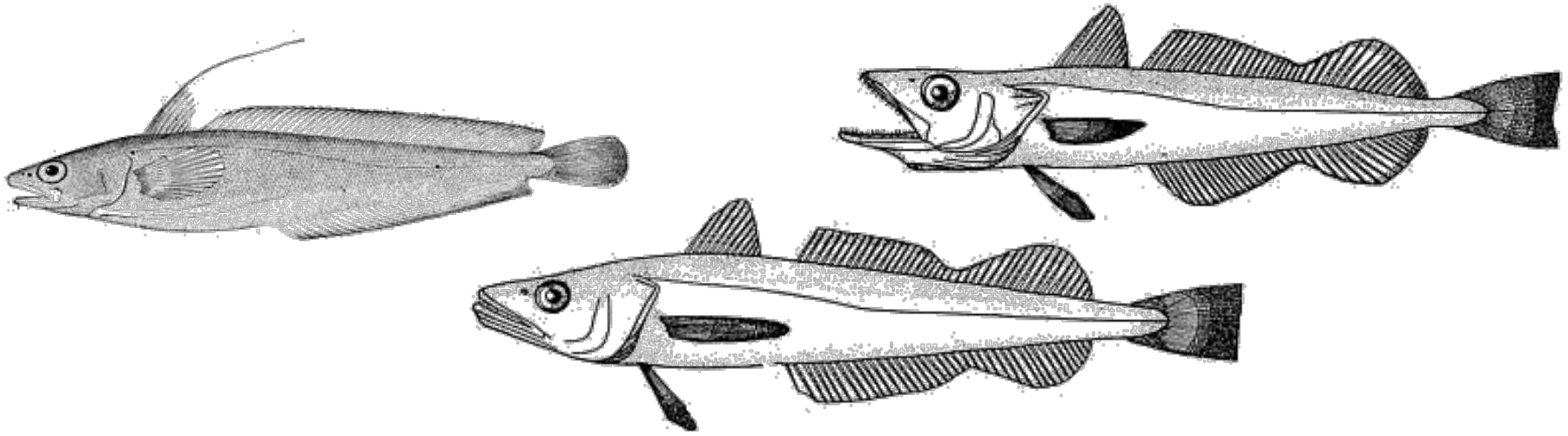


2014 Hake Assessment Update and Proposed ABC Specification for FY 2015-2017

Larry A. Alade
NEFSC, Population Dynamics Branch

Whiting PDT
Statistical and Scientific Committee Meeting
August 26, 2014
Boston, MA

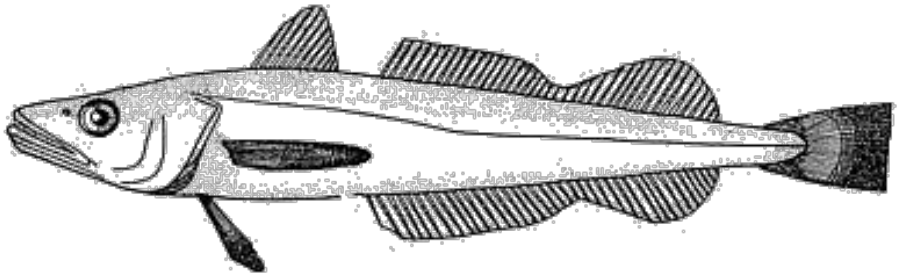
State of the Stocks

- ***Silver hake***
  - Both northern and southern Stocks for are NOT overfished and overfishing is NOT occurring
- ***Red Hake***
  - ***Northern stock*** is NOT Overfished but Overfishing IS occurring
  - ***Southern stock*** is NOT Overfished and overfishing is NOT occurring
- ***Offshore hake***
  - stock status determination remains undetermined because the fishery data were not sufficient and the survey trends did not reflect the stock trends

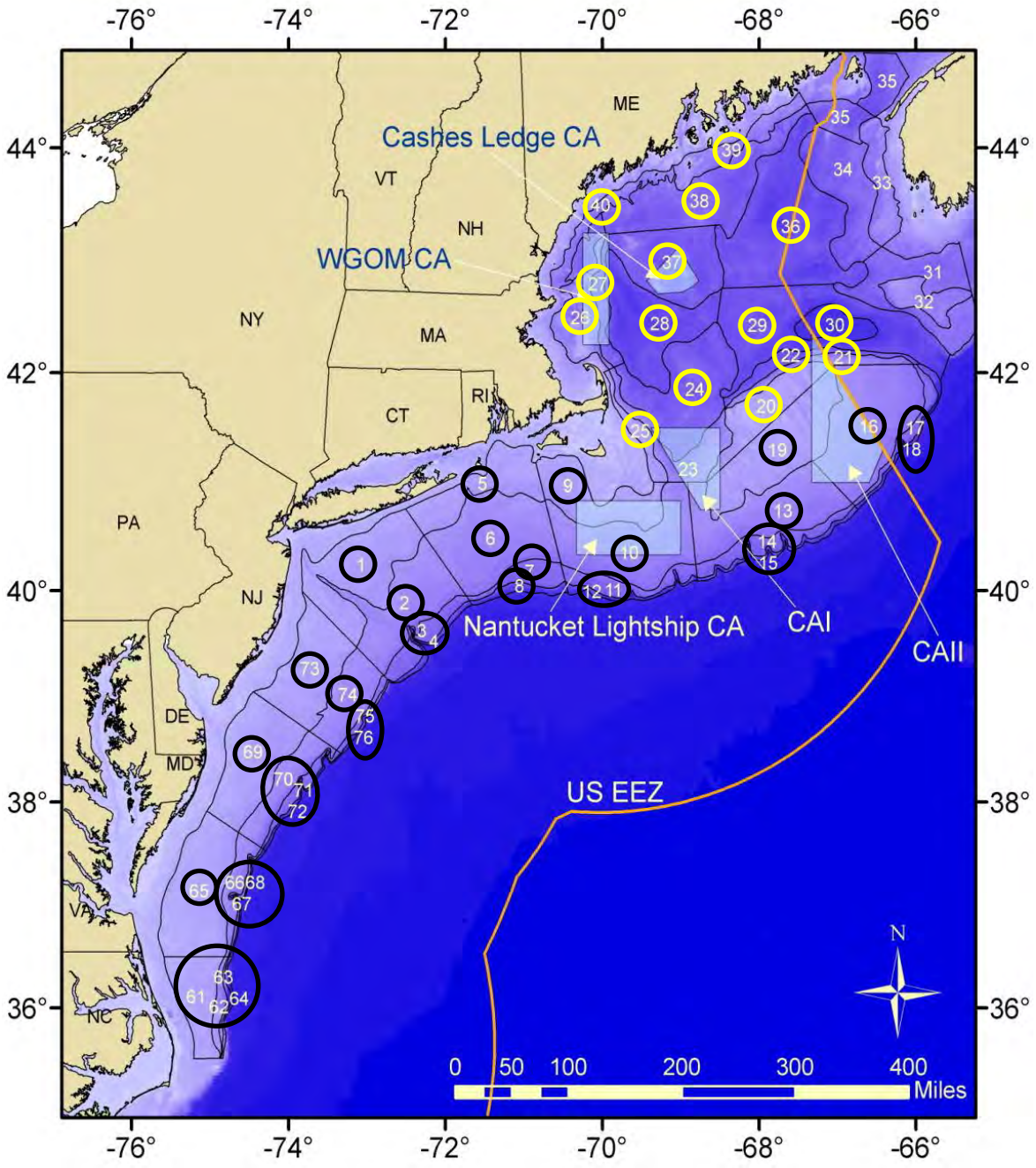
Outline

- Survey Data
- Catch Data
- OFL and ABC measure of uncertainty
    - NEFSC Survey
    - F_{MSY} Reference Point
- Risk Analyses
- Sensitivity Analyses
- Summary
- Red hake Letter
    - Survey coverage
    - Stock Structure

