



NOAA
FISHERIES
NEFSC

RIGHT WHALE POPULATION ASSESSMENTS AT NEFSC

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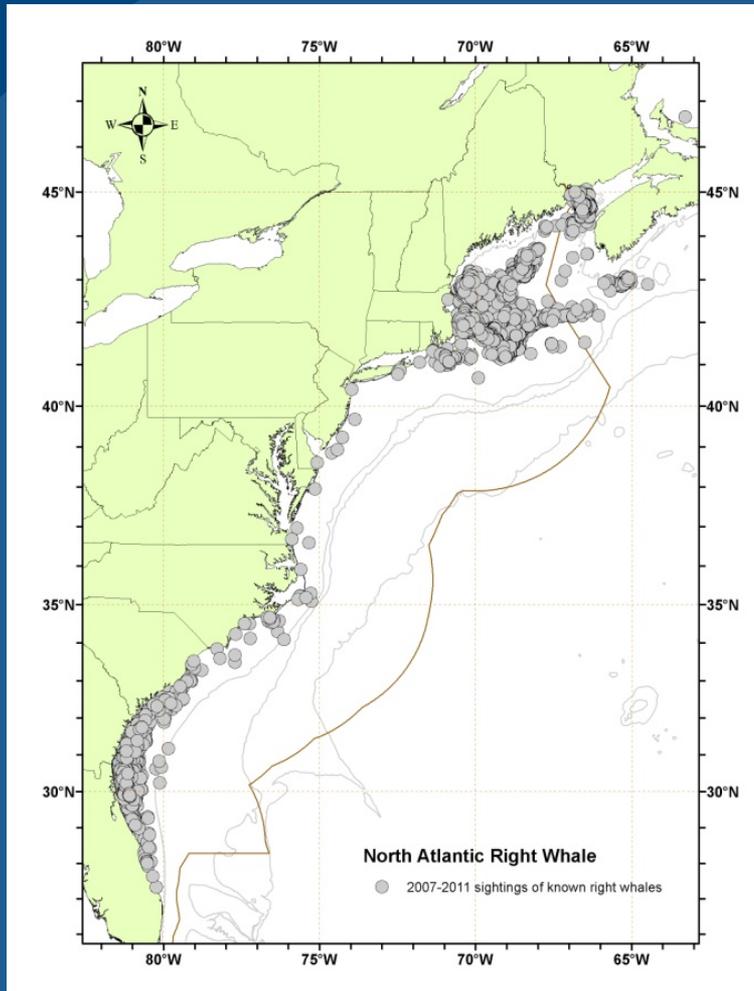
April 14, 2015

Right Whales and Photo-ID

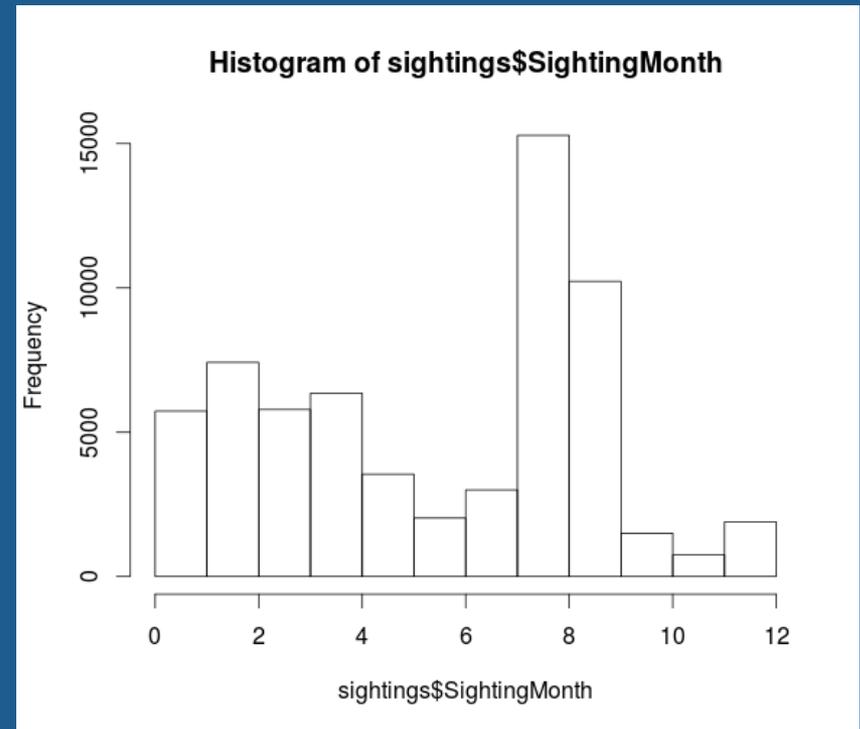
- Individually identifiable
- Long history of work – since 1980
- North Atlantic Catalog @ NEAq (Boston)
 - Many contributors
- Frequent photographic recapture
- N=681 (incl. known deaths)



