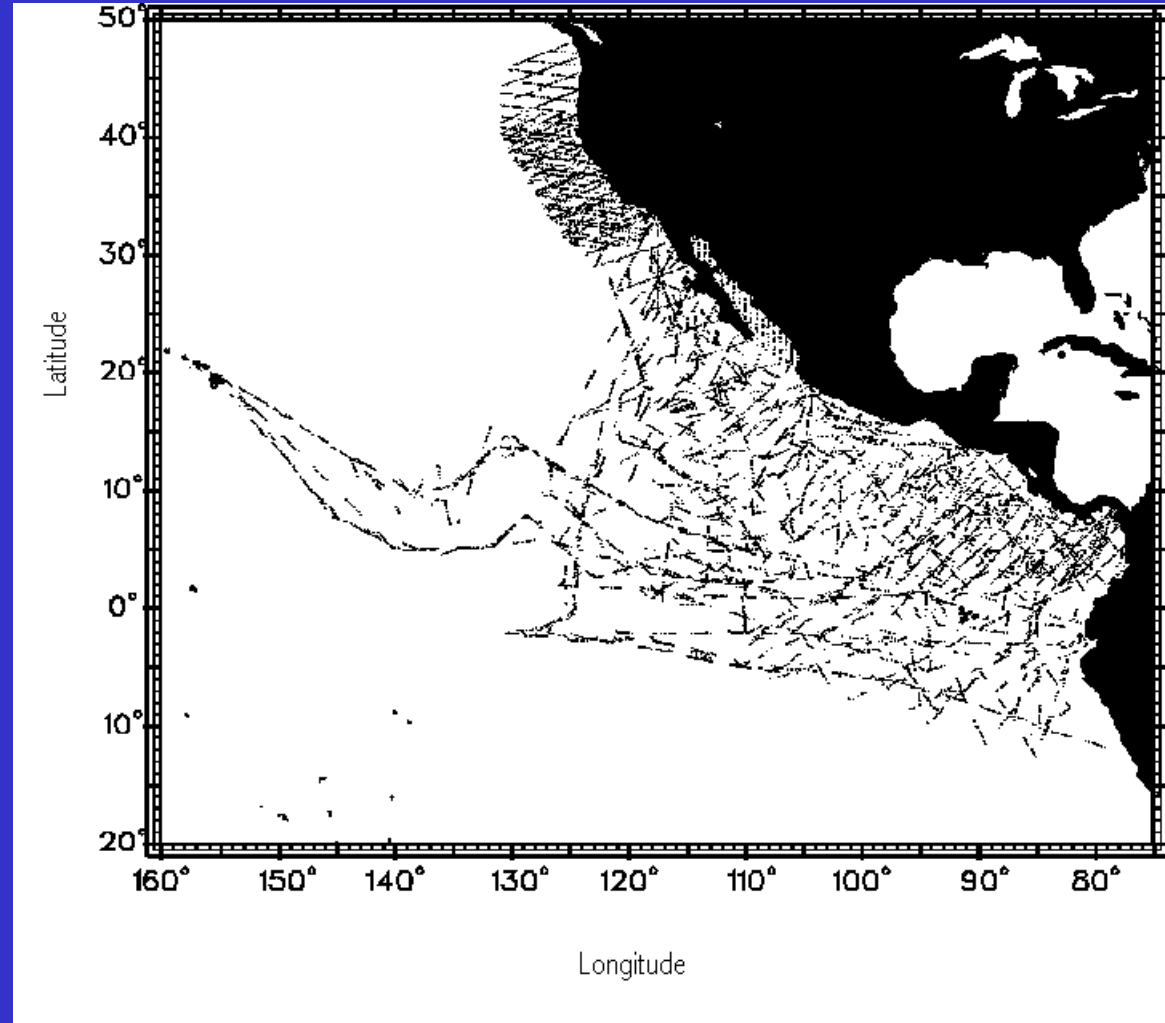
Southwest Fisheries Science Center Ship-based Marine Mammal Surveys