Silver hake Survey Trends



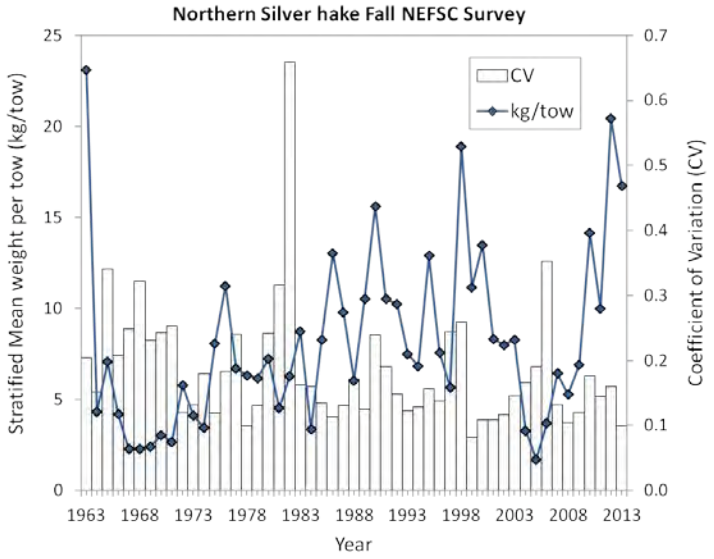
Survey Strata Map

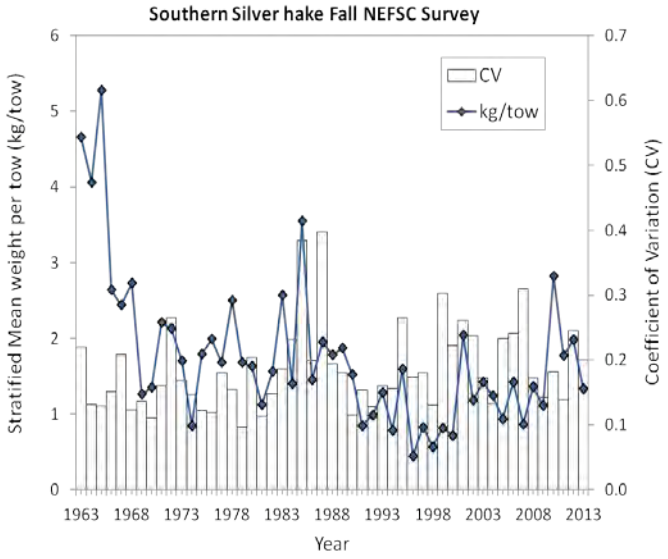


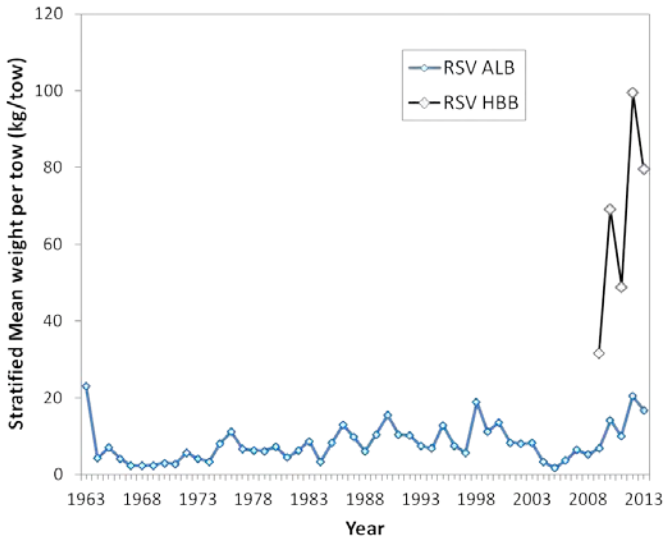
Northern Strata:
20-30, 36-40

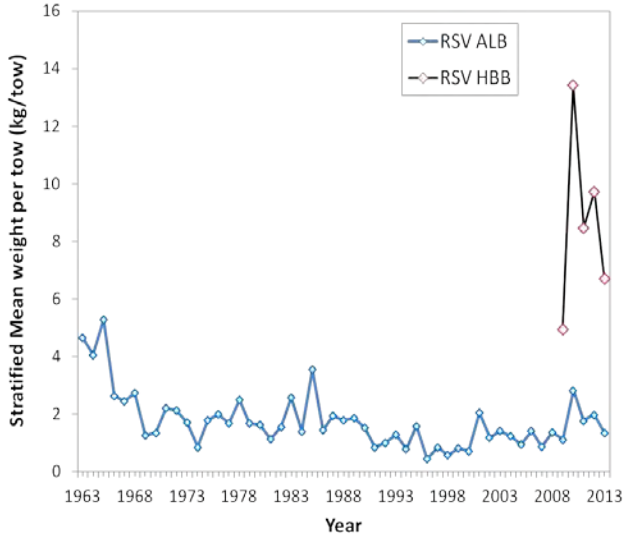
Southern Strata:
01-19, 61-76

Silver hake NEFSC survey trends





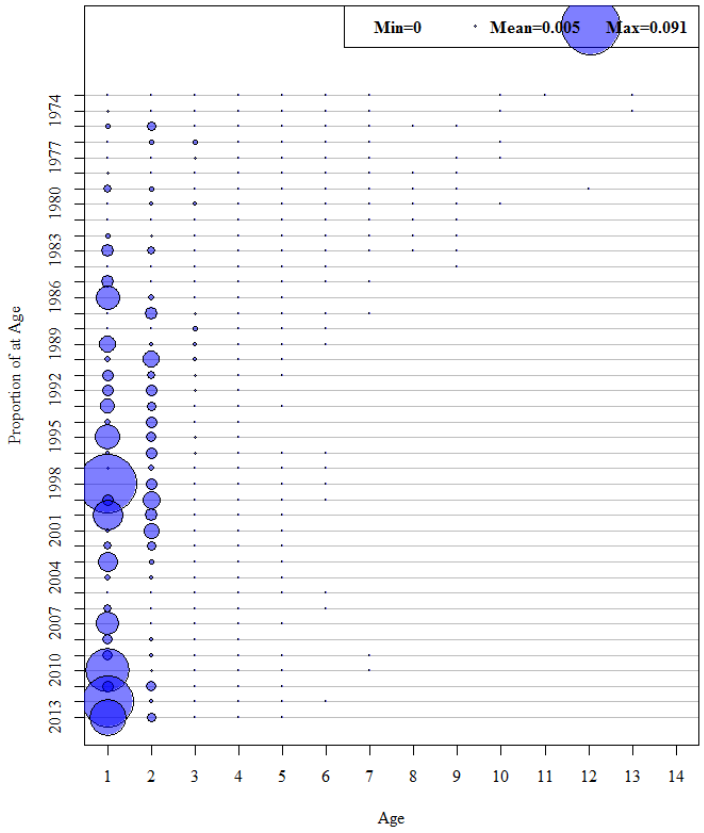




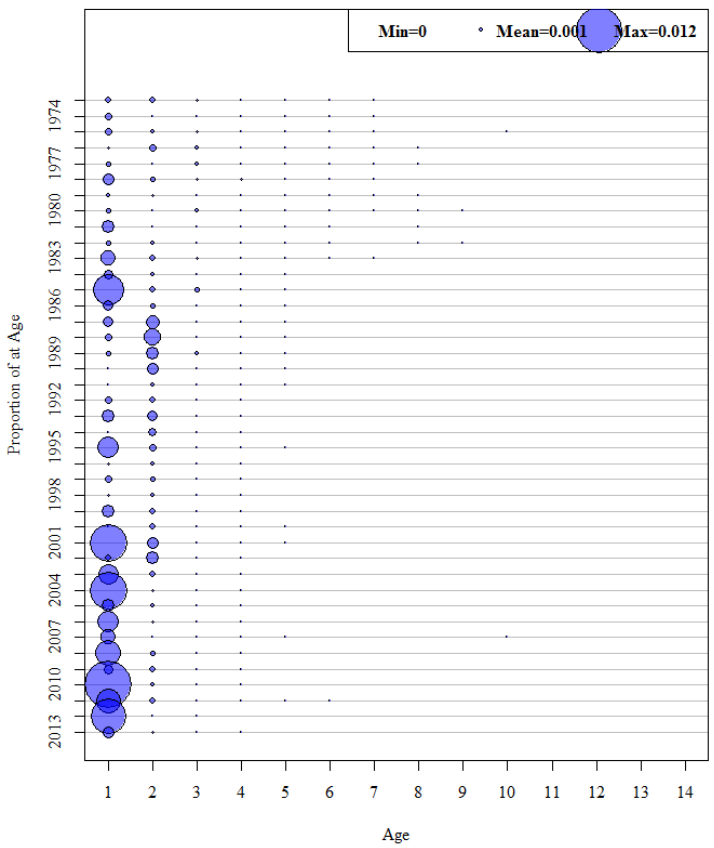
- Length Based Calibration Coefficients were applied
- Numbers at Length were converted to weight using a LW relationship
- The HBB is approx. a factor of 5 in the Spring and a factor of 5-7 in the Fall relative to ALB

Silver hake NEFSC Fall survey Catch-at-age

North



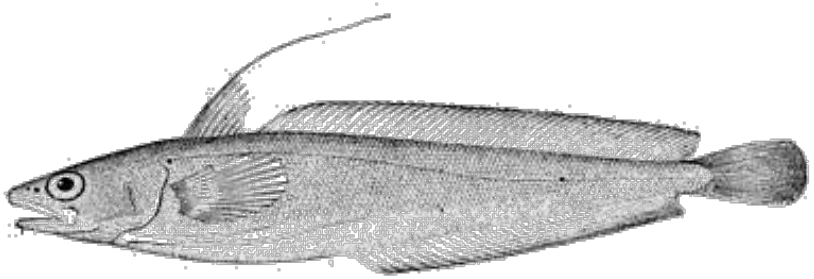
South



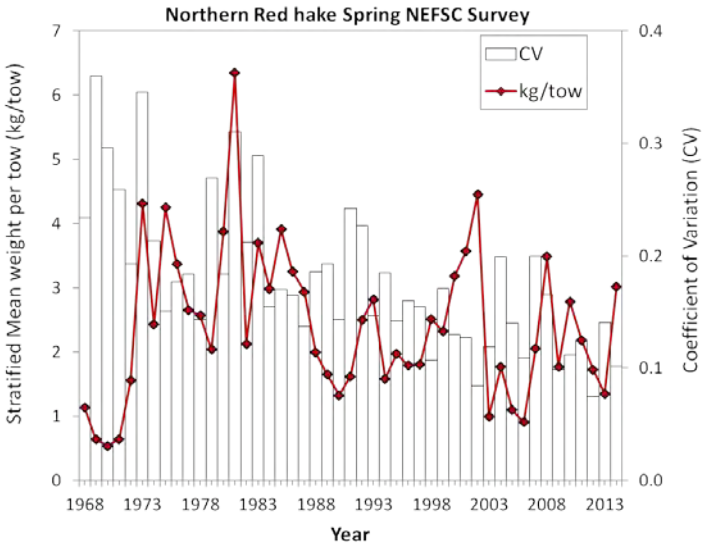
- Strong recruitment in the recent years
- Lack of expansion in age structure
- Predation and Cannibalism could be a factor

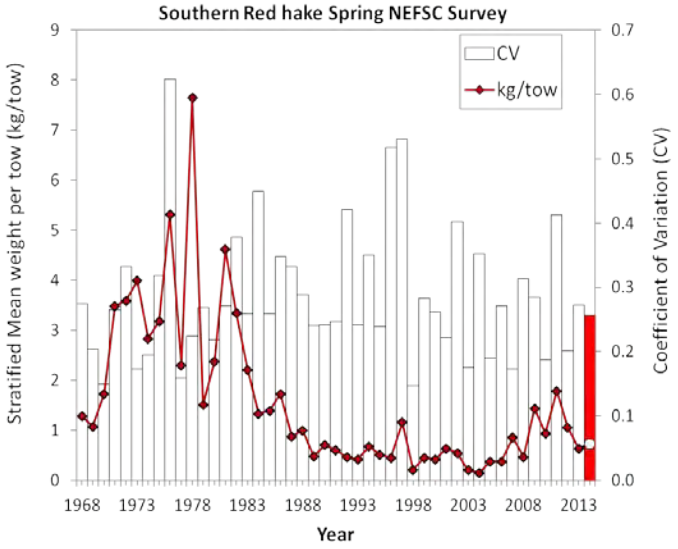
Age1 15-30cm **Age3** 38-45cm **Age5**-6 >45 cm
Age2 31-37cm **Age4** 27-49cm

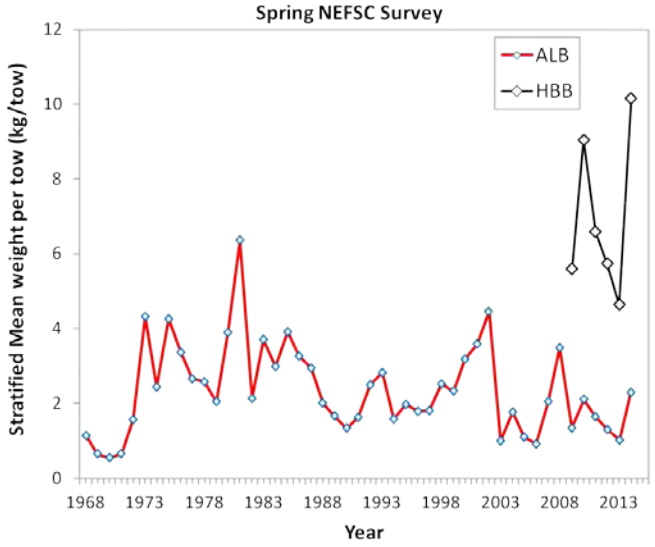
Red hake Survey Trends

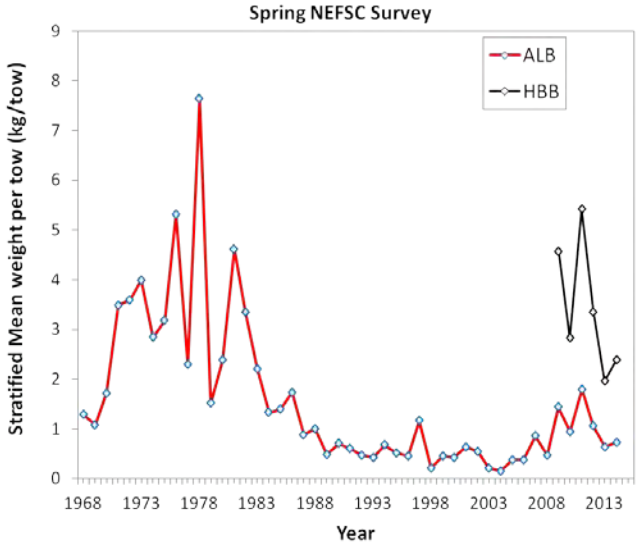


Red hake NEFSC survey trends







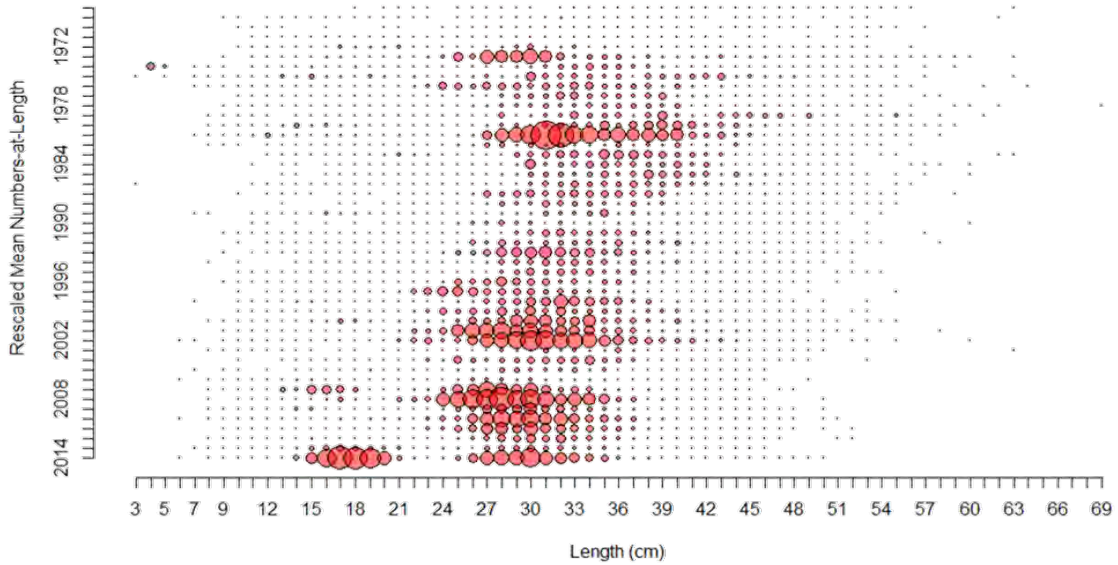


-Decline in the spring survey with the exception of 2014

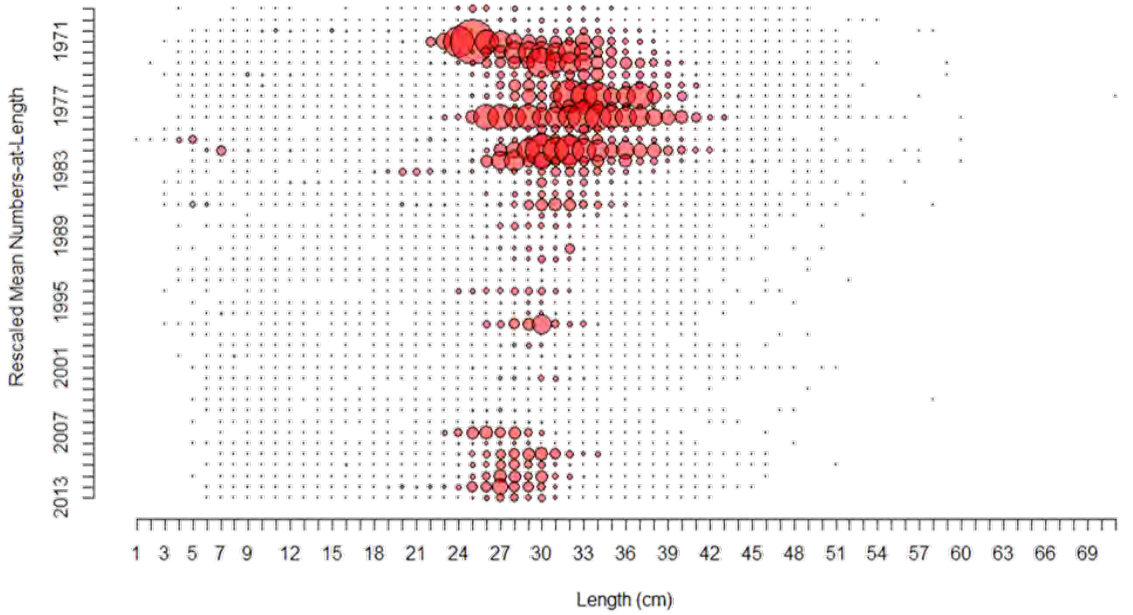
- Approx. factor of 4 in the spring and factor of 2 in the fall (Conv. HBB to ALB)