ID's from both Feeding AND Calving areas throughout the Year

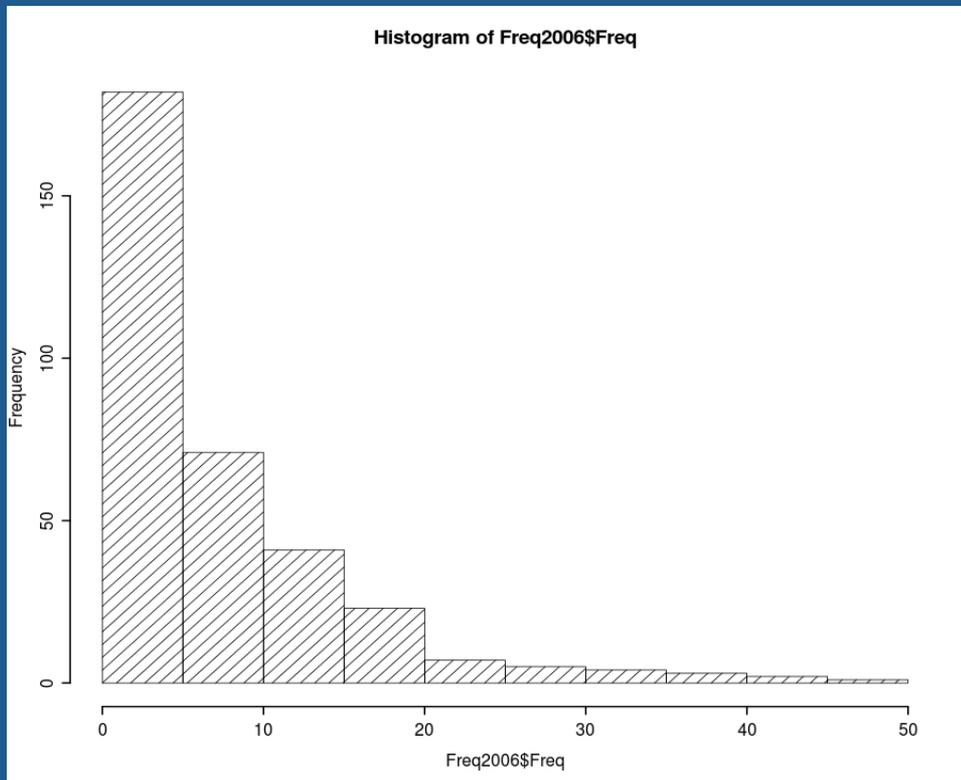


Every Month



Individual ID

Large amounts of Effort (Mult. Org.) Yield Frequent Re-sights of individuals



Ex. 2006

339 Whales seen >0

Median 5 times

High 46

Definitions

Capture Sequence = a series of counts representing the number of times a whale seen for each year in the database

Capture History = a capture sequence reduced to binary

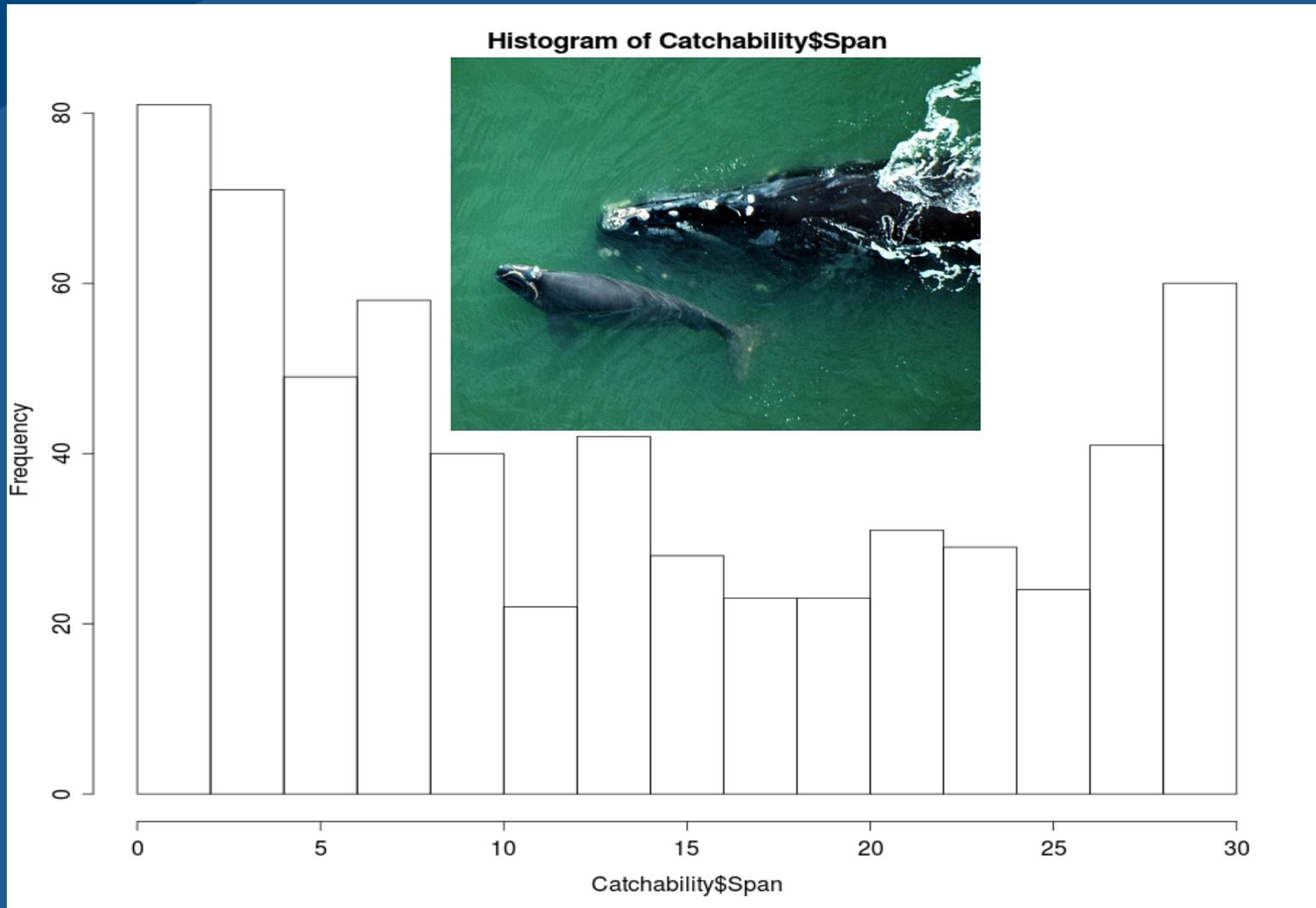
Capture Span = the number of years from the first to the last sighting