Season:
summer & fall

Years:
1986-96

Tracklines:
200,000 km

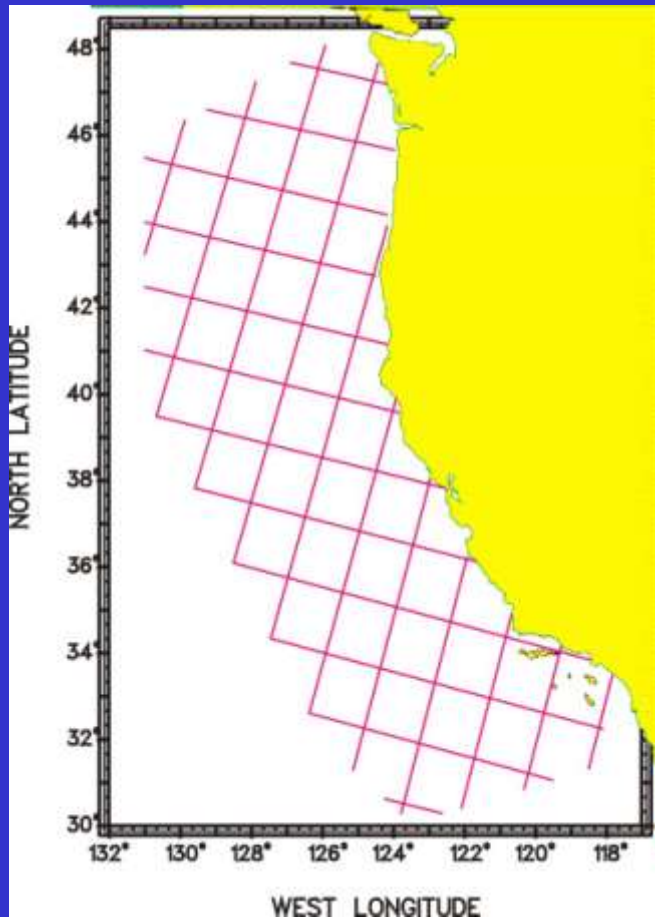
Survey Area:
> 25 million km²





Ship-based Marine Mammal Surveys

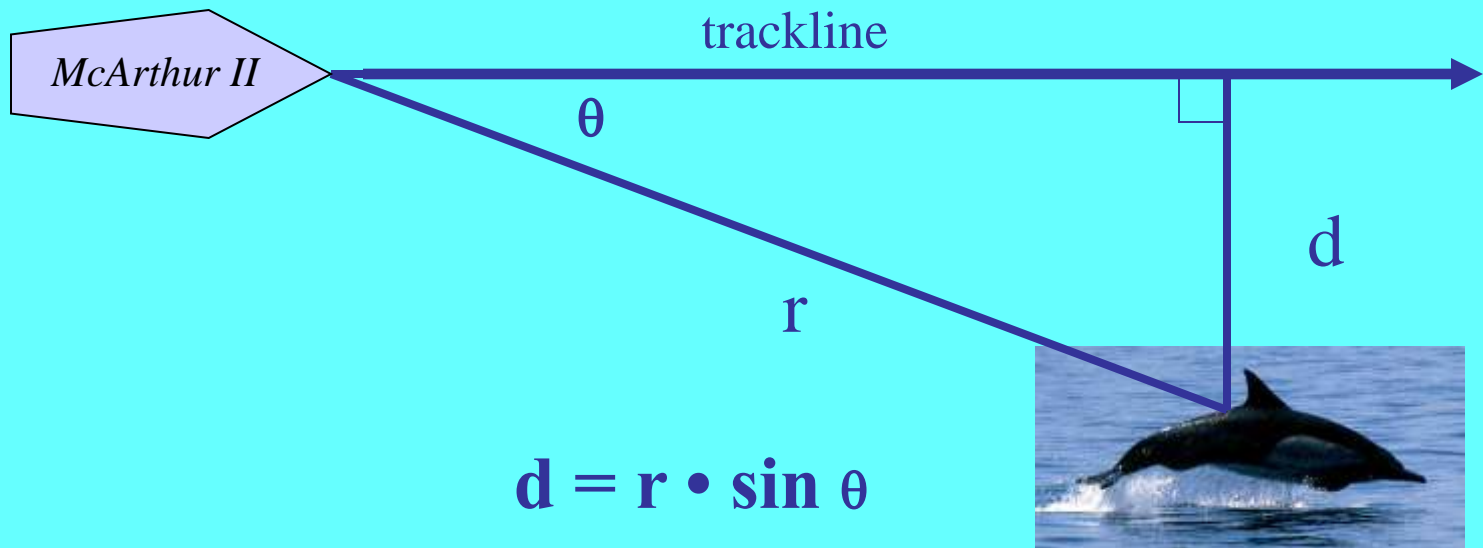
Survey Design: 120 sea days





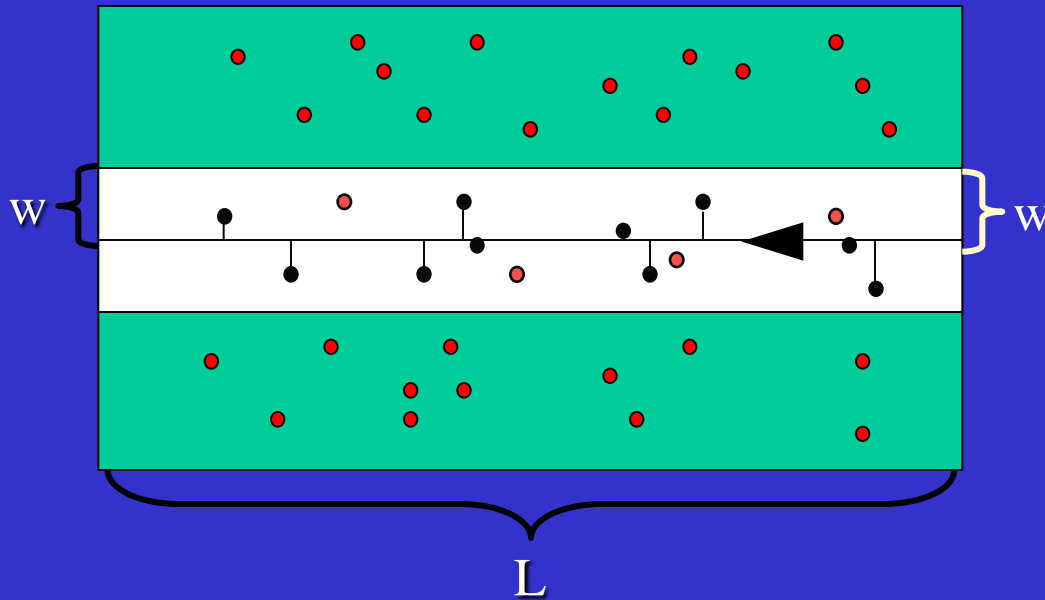
Line transect survey methods

(Bird's eye view)



(radial distance r calculated from reticles in binoculars)

Transect Surveys



Strip Transect

Assumes all animals are seen to distance w

Line Transect

Assumes all animals are seen on the trackline.