Red hake Spring Survey Length Composition

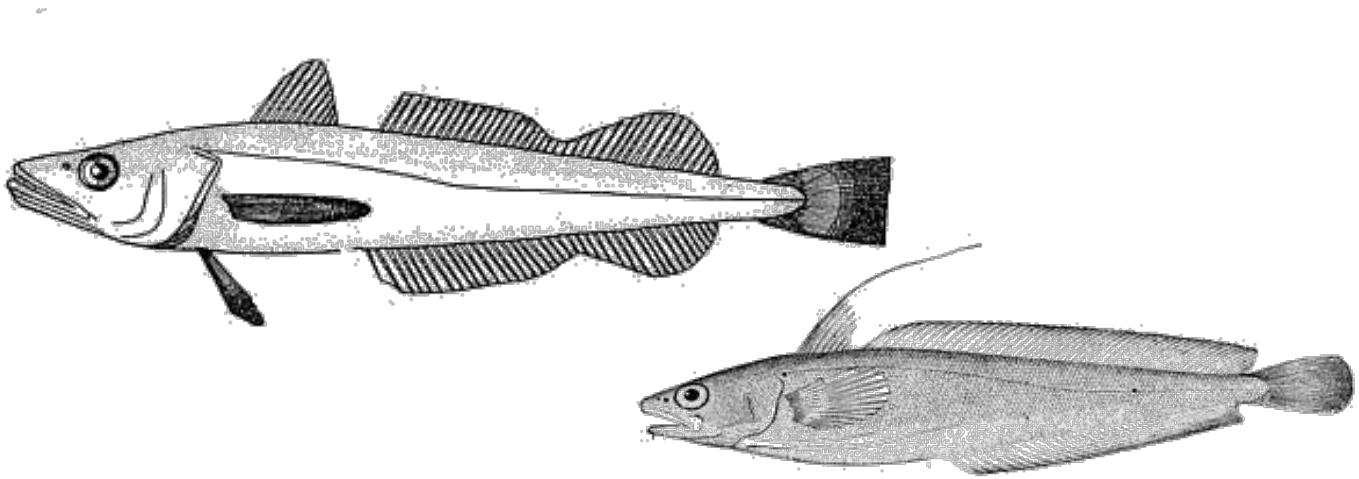
North

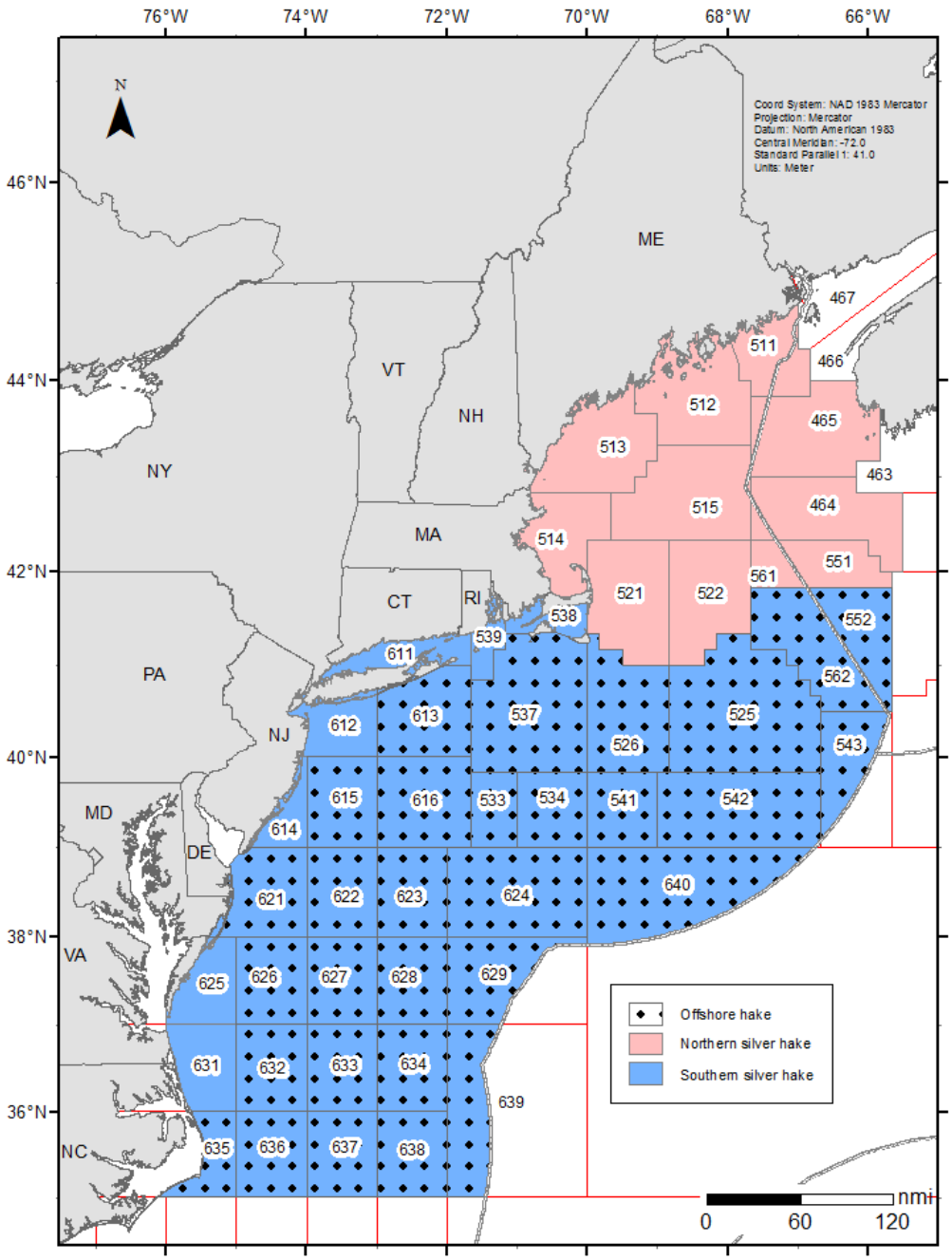


South



Silver and red hake catch Data



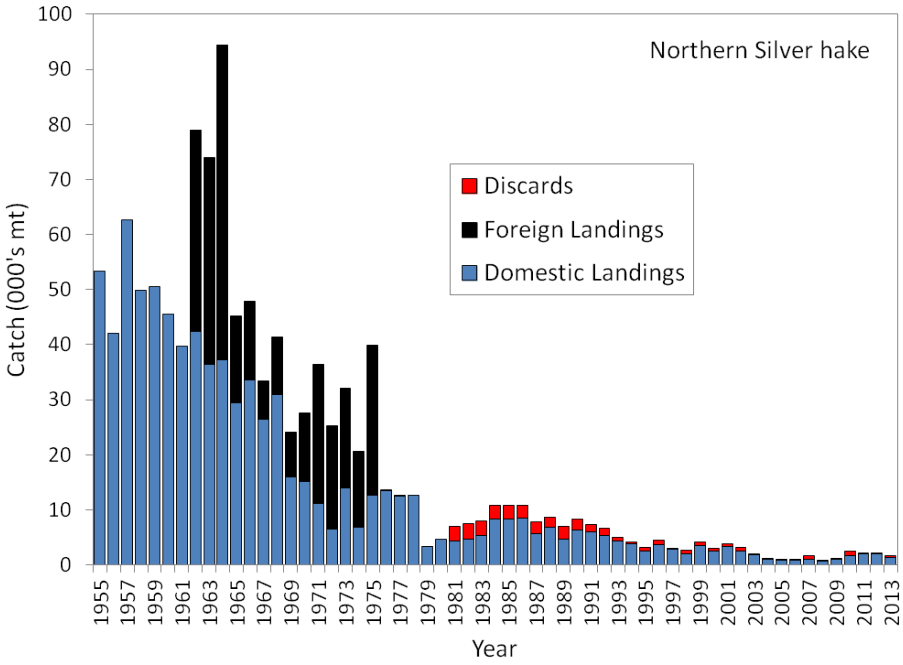


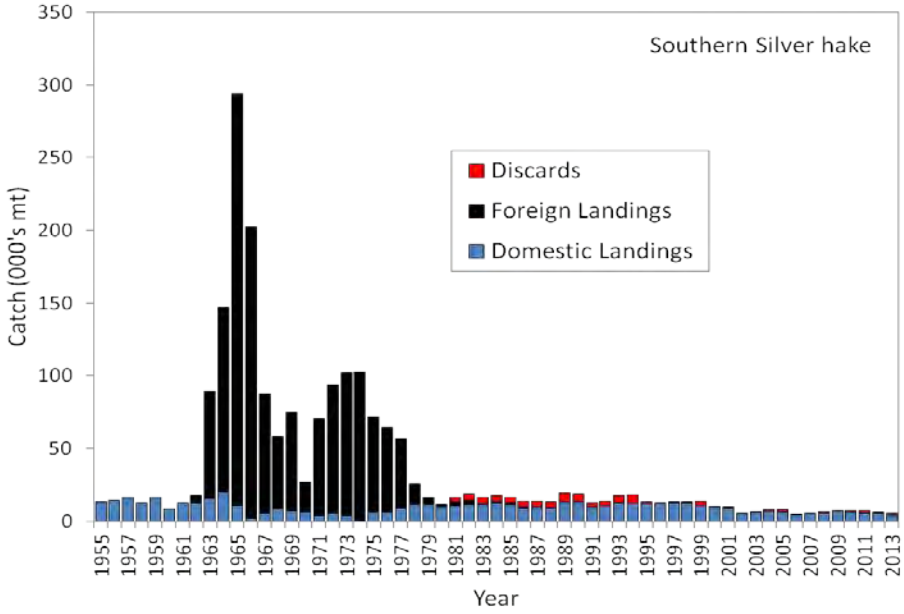
Commercial Statistical Areas

Northern Stock:
512-515, 521-522 and 561

Southern Stock:
525-526, 562, 533-534, 537-539, 541-543, 611-616, 621-623, 625-628, 631-638

Silver hake total catch

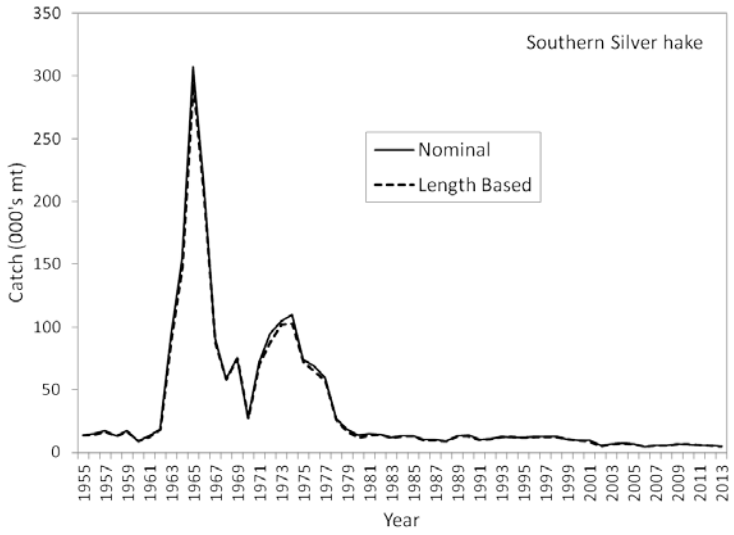


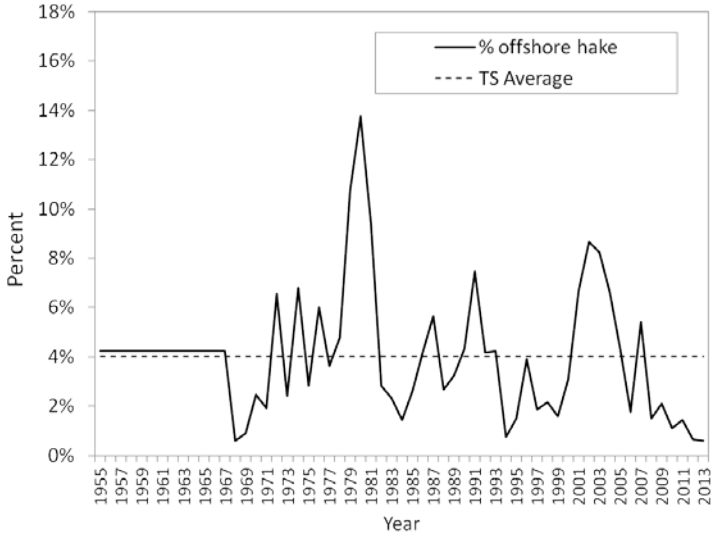


2013 North
Landings: 1,370 mt (85%)
Disc: 250 mt (15%)
Total Catch: 1,620 mt
> 90% landings contributed by Trawl
In recent years