0 0 0 3 0 2 5 1 0 3 5 0 0 4 0 0 0

0 0 0 1 0 1 1 1 1 1 0 0 1 0 0 0

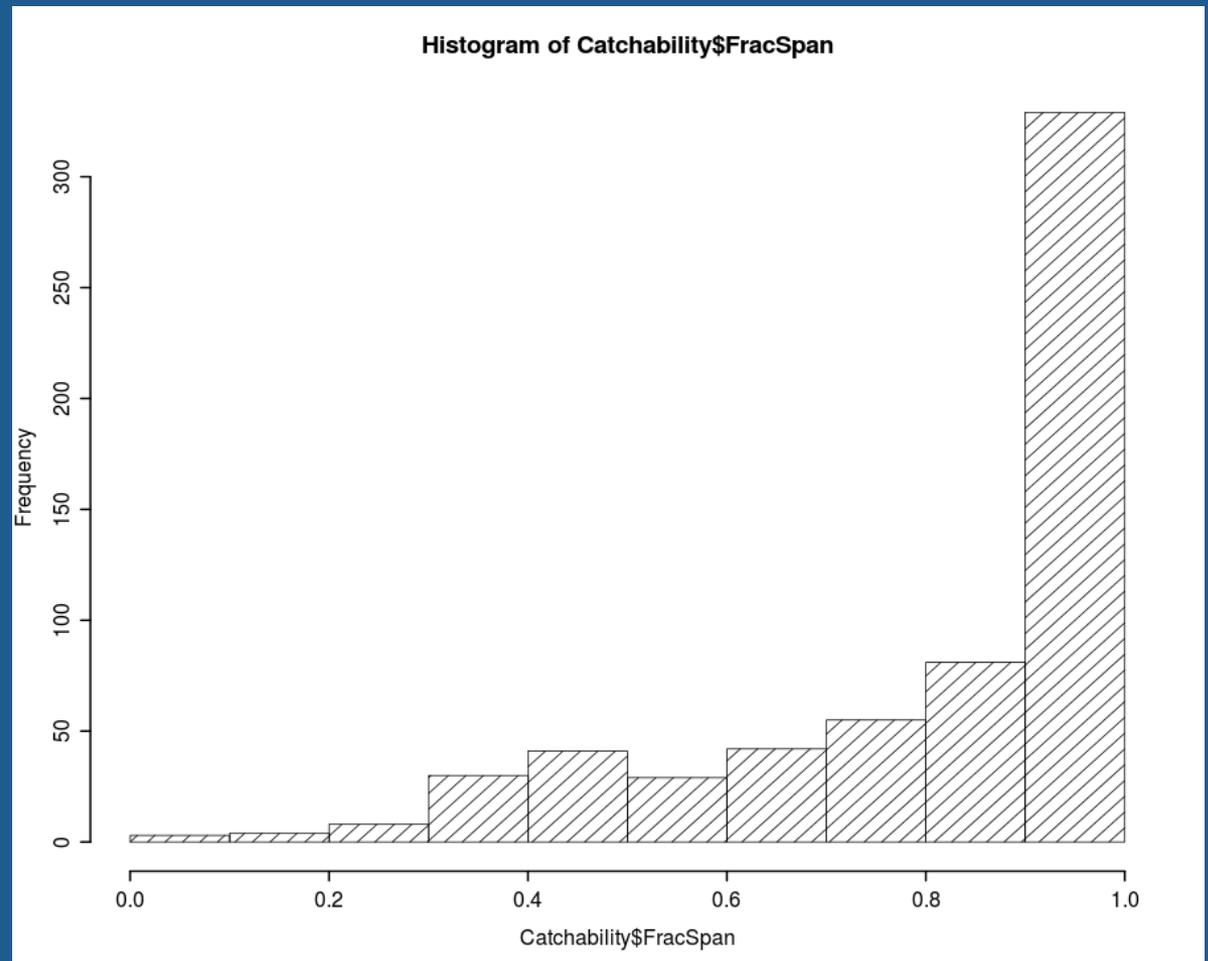
0 0 0 1 1 1 1 1 1 1 1 1 0 0 0 → Span=10

LONG INDIVIDUAL HISTORIES:

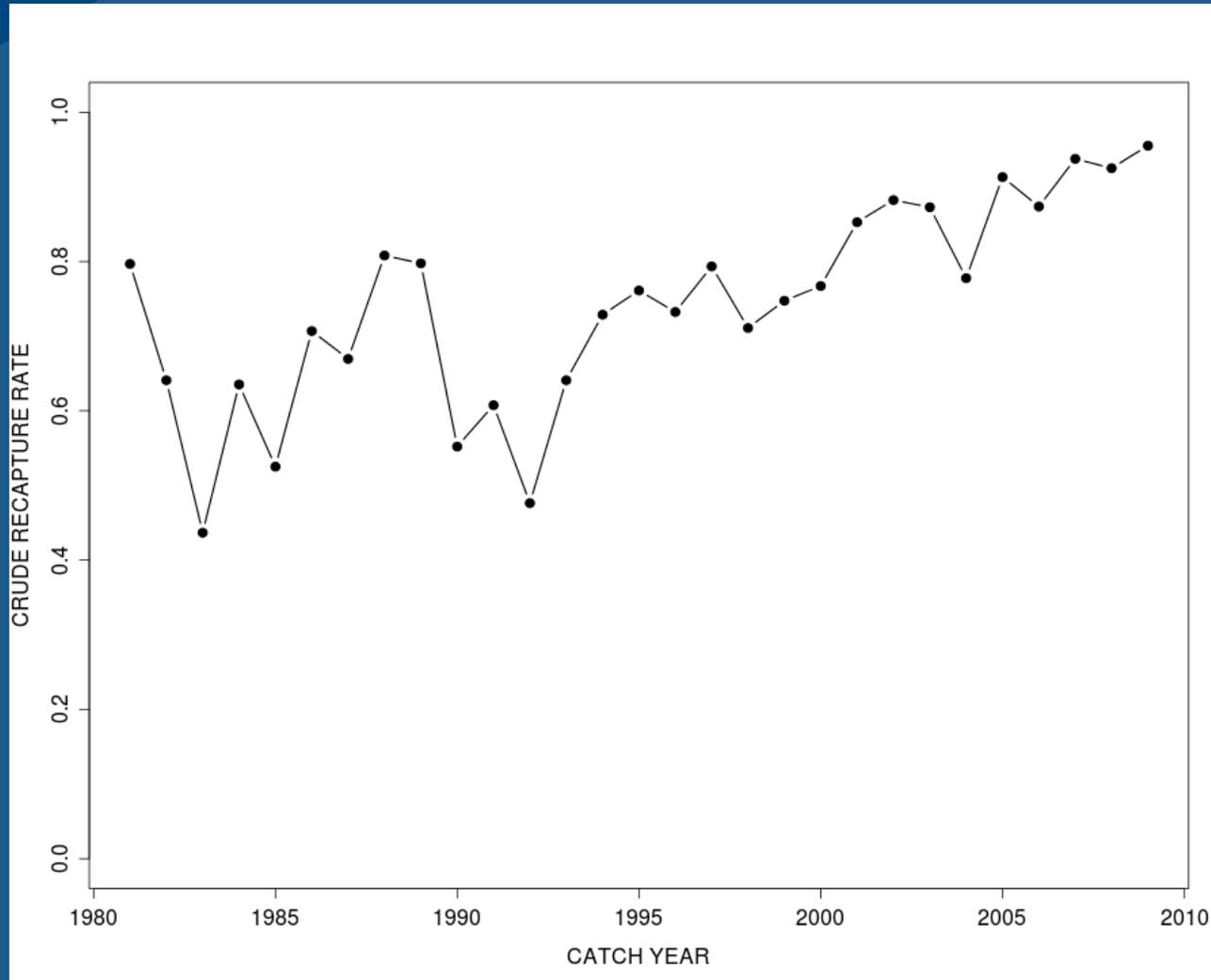


Not a Complete Census: Some whales are missed each year

>300 have been
Seen 90%
or more
Years in their
known spans



Crude Recapture Success



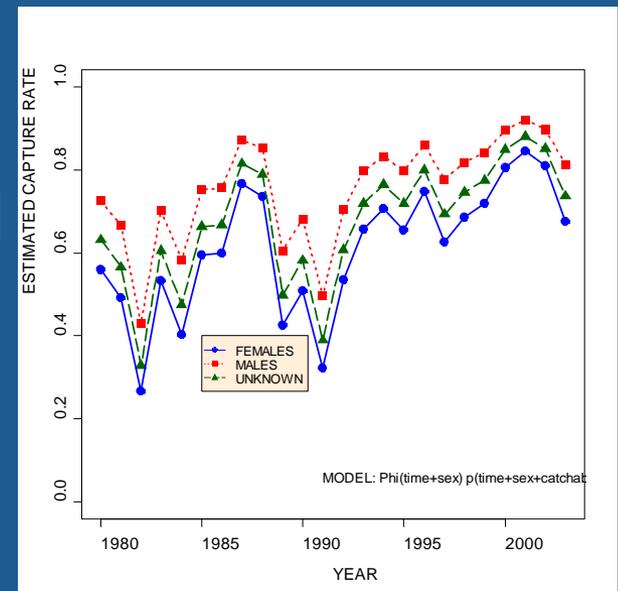
NOTES

- We have developed 'estimates'
- E.g. Horvitz-Thompson like
 - Assume detectability equal (a lie)
 - N_i/p_i where p_i 's come from a MRR model

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- Interesting but unnecessary in PBR paradigm

N_{\min} = provides "reasonable assurance that the stock size is equal to or greater than the estimate"



Calculate Minimum Number Alive

Count all whales known to be alive (accounting not stats)