$D = \text{Density}$

$n = \text{number of sightings}$

$s = \text{average group size}$

$L = \text{length of transect}$

$w = \text{strip width}$

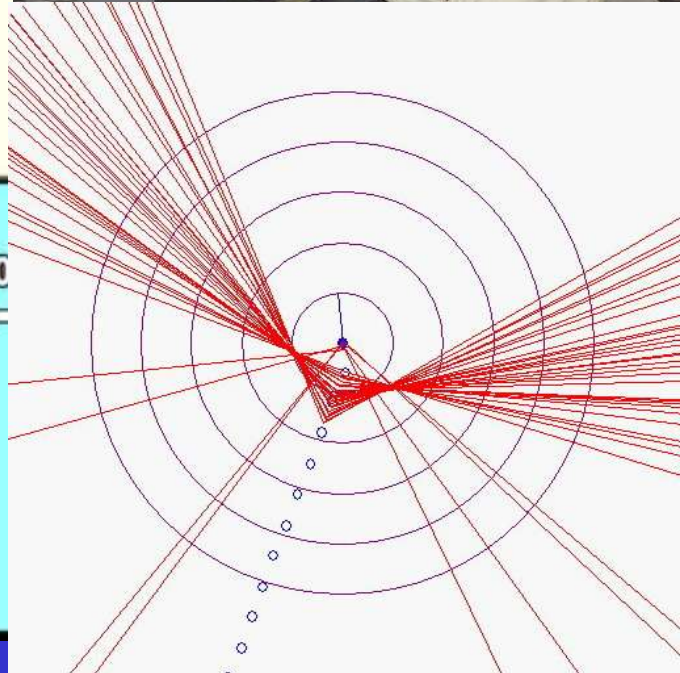
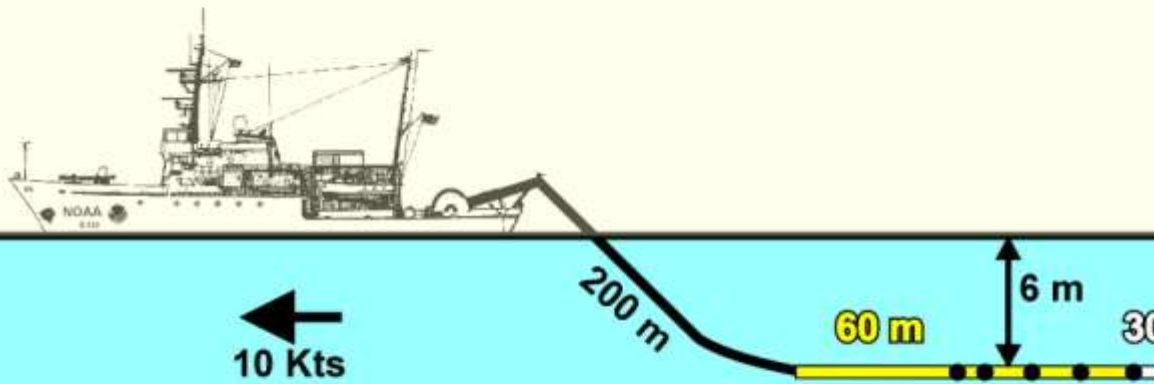
$$D = \frac{n * s}{L * 2 w}$$

$$D = \frac{\text{animals seen}}{\text{area searched}}$$

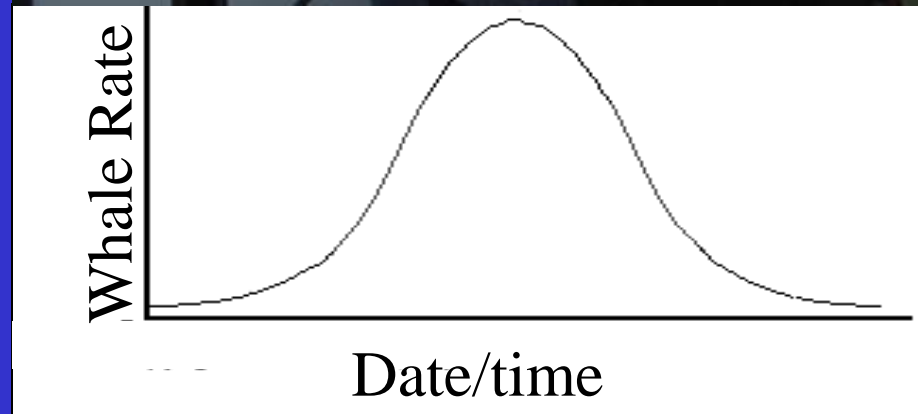
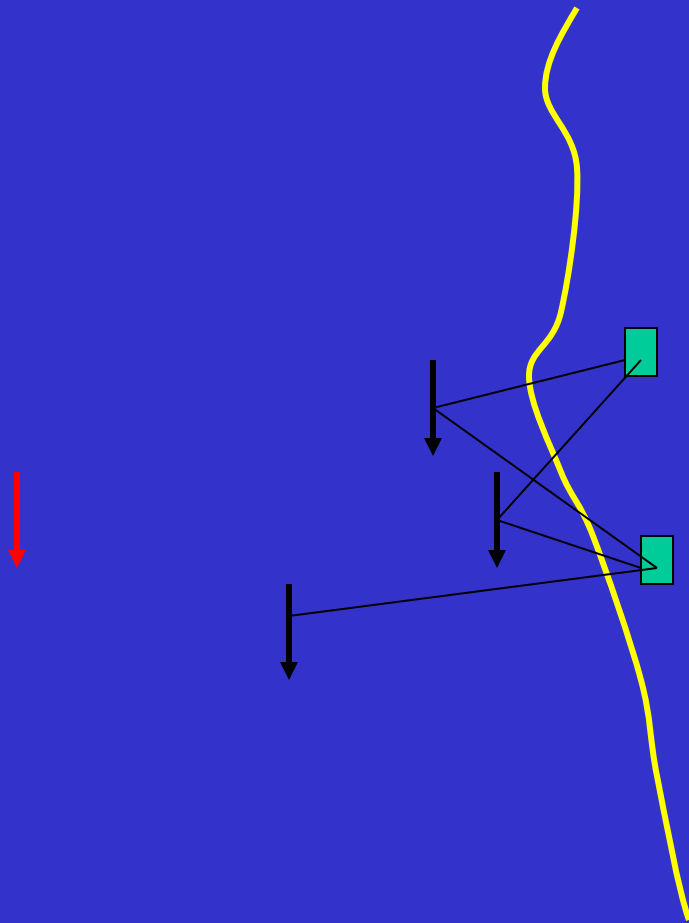
If animals are missed (red dots above): $w = \text{effective strip width}$