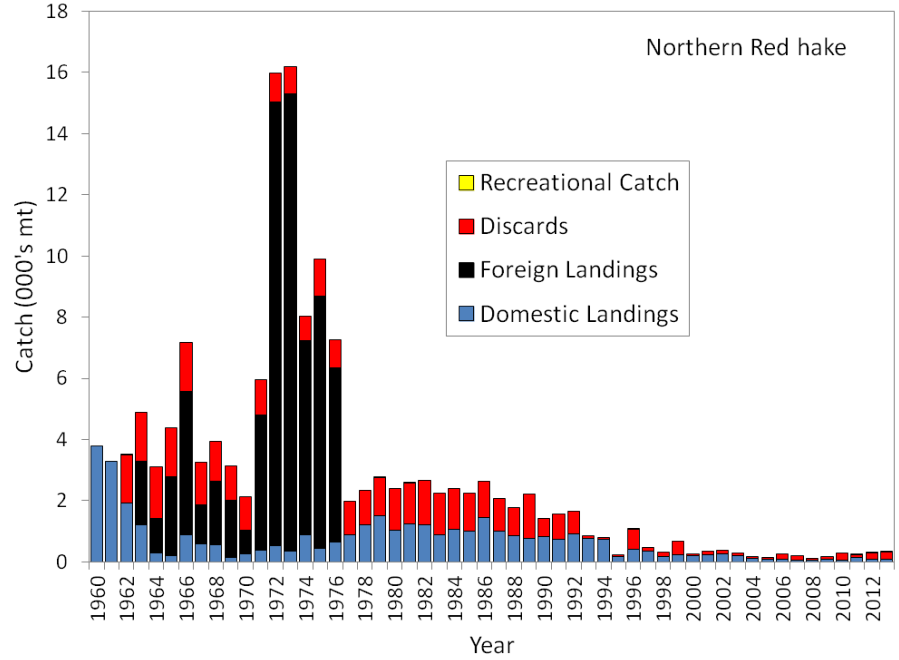
2013 South
Landings: 4,790 mt (88%)
Disc: 640 mt (12%)
Total Catch: 5,420 mt
> 90% of landings are also by trawl fishery in recent years

Percent offshore hake in the ***Southern whiting*** (BOTTOM) derived from the length-based model for years 1955-2013

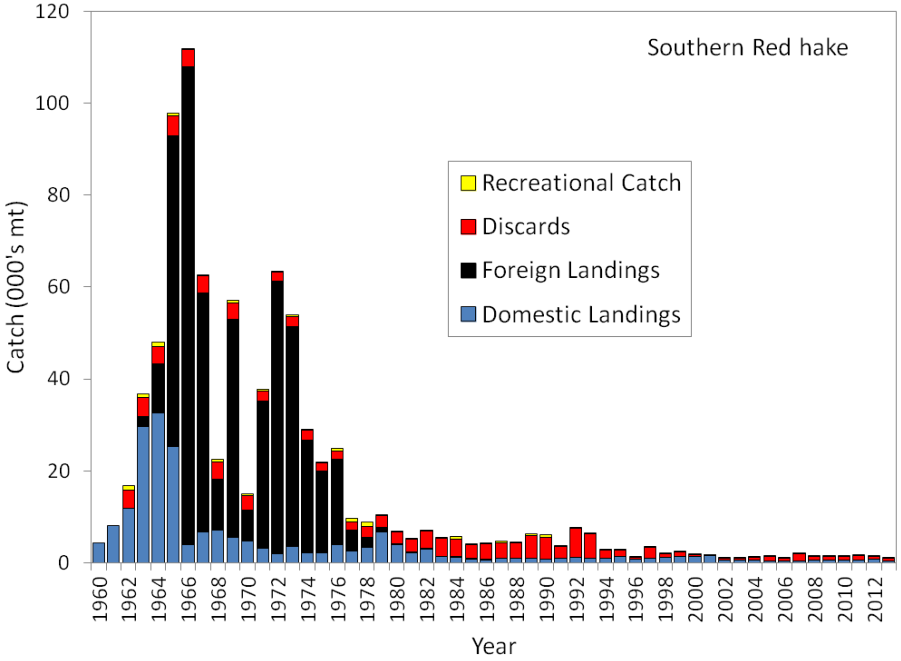




Red hake Total Catch



<u>2013 North</u>
Landings: 95 mt (30%)
Rec: 2.4mt (< 1%)
Disc: 216 mt (69%)
Total Catch: 310 mt
> 90% landings contributed by Trawl
In recent years



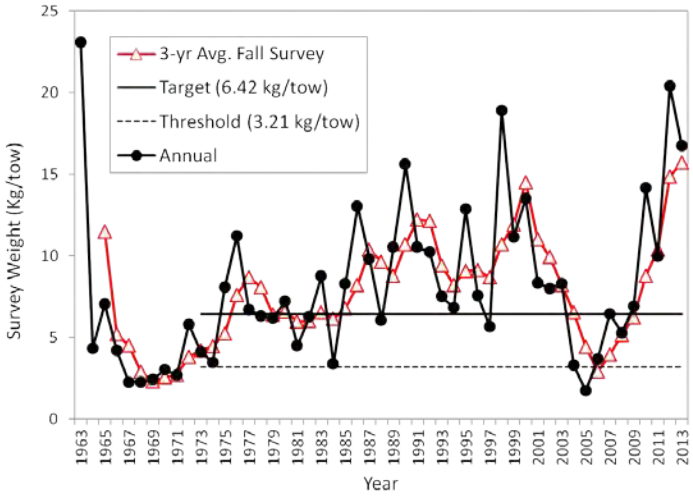
<u>2013 South</u>
Landings: 440 mt (40%)
Rec: 76mt (7%)
Disc: 580 mt (53%)
Total Catch: 1100 mt
> 90% landings contributed by Trawl
In recent years

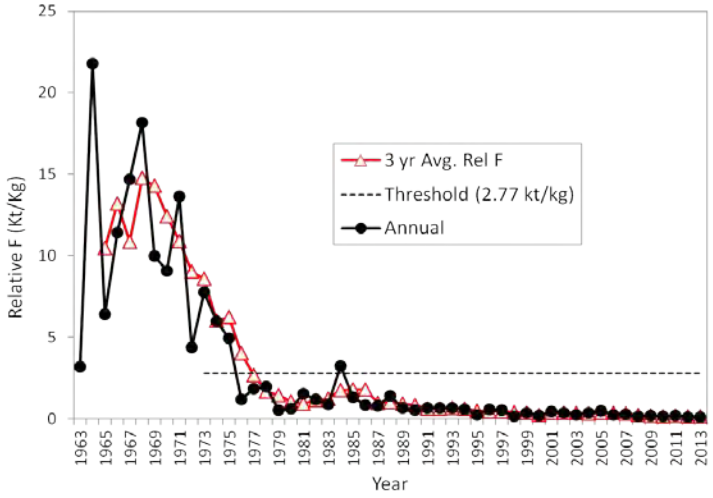
SARC 51 Silver hake Biological Reference Points

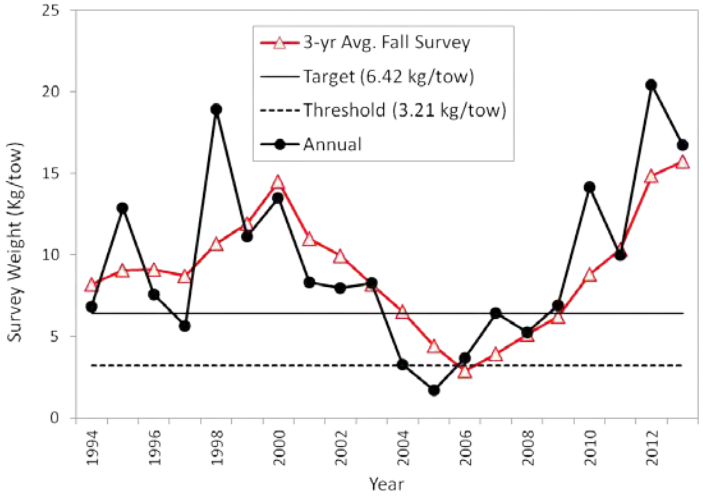
- Lack of ASAP model, the panel recommended the fallback method (Survey Index approach)
- Biomass reference points based on the arithmetic average of fall Survey (1973-1982)
- Exploitation Index is based on ratio b/w total catch and arithmetic fall survey index averaged from 1973-1982

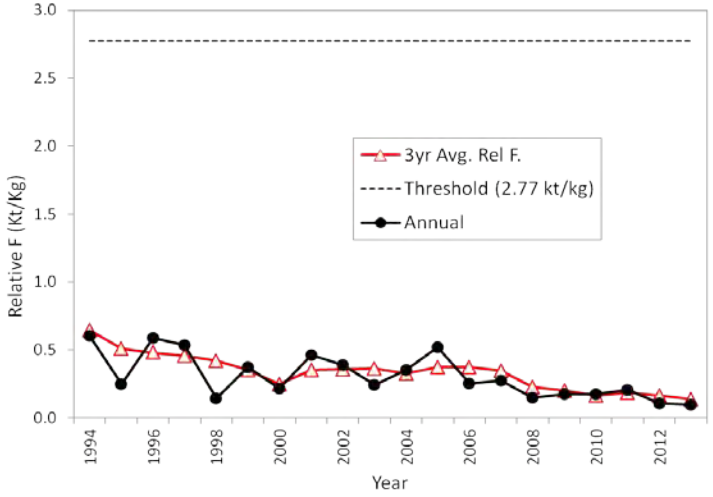
STOCK	THRESHOLDS (SARC 51)	TARGETS(SARC 51)
Northern Silver Hake	1/2 B_{MSY} Proxy (3.21) F_{MSY} Proxy (2.78)	B_{MSY} Proxy (6.42) F_{MSY} Proxy (NA)
Southern Silver Hake	1/2 $_{BMSY}$ Proxy (0.83) F_{MSY} Proxy (34.17)	B_{MSY} Proxy (1.65) F_{MSY} Proxy (NA)

Northern Silver hake Fall Survey Biomass (kg/tow) and Relative Exploitation (kt/kg)

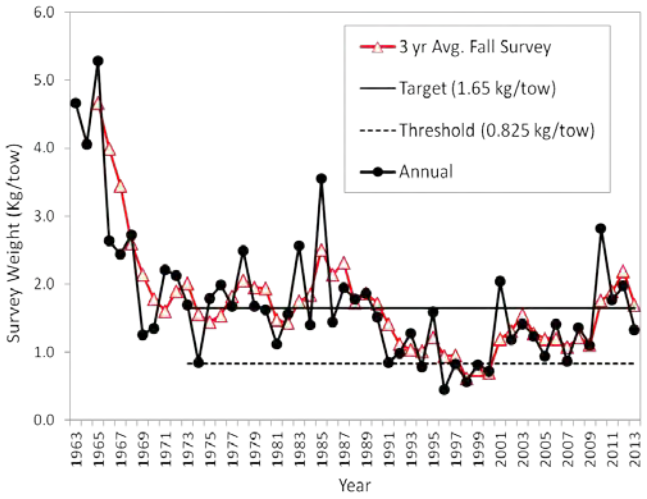


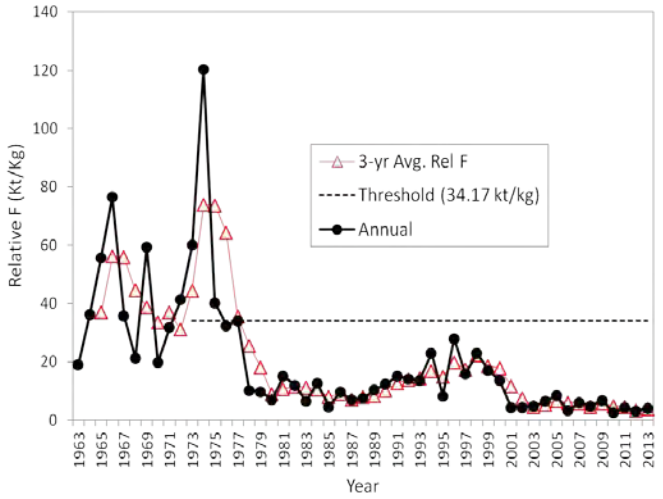


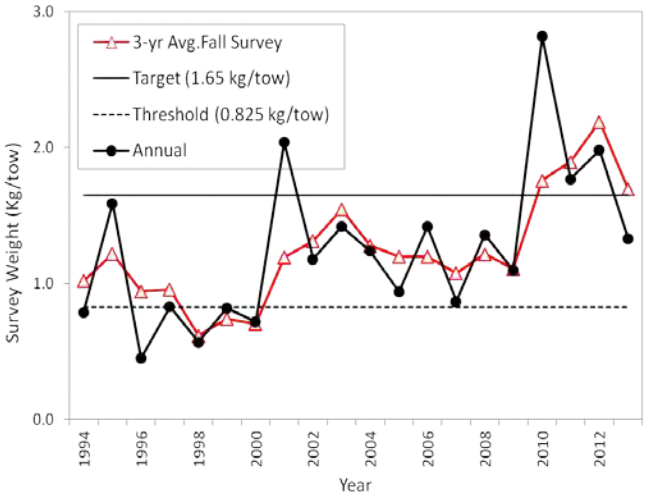


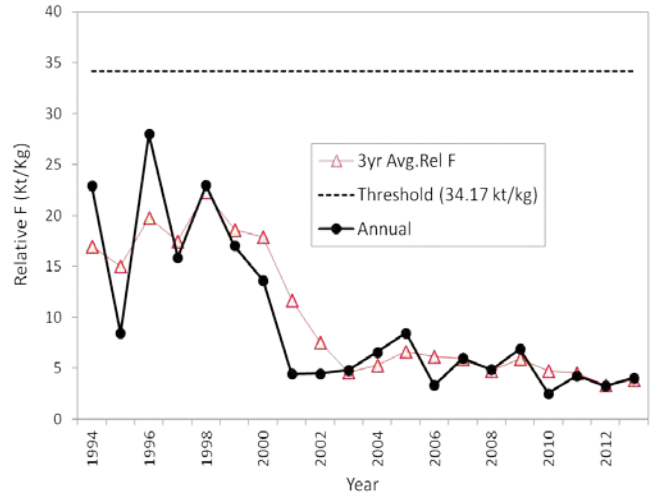


Southern Silver hake Fall Survey Biomass (kg/tow) and Relative Exploitation (kt/kg)