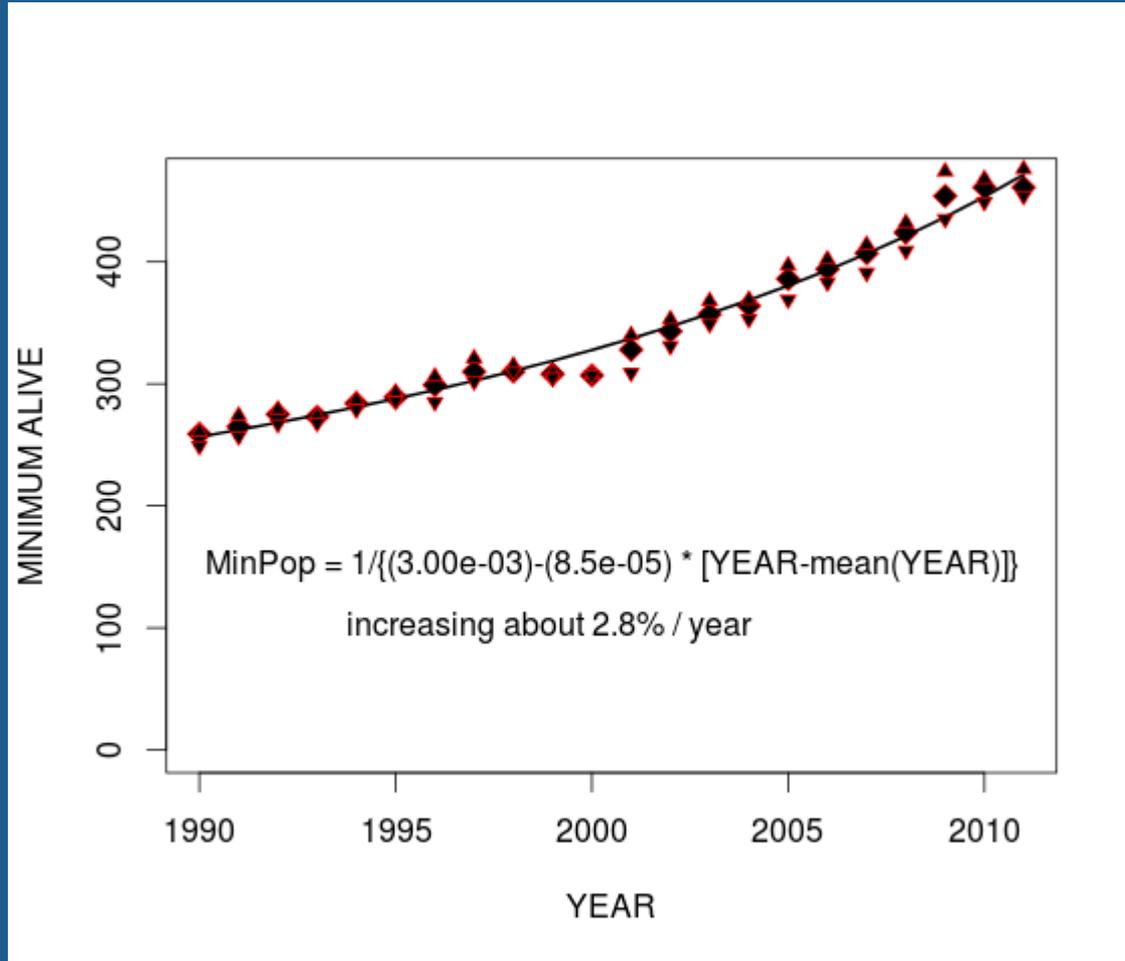
$$N_{\min}(2011) = 465$$

High detectability

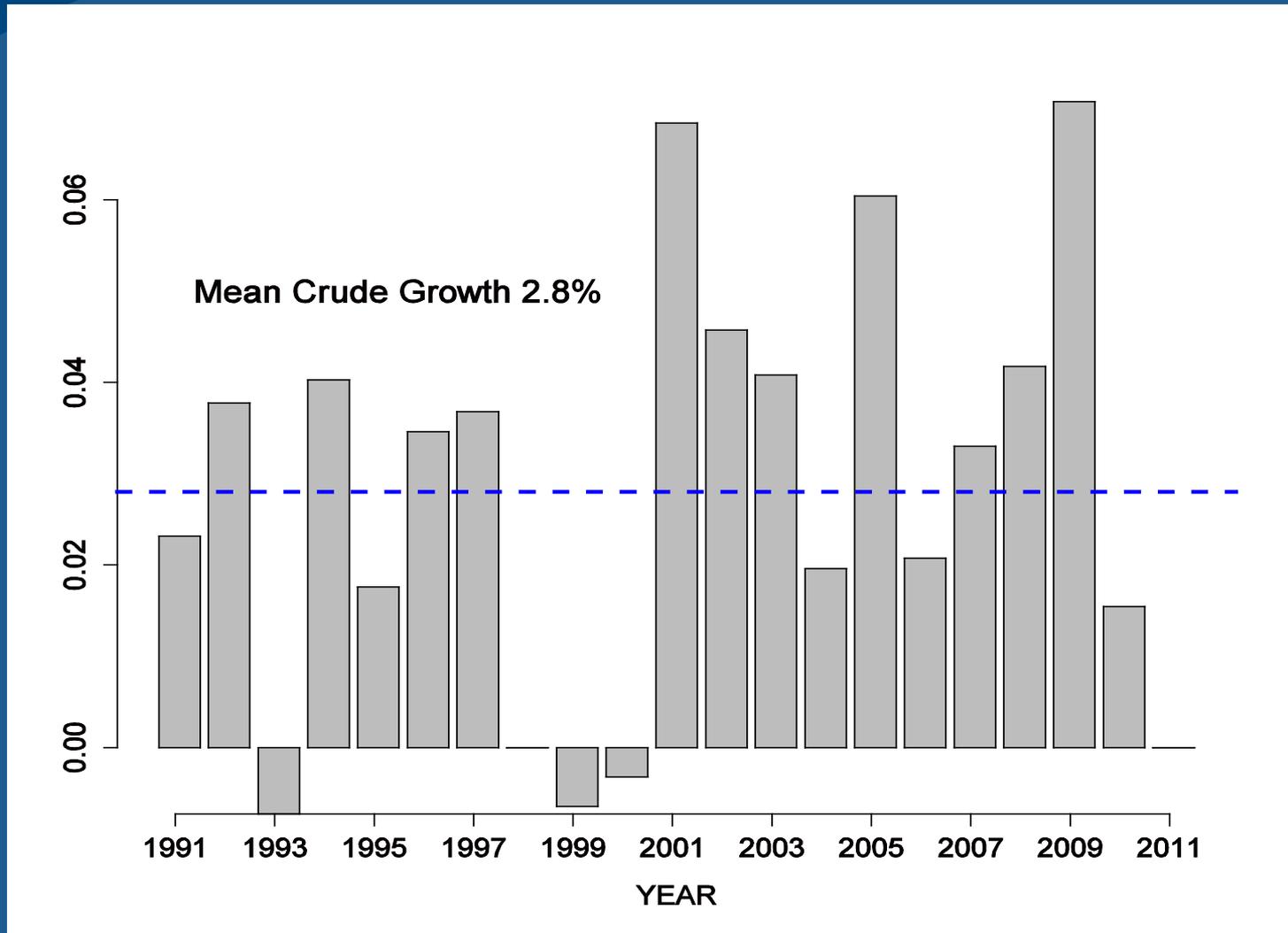
Lag time sensitive

Allow time to capture those missed in Year i

Only 4/1000 chance of not seeing a average whale 3 years



"Apparent" Population Growth



Wonderful ... Not Perfect

- Modest Fraction of Unknown Sex
 - (important later)
- Only about half are of known age (increasing)
- Some retrospective recaptures (influence survival estimates {bias High})

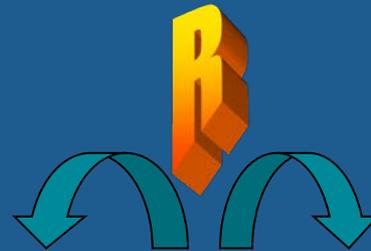
Beyond just N

Use the mark-recapture treatments of Capture histories to estimate

SURVIVAL

Sighting histories $\sim \text{MULT}(G_j, \Phi_i, p_i)$

General form (time dependent Φ, p) CJS after Cormack-Jolly-Seber



$$\text{Pop}_{\text{new}} = \text{Pop}_{\text{old}} + \text{Births} - \text{Deaths}$$

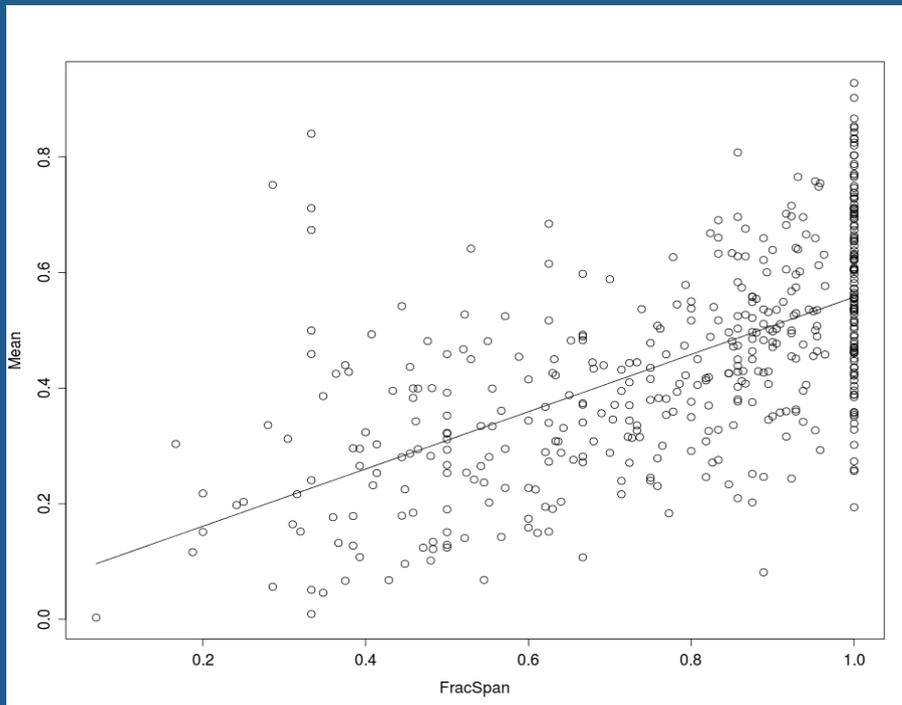
Individual Covariate: Heuristic Catchability