SWFSC Acoustic Line-Transect Methods

SWFSC Towed Hydrophone Array



Shore-based Migration Counts to Estimate Abundance



Humpback Whale Abundance in the North Pacific: estimated by photographic capture-recapture with bias correction from simulation studies

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Briana Witteveen

Manami Yamaguchi

+ 400 of our closest friends



**And a cast of
thousands.**

Every whale is special ... and distinct.

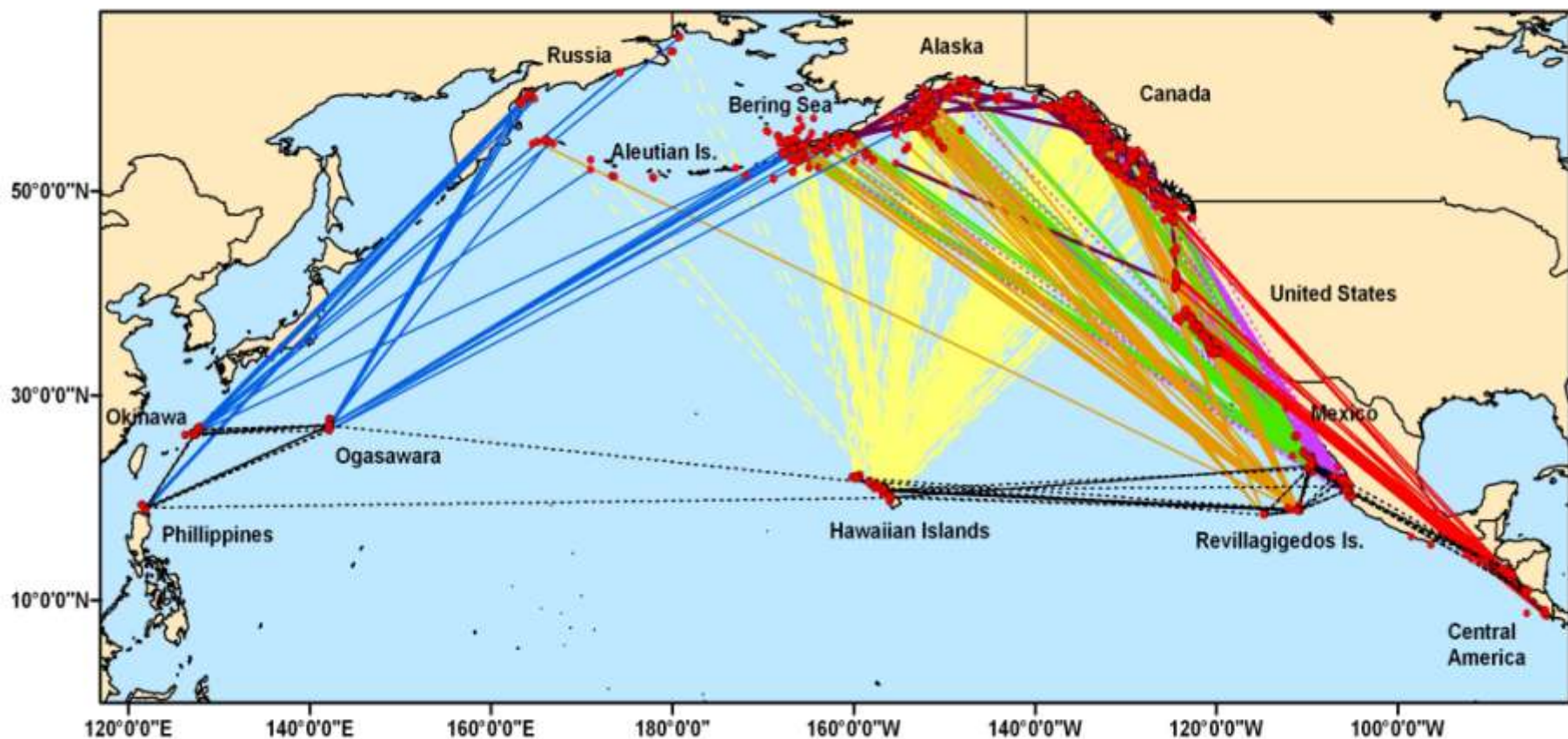


SPLASH: Ocean-basin Study



Scale varies in this perspective.