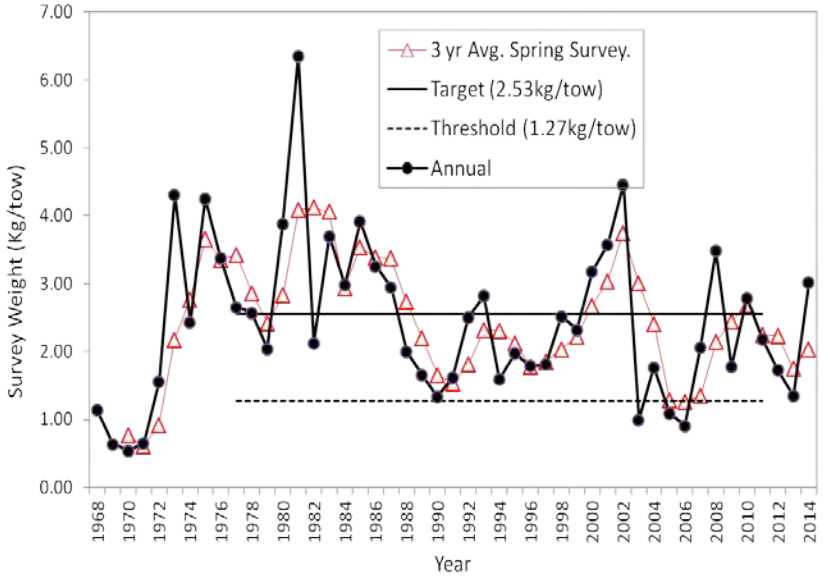


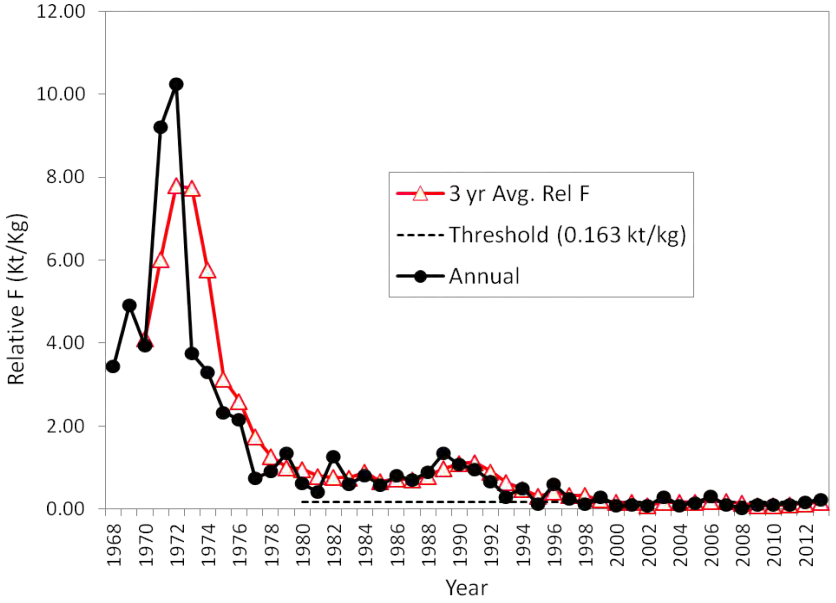
SARC 51 Red hake Biological Reference Points

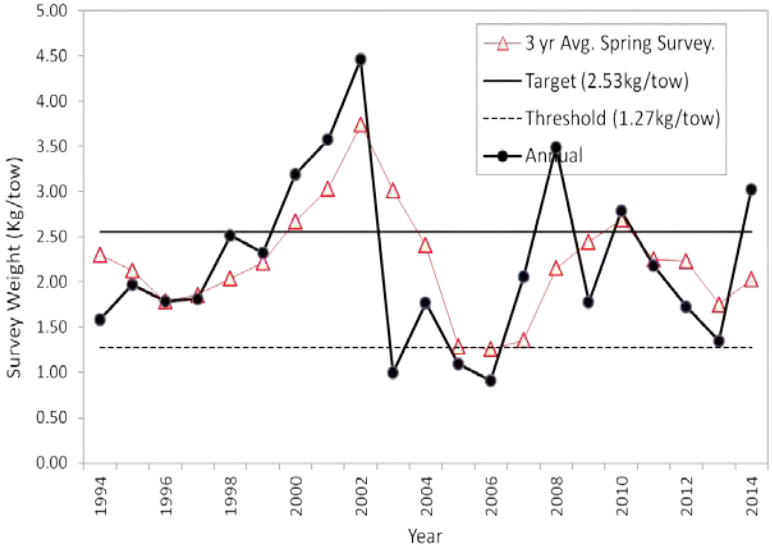
- Lack of adequate model formulations, the panel recommended the “fall back” 3yr Survey Index method
- Biomass reference points based on the arithmetic average of Spring Survey (1980-2010)
- Exploitation Index is based on ratio b/w total catch and Spring survey index from 1980-2009 from AIM analyses

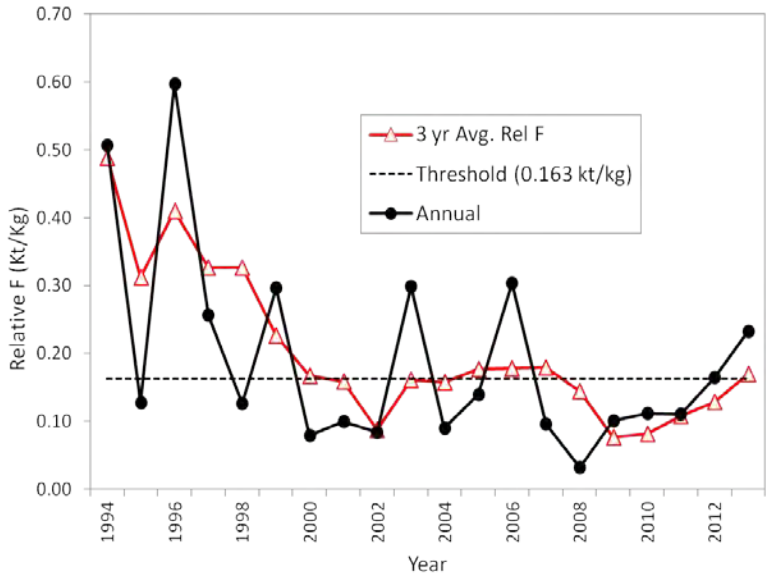
STOCK	THRESHOLDS (SARC 51)	TARGETS(SARC 51)
Northern Red Hake	$1/2B_{MSY}$ Proxy (1.27) F_{MSY} Proxy (0.16)	B_{MSY} Proxy (2.54) F_{MSY} Proxy (NA)
Southern Red Hake	$1/2B_{MSY}$ Proxy (0.51) F_{MSY} Proxy (3.04)	B_{MSY} Proxy (1.02) F_{MSY} Proxy (NA)

Northern Red hake Fall Survey Biomass (kg/tow) and Relative Exploitation (kt/kg)

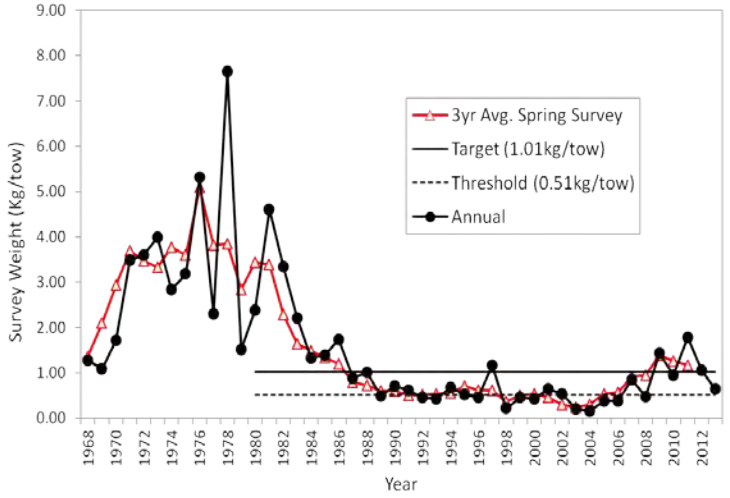


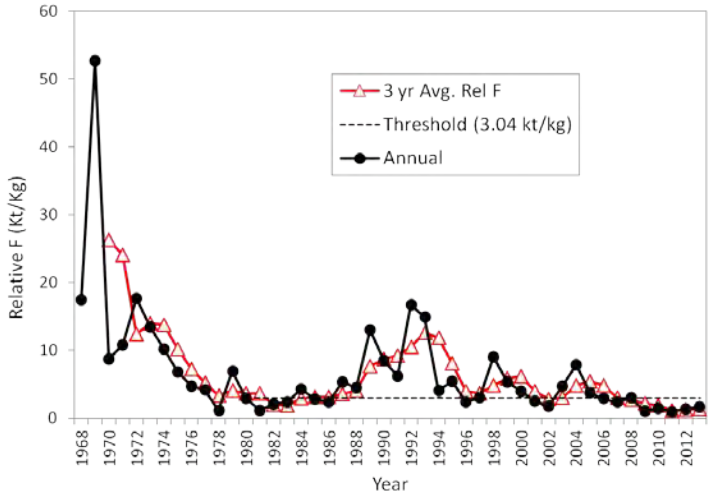


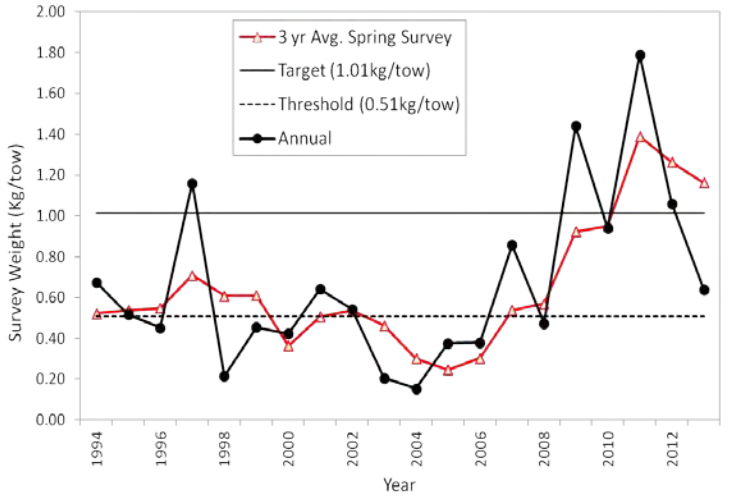


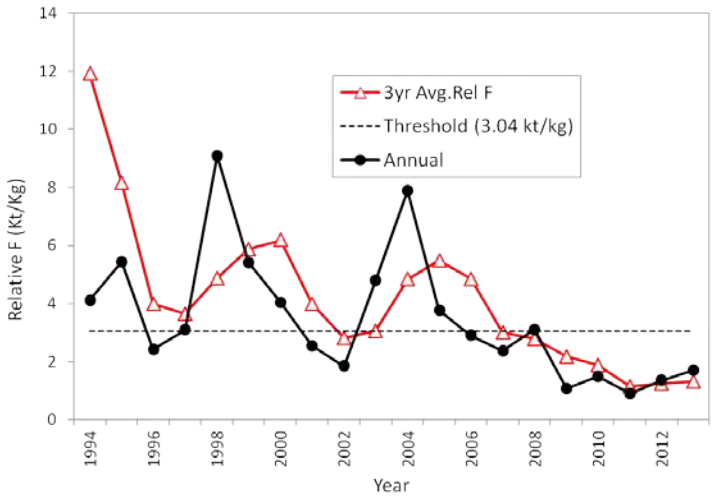


Southern Red hake Fall Survey Biomass (kg/tow) and Relative Exploitation (kt/kg)