Ranked whales within a year

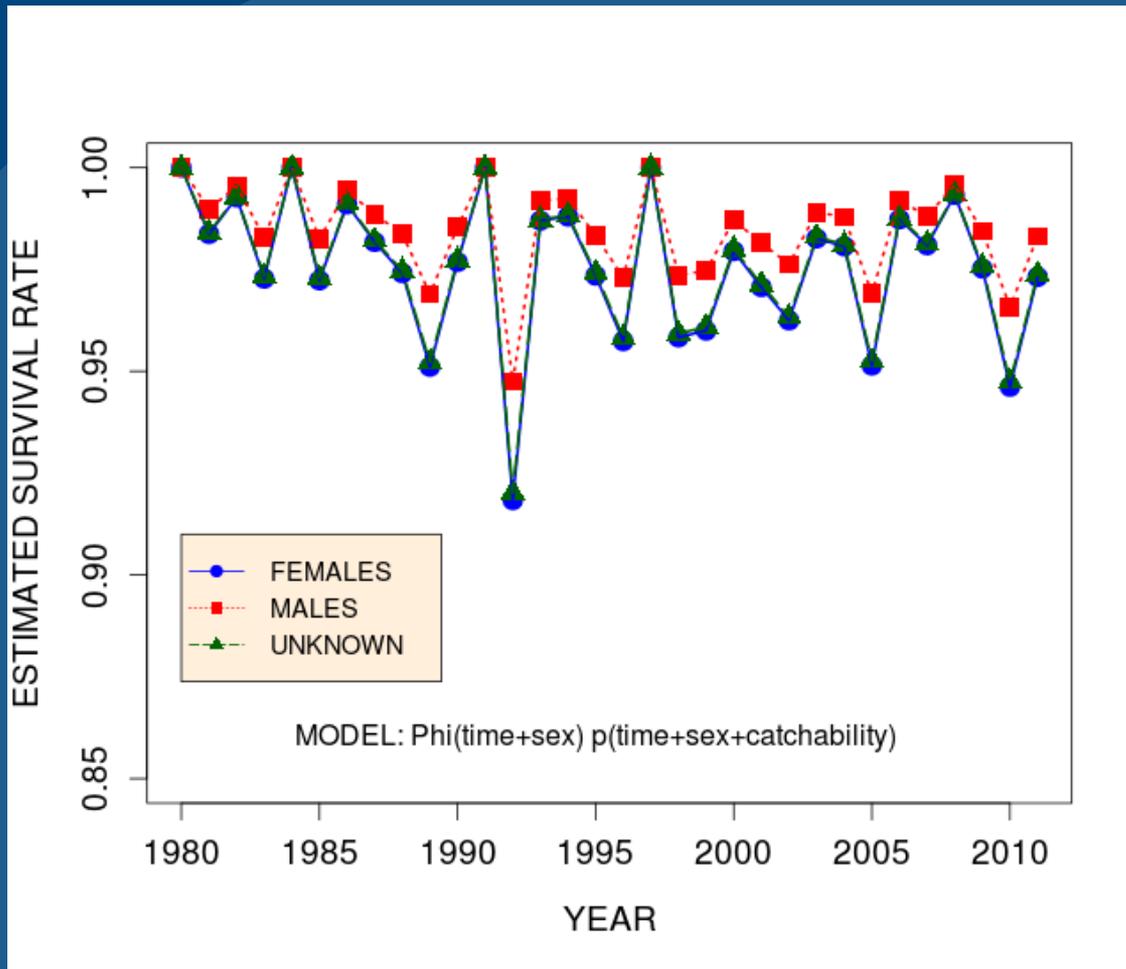
Normalized ranks among years (rank/mean)