Adapted from National Geographic maps.

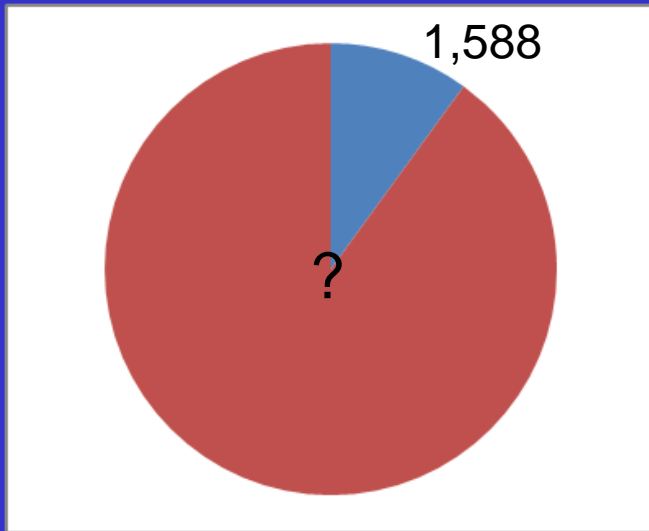
SPLASH Sampling: A United Team with United Cause – 18,000 Fluke ID's



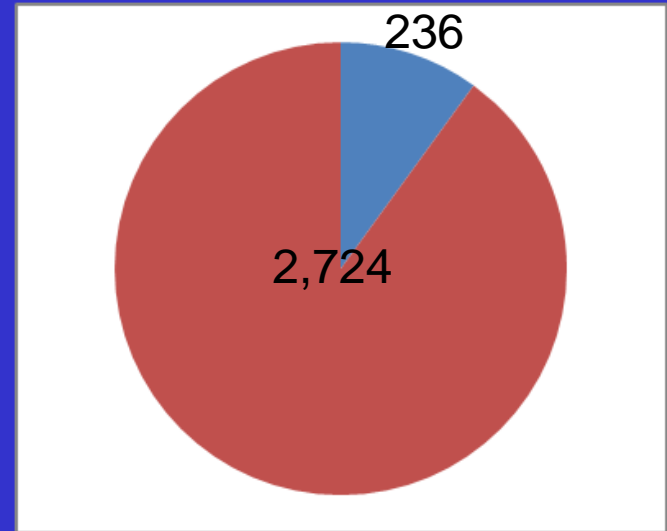
Mark-recapture Abundance Estimation from Photo-Identification

$$\frac{1,588}{N} = \frac{236}{2,724}$$

$$N = \frac{1,588 * 2,724}{236} = 18,329$$



First Sample: 1,588 photo-IDs from an unknown number of whales.



Second Sample: 2,724 photo-IDs with 236 matches from the previous sample.

Mark-recapture Abundance Estimation from Photo-Identification

Petersen mark-recapture estimator:

$$N = \frac{n_1 * n_2}{m} = 18,329$$

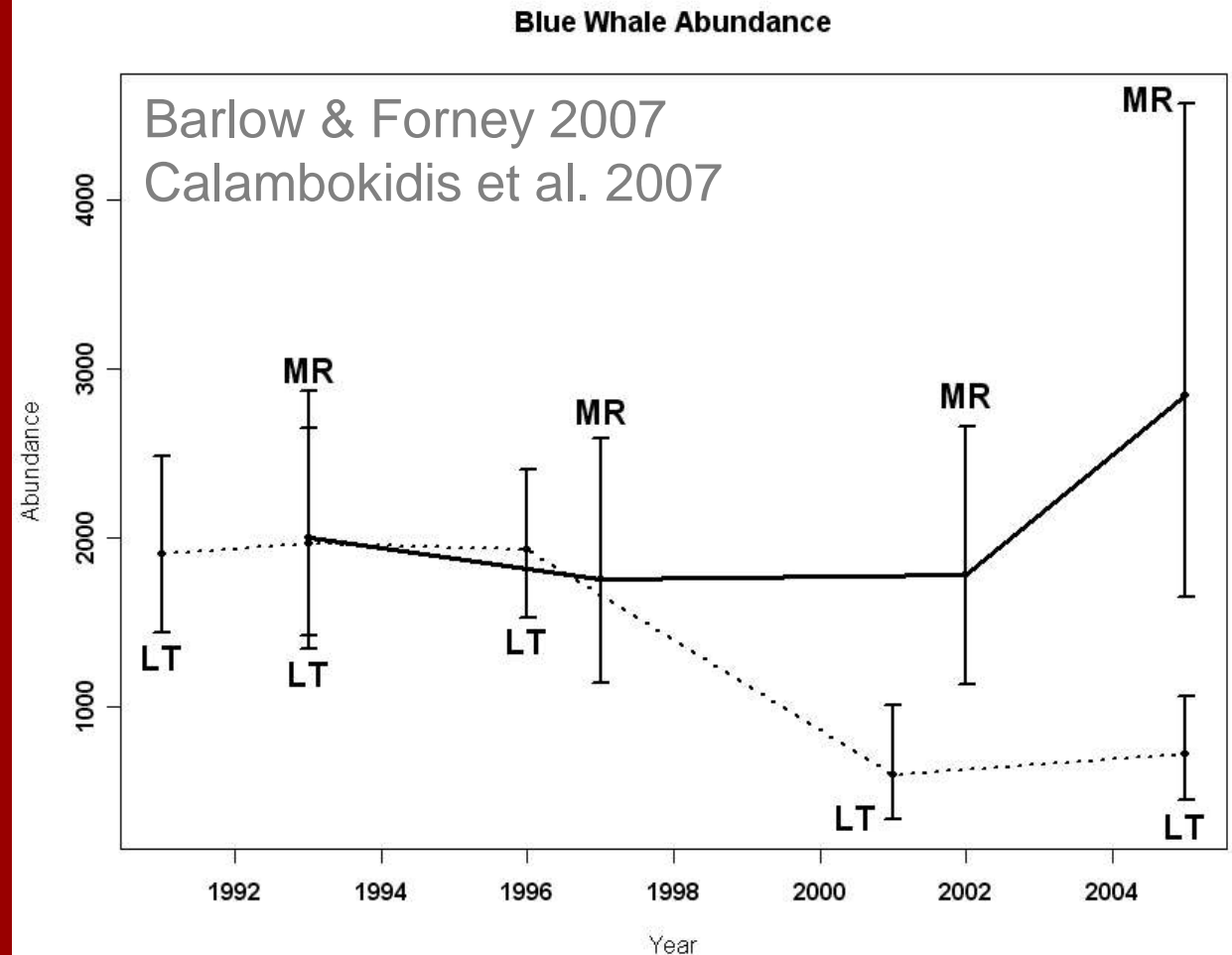
Assumptions: Population is closed (no birth or death), every individual has an equal probability of being sampled, and all matches are found.

Different mark-recapture estimation formulae can be used if these assumptions are not met. Also, computer simulation modeling can be used to correct bias if that bias can be accurately modeled.

Blue Whale Trends in Abundance from Multiple Methods: Line-Transect (LT) and Mark-Recapture (MR)

Rarely, abundance data are available from two different methods.

If so, the differences can tell you something about your populations.



How Do I Get Started?

Establish collaborations. Almost all abundance studies are too large to be done alone.

Develop a good study design. If your design is faulty, all your good effort can be lost. Consult with experts. Choose the best method for your species/area/budget. Get peer-review of your design before you start.

Read the literature. There are lots of good examples that you can follow.

Consider safety. Work from small boats and aircraft is intrinsically dangerous. Know your limits and don't exceed them.

References

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