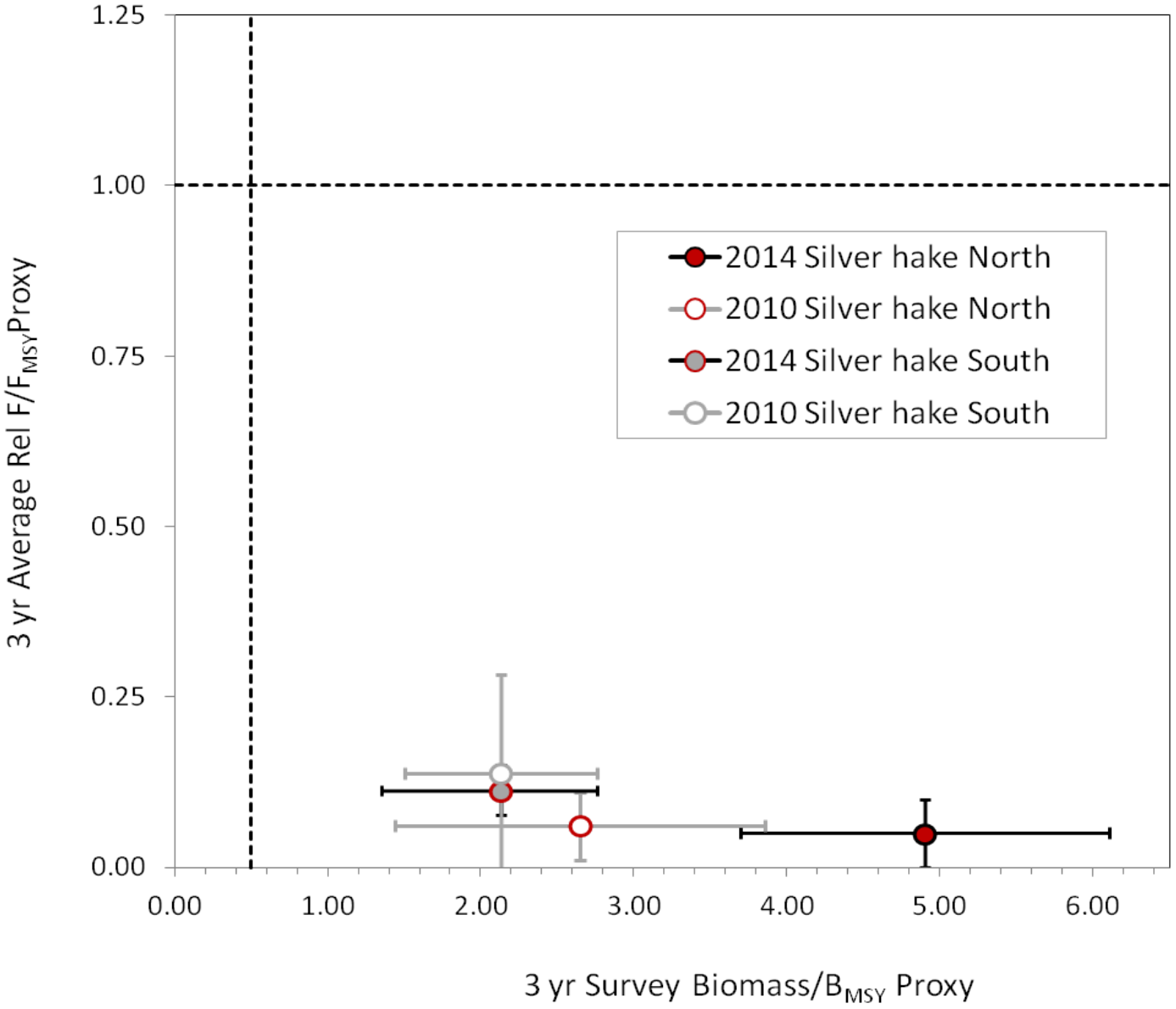




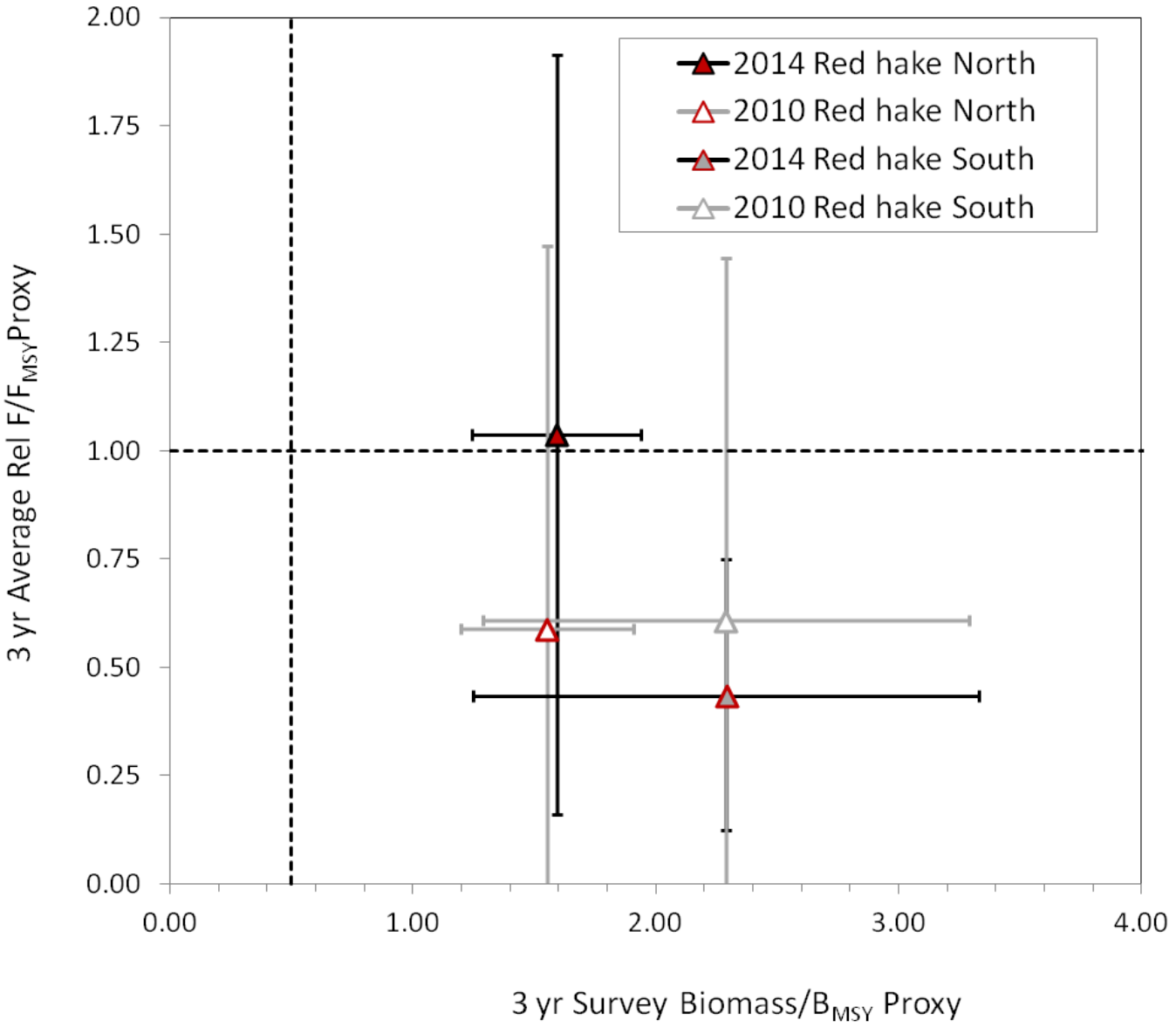




Summary Silver hake Stock Status



Summary Red hake Stock Status



Analytical Frame work for Setting ABCs

Overfishing Level (OFL)

$$OFL \sim I^{S}_{yr1-yr3}(kg)\ x\ F^{S}_{MSY}\ proxy(kt/kg)$$

Where

$$I^{Silverhake}_{2011-2013} = Fall\ Biomass$$

$$I^{\mathrm{Re}dhake}_{2012-2014} = Spring\ Biomass\ North$$

$$I^{\mathrm{Re}dhake}_{2011-2013} = Spring\ Biomass\ South$$

$$F_{MSY}\ proxy\ (silver\ hake) = 1973-1982$$

$$F_{MSY}\ proxy\ (red\ hake) = 1980-2010$$

Estimating Uncertainty in OFL

- Uncertainty in OFL
  - Estimated as a cross product between the uncertainty (i.e. probability distribution) in **F_{MSY} proxy** and the most recent **3-year survey Index**
- Uncertainty in F_{MSY}
  - ***Silver hake***: Mean and variance of the exploitation ratios from 1973-1982 and assumed lognormal error structure
  - ***Red hake***: Based on the bootstrap probability distribution from AIM Model (1980-2010) and assumed a normal error structure

Estimating Uncertainty in OFL cont'd

- Uncertainty in Survey
  - Mean and variance from the most recent three year Survey (2011-2013) in Albatross units
  - Bigelow Survey variance application – Caveat
    - Incorporates conversion factor and variances of conversion factor from the calibration experiment
    - Survey mean weights converted to Albatross equivalent (Length based conversion)
    - Variance derived from constant model as a proxy for length-based estimates (mean weights were fairly similar)

Variance Statistics

$$V(I_{survey}) = V\left[\frac{I_{HBB}^{yr1} + I_{HBB}^{yr2} + I_{HBB}^{yr3}}{3}\right]$$

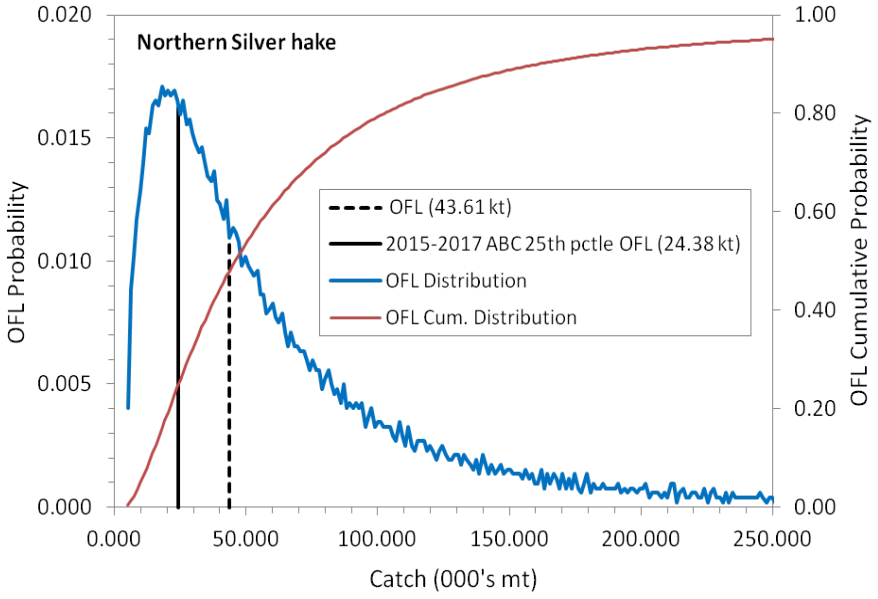
$$V(I_{HBB\rightarrow ALB}^{yr1-yr3}) = \left(\frac{I_{HBB}^{yr}}{\rho}\right)^2\left[\frac{V(I_{HBB}^{yr})}{E(I_{HBB})^2} + \frac{V(\rho)}{E(\rho)^2}\right]$$