Catchability = average adjusted rank in years seen

Outperforms random component



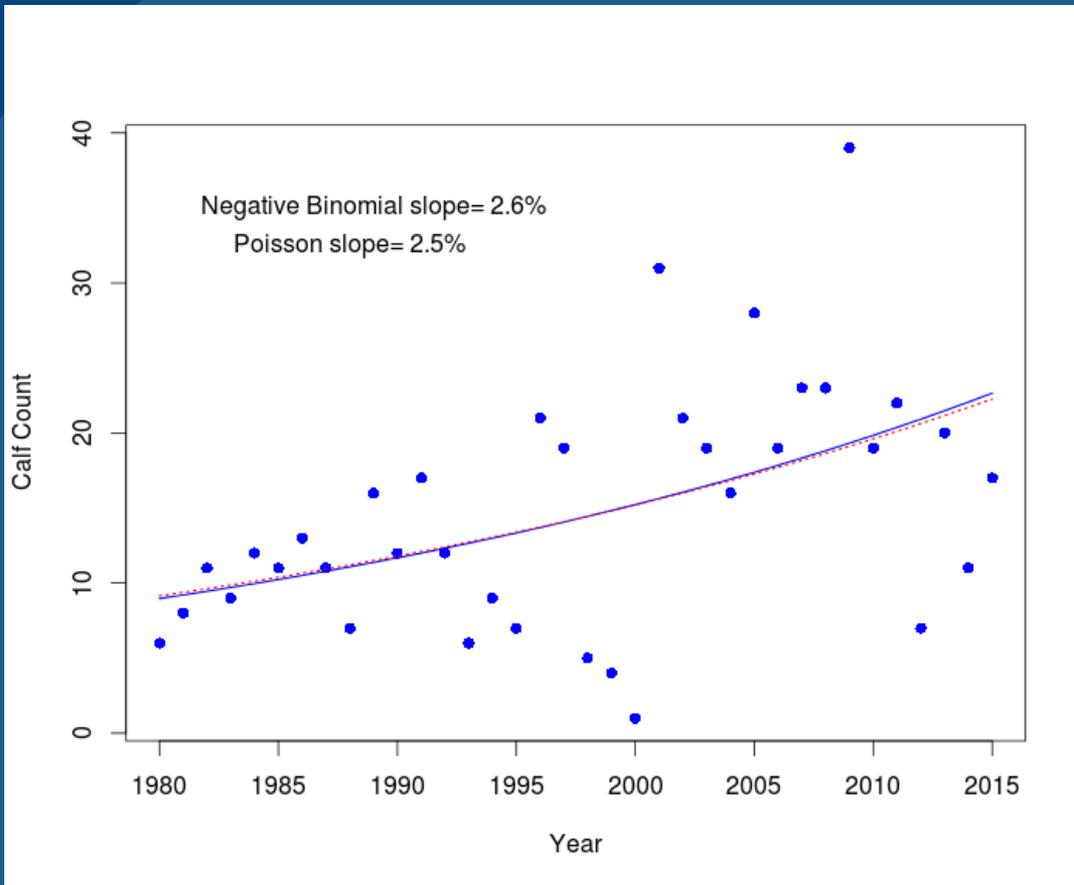
Competing Models



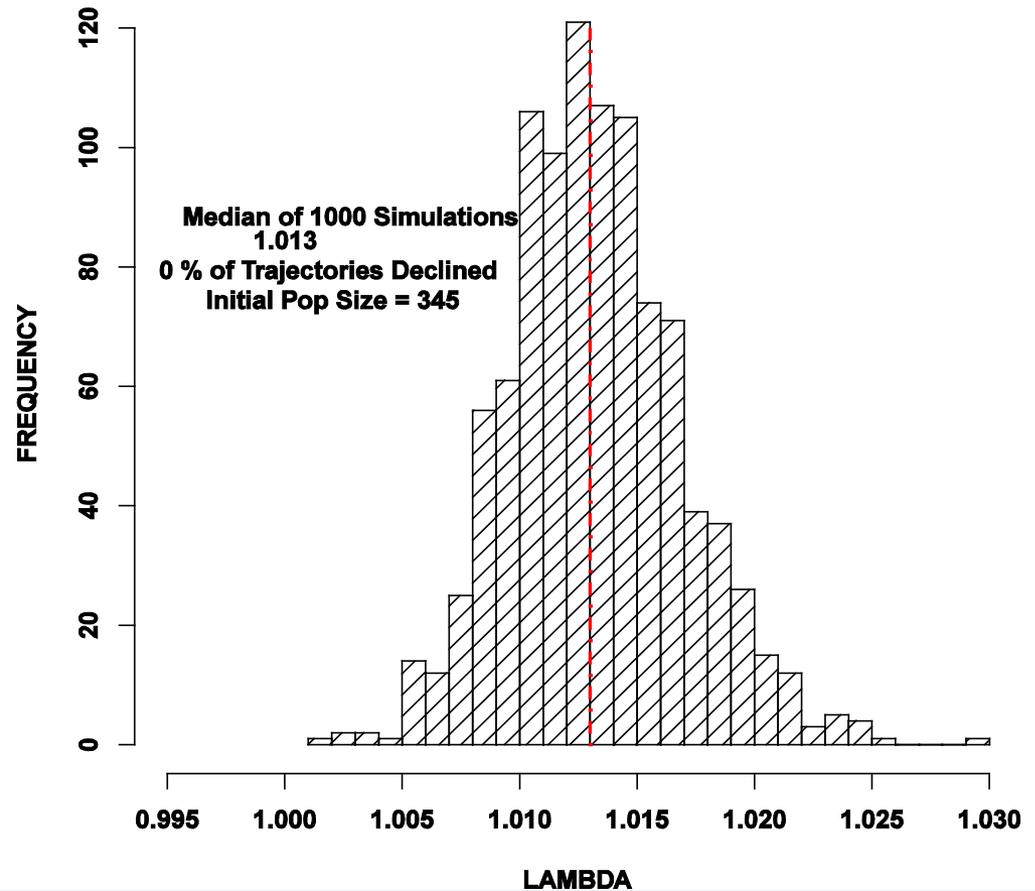
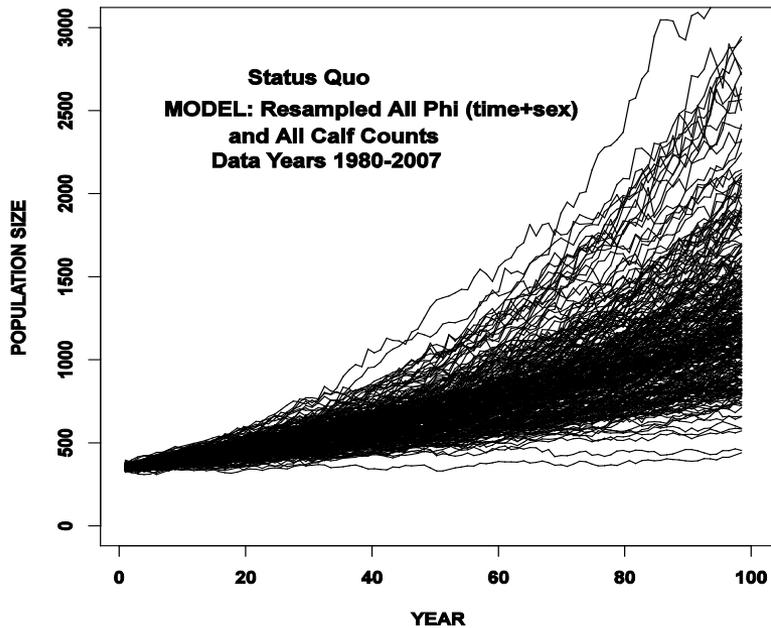
- Sex Effects (Φ, ρ)
- Annual variation (Φ) (always in ρ)
- Linear (logistic) in time
- Fully time varying
- interacting time and sex
- Measures of Effort (ρ)
- Catchability (ρ)

OTHER MODELS

Model Calf production over time
Over dispersed Poisson or
Negative Binomial Regression



Simulation Games (PVA)



Ask What if questions

How much will saving n whales increase population growth?

Other management questions

Has past management been effective?

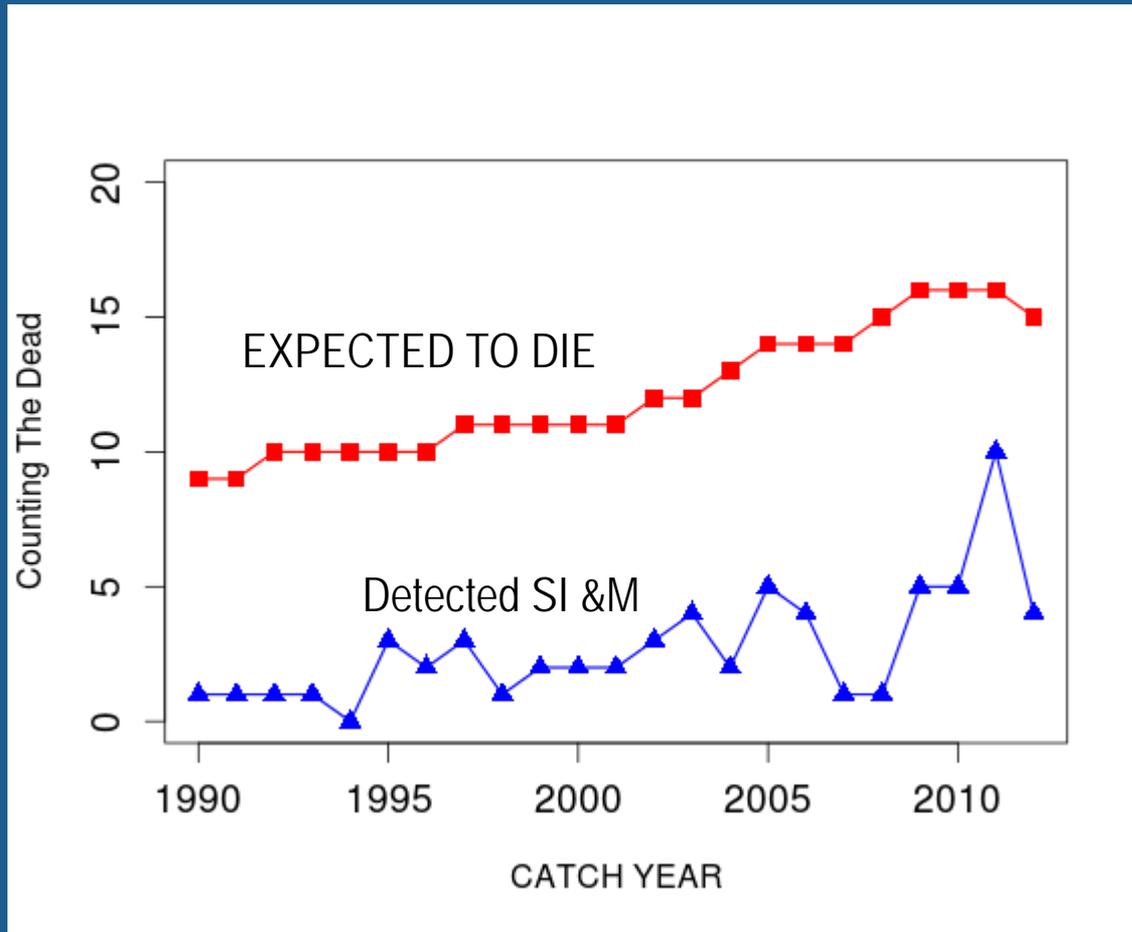
Appears to be no significant signal in the survival time series

Are there other ways to address?

Question the veracity of DETECTED MORTALITIES

	1999	2000	2001	2002	2003	2004
RIWH Ship Strike	1	2	2	1	1	3
RIWH Entanglement	2	1	1	0	0	2
	2005	2006	2007	2008	2009	2010
RIWH Ship Strike	1	1	0	1	0	1
RIWH Entanglement	2	0	2	1	1	1

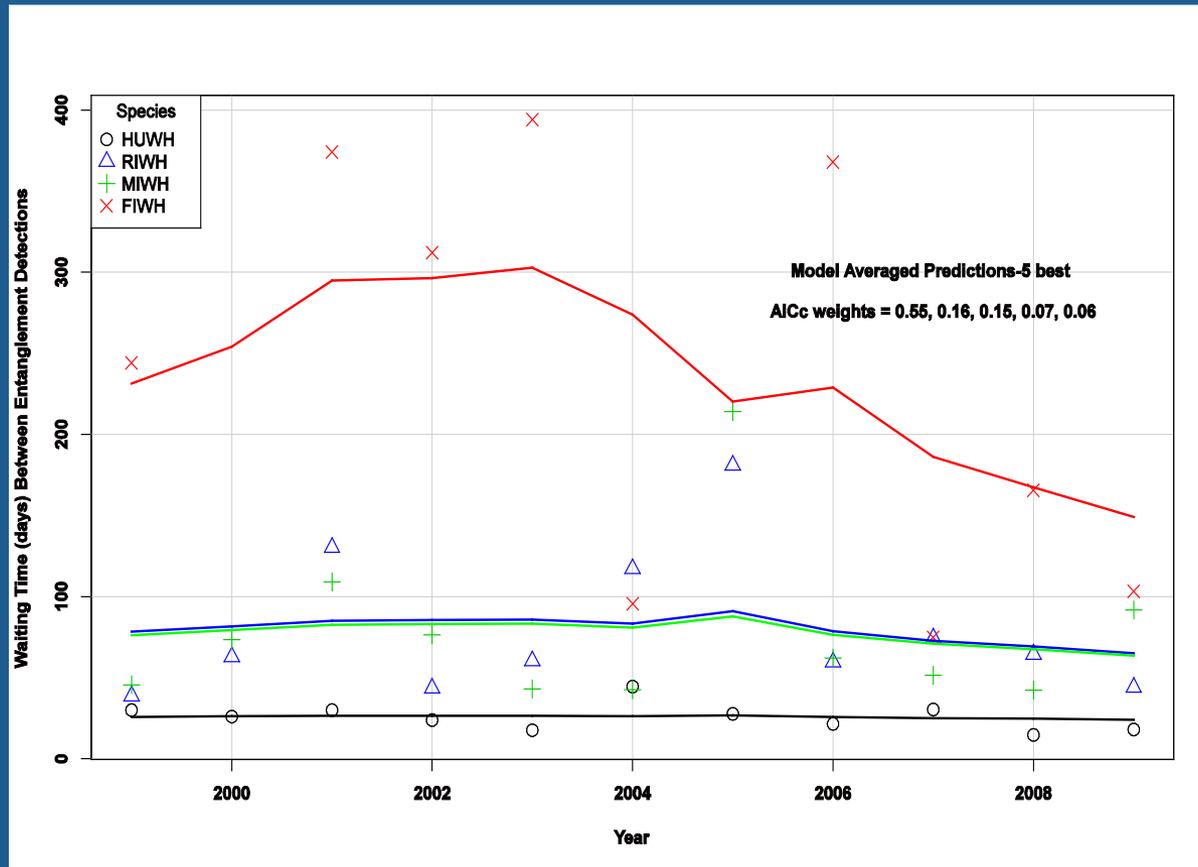
Cryptic Mortality – Cause Specific



EVENT COUNTS (SI&M) ARE MINIMUMS

Unknown detection functions <1 a.s.

Is there a signal in these small numbers?



Novel analysis of the time between events found no evidence of significant positive impact prior to ground line rule (1999-2009)

Heuristic CALCULATION METHOD for Cause Specific Mortality

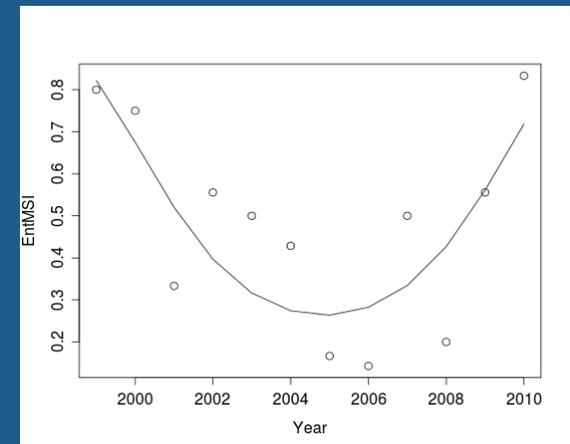
Proposed and evaluated HuCSIM

Product of an estimates of the Fraction of SI&M from Entanglement or Ship Strike

Mark Recapture estimates of total Mortality

MinAlive

Simple concept but too many significant assumptions



Current Work

Hierarchical Model of Capture Histories
Detected Carcasses and Serious Injuries
Detected Reproduction

Parameters of interest Overall Survival,
Abundance (Growth), Entanglement-related
Mortality

A few large whale stocks, especially NA RIWH, offer an opportunity to produce annual assessments of their status that are more meaningful than abundance related to a conservation metric (PBR)