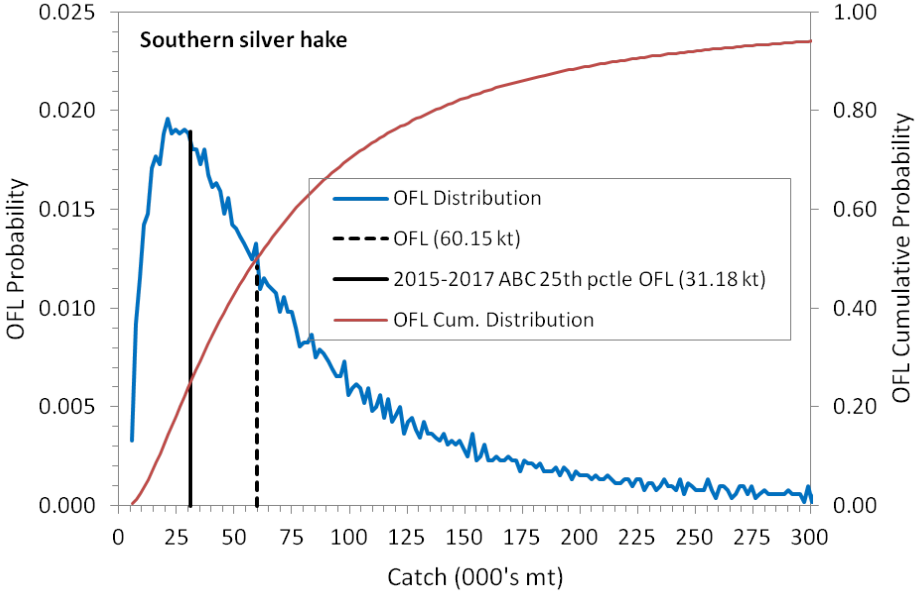
$$V(\mathrm{Re}lF) = \left(\frac{E(C)}{E(I)}\right)^2\left[\frac{V(C)}{E(C)^2} + \frac{V(I)}{E(I)^2} - \frac{2Cov(C,I)}{E(C)E(I)}\right] \text{.....} Alternative$$

$$V(\mathrm{Re}lF) = \frac{\sum_{yr1}^{yr(n)}\left(\frac{C}{I} - \left(\frac{C}{I}\right)\right)^2}{n-1} \text{ (basis for update)}$$

$$V(OFL) = V(\mathrm{Re}lF, I_{Survey}) \text{ cross product}$$

Proposed OFL and ABC for Northern and Southern Silver hake





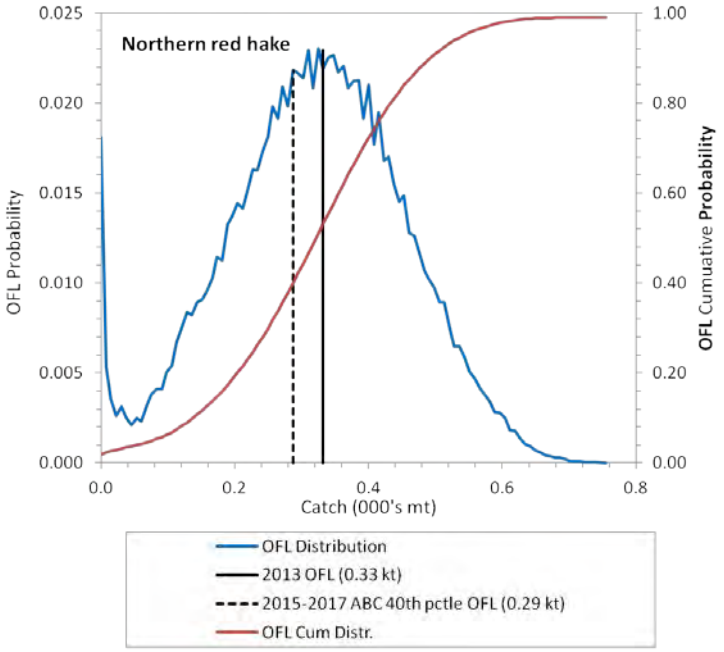
North

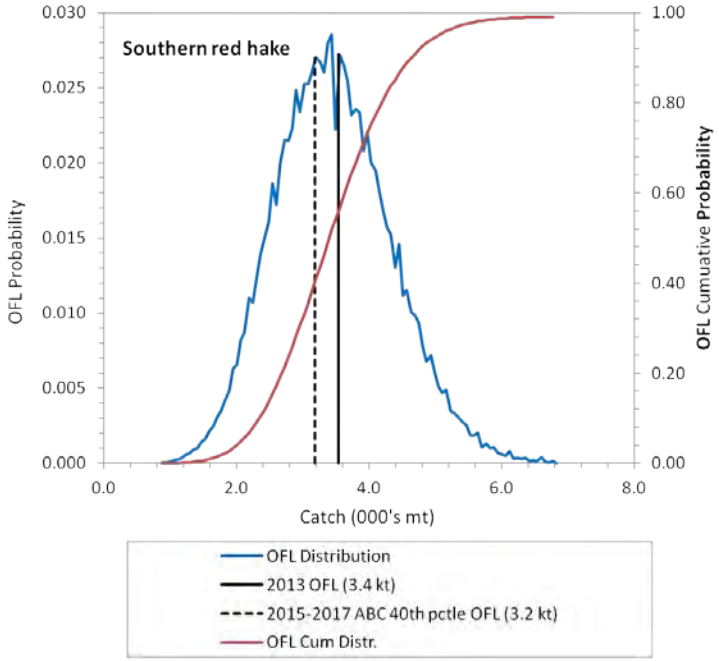
Pctile of OFL	Catch (kt)	% of 2014 OFL (45.87 kt)	% of 2013 Catch	Prob. ($F > FMSY_{Proxy}$)
5	9.96	22%	576%	0%
10	13.83	30%	799%	0%
20	20.85	45%	1205%	0%
25	**24.38**	**53%**	**1409%**	**0%**
30	28.05	61%	1621%	0%
40	36.19	79%	2092%	4%
45	40.79	89%	2358%	25%
50	**45.87**	**100%**	**2652%**	**68%**
60	58.33	127%	3372%	99%
70	75.43	164%	4360%	99%
80	102.58	224%	5929%	99%

South

Pctile of OFL distr.	Catch (kt)	% of 2014 OFL (59.69 kt)	% of 2013 Catch	Prob. ($F > FMSY_{Proxy}$)
5	12.34	21%	215%	0%
10	17.39	29%	302%	0%
20	26.55	44%	462%	0%
25	**31.18**	**52%**	**542%**	**0%**
30	36.05	60%	627%	0%
40	46.81	78%	814%	4%
45	52.97	89%	921%	27%
50	**59.69**	**100%**	**1038%**	**56%**
60	76.23	128%	1326%	97%
70	99.47	167%	1730%	99%
80	136.27	228%	2370%	99%

Proposed OFL and ABC for Northern and Southern Red hake





North

Pctile of OFL	Catch (kt)	% of 2014 OFL (0.322 kt)	% of 2013 Catch (0.364 kt)	Prob. ($F > FMSY_{Proxy}$)
5	0.077	24%	21%	0%
10	0.137	43%	38%	0%
20	0.204	63%	56%	0%
25	0.228	71%	63%	0%
30	0.250	78%	69%	0%
35	0.269	84%	74%	0%
40	**0.287**	**89%**	**79%**	**6%**
45	0.305	95%	84%	17%
50	**0.322**	**100%**	**88%**	**37%**
60	0.356	111%	98%	78%
70	0.392	122%	108%	95%
80	0.433	135%	119%	99%

South

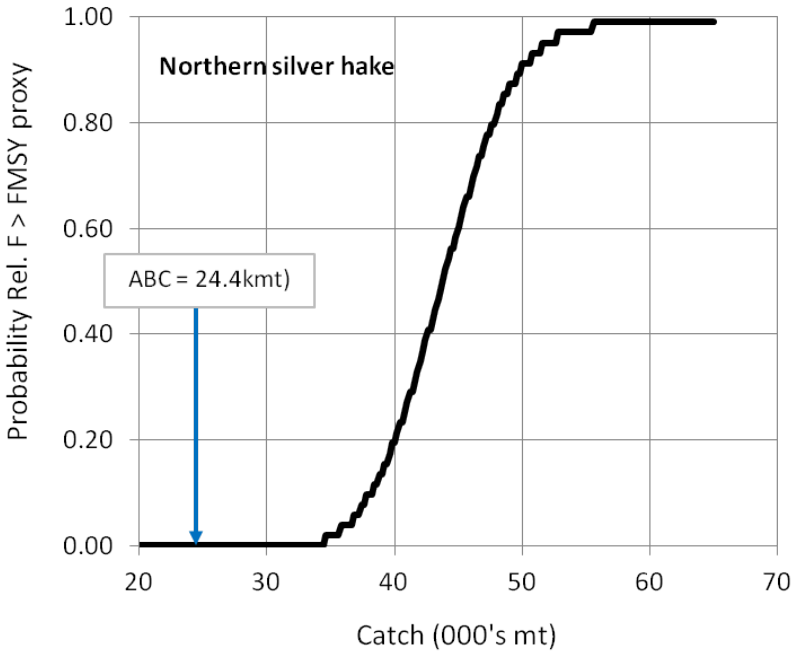
Pctile of OFL	Catch (kt)	% of 2014 OFL (3.40 kt)	% of 2013 Catch (1.10 kt)	Prob. ($F > FMSY_{Proxy}$)
5	2.08	61%	189%	0%
10	2.34	69%	213%	0%
20	2.68	79%	244%	10%
25	2.82	83%	257%	14%
30	2.95	87%	268%	17%
35	3.07	90%	279%	23%
40	**3.18**	**93%**	**289%**	**29%**
45	3.29	97%	299%	35%
50	**3.40**	**100%**	**309%**	**41%**
60	3.63	107%	330%	54%
70	3.88	114%	353%	68%
80	4.19	123%	381%	82%

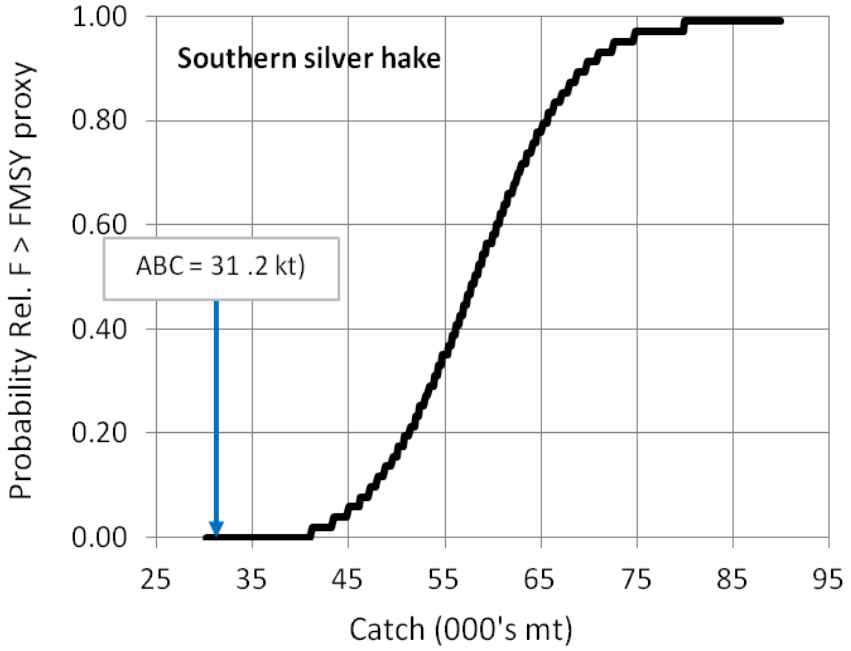
Risk Analyses

- Defined as the probability of exceeding of F_{MSY} proxy given the current population Index (Two step process):
- Calculated corresponding Rel. F for each survey realization from the survey cum. distribution.
  - Corresponding Rel F= (OFLcurrent/Index_distr)

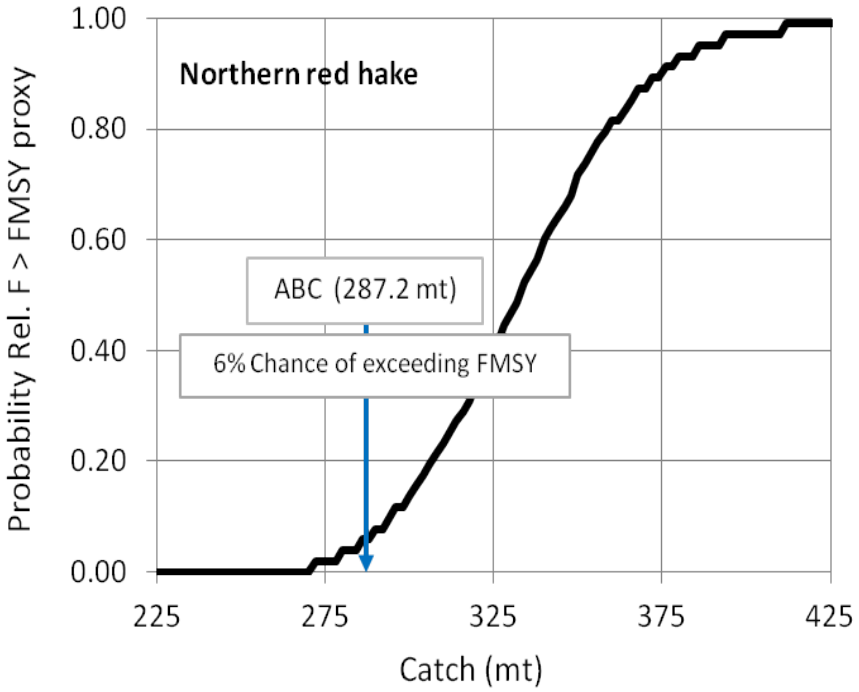
- The Probability of Rel. F for a given catch exceeding F_{MSY} proxy is a function of two probabilities:
  - Probability of each survey realizations
  - Probability of each corresponding Rel F of exceeding F_{MSY} proxy computed over a range of catch

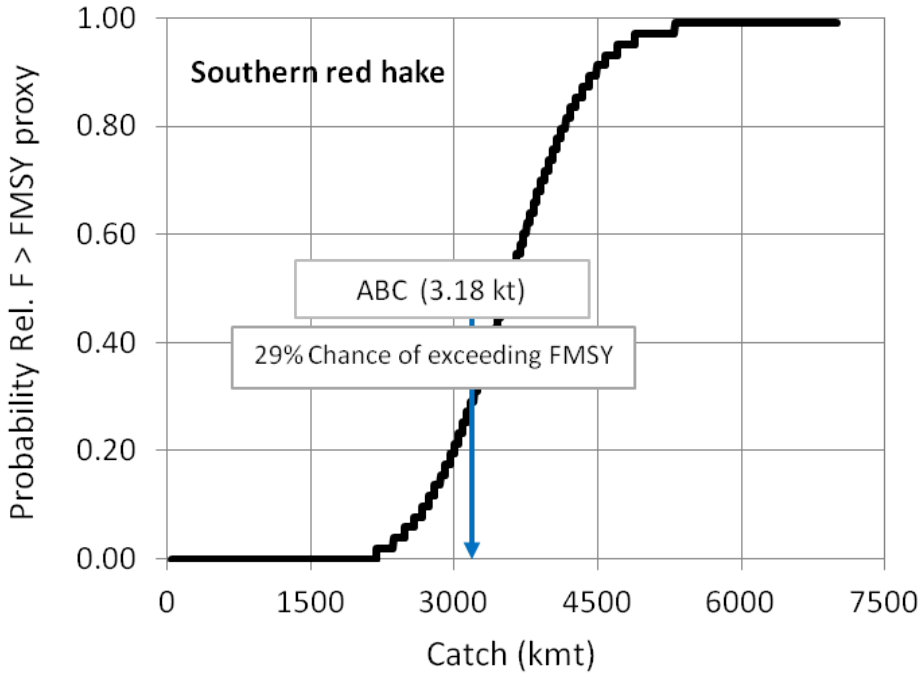
Silver hake: Probability of exceeding F_{MSY} Proxy





Red hake: Probability of exceeding F_{MSY} Proxy





Summary_Silver Hake

- Stock status for both stocks of silver hake continues to improve with increasing trends in the population
- The proposed OFL suggest that both stocks can withstand higher level of catches with minimal risk of exceeding FMSY proxy
- Catch remain a source of major uncertainty for silver hake as implied in the OFL estimates. Lacks contemporary measures of stock productivity

Summary_Red Hake

- For red hake, catches continue to increase, dominated by discards in the fishery due to little market demand.
- Although red hake appears to show signs of an incoming year class in 2014 in the north, prior years have shown a declining trend.
- The proposed ABC suggests a low risk of exceeding the overfishing limit, should the population remain at current levels
- Catches have been at or above ABC in recent years, likely explaining the poor response to population growth in the north.
- It would be premature to infer the strength of the 2014 YC until verified by additional years of survey sampling
- In the south, red hake population has also shown a declining trend. Catches has also increased; also dominated by discards.
- Recruitment has been poor over the last two decades and should the this trend continue into the future, the population will likely decline.

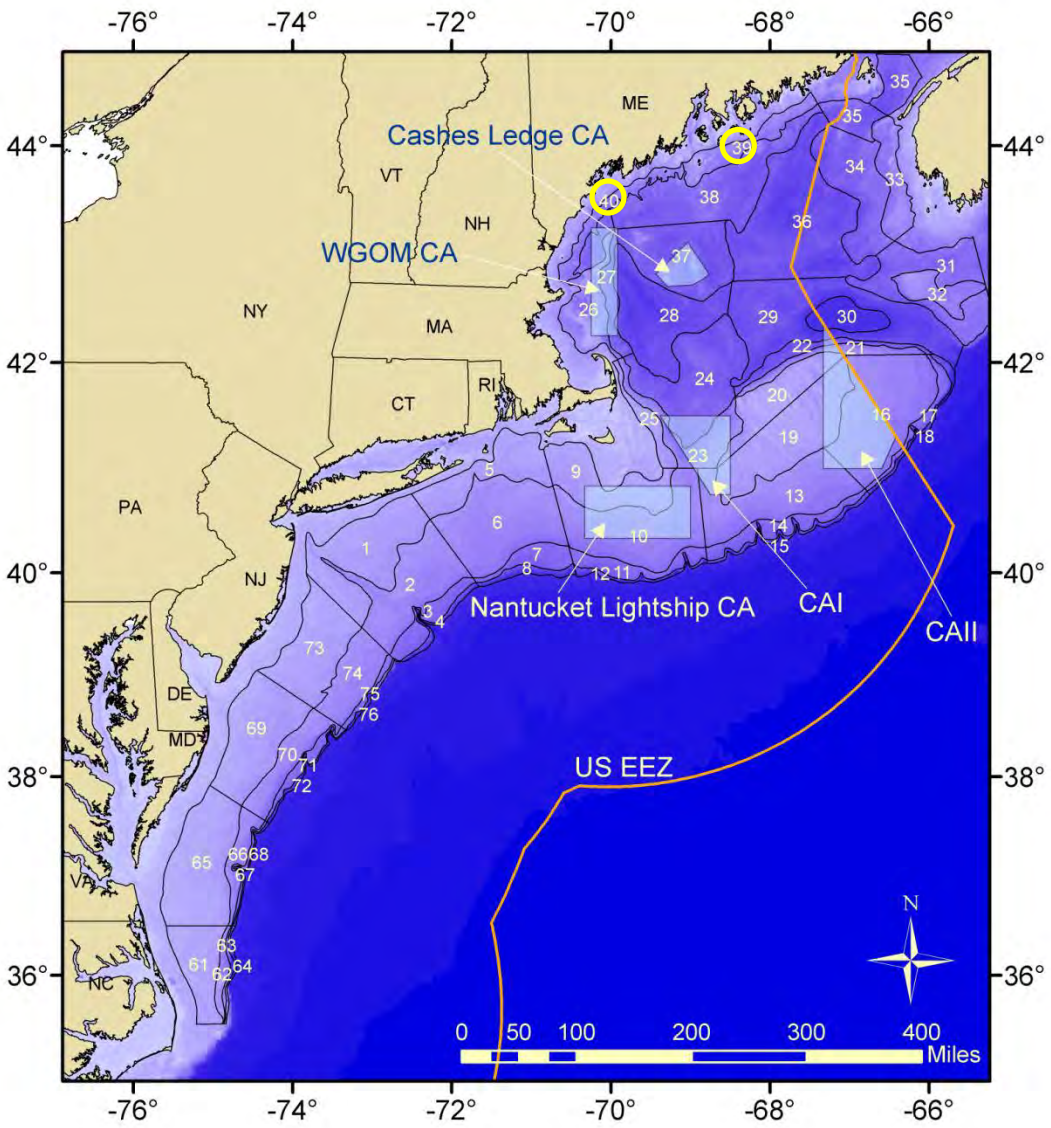
Red hake letter - August 18th 2014

- Addressed to the SSC, PDT and Council members
- Concerns regarding northern red hake stock
- Two Main Issues
  - Representativeness of Survey Coverage
    - Particularly the inshore region with Commercial Fixed gear (lobster traps)
  - Stock Structure
    - Migration
  - Two Recommendations
    - Fixed gear management for sampling purposes
    - Basis for setting ABC

NEFSC Bottom Trawl Survey

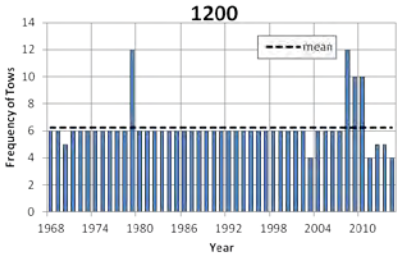
- Inshore GOM is one of our most difficult regions to sample
  - Bad bottom and lobster gear
- Lobster gear interferes with our ability to sample in GOM
  - Particularly in Strata 39 and 40 (See Map)
- The effect on northern red hake is not well known. The fraction of positive tows has been steadily increasing since the early 1990s.
- Presence of fixed gear does make it challenging to sample in these strata. Occasionally we are forced to move to alternate stations due to time constraints. The frequency of these moves can be quantified.
- Last 2010 Benchmark – State inshore surveys were explored to evaluate the utility of these survey for the red hake benchmark assessment (i.e. MassDMF and MENH).

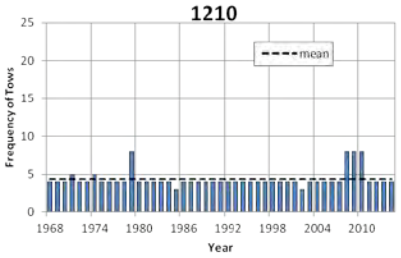
NEFSC groundfish bottom trawl survey

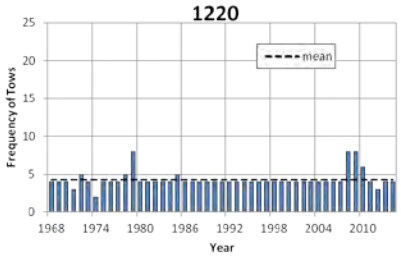


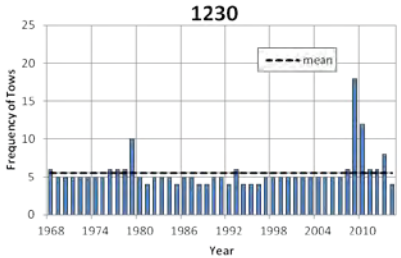
NEFSC Spring BTS (1968-2014) based on red hake Strata 20-40

N.GBK

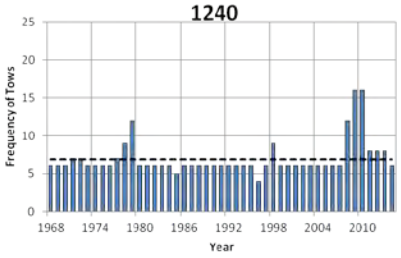


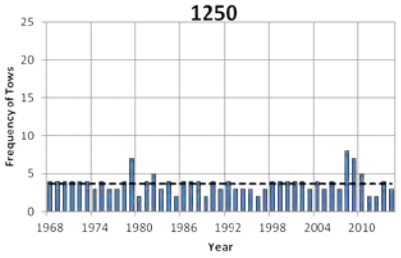


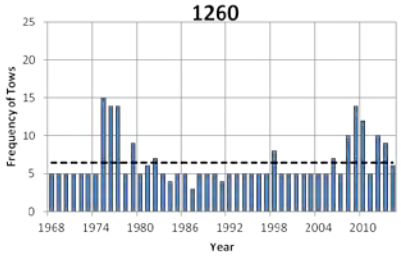


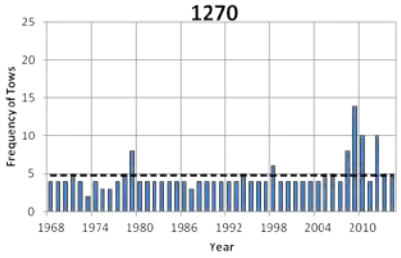


W.GOM

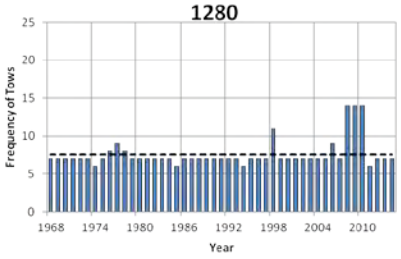


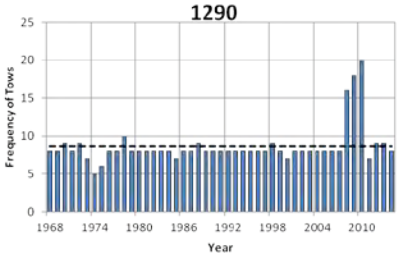


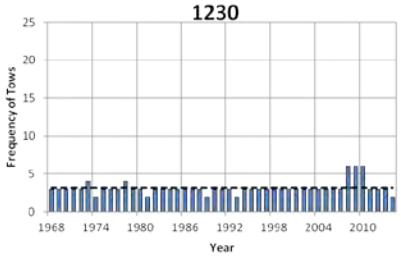


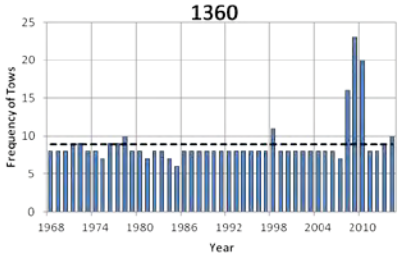


E. GOM

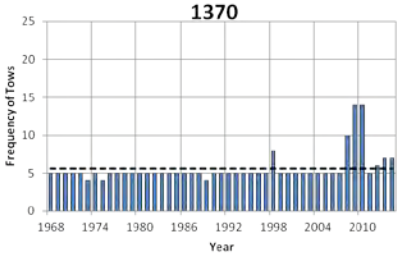


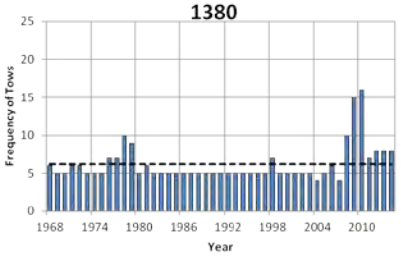


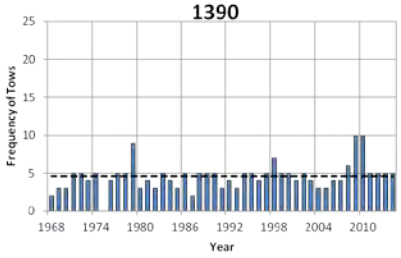


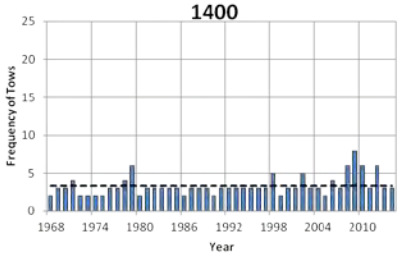


Cent. & NW GOM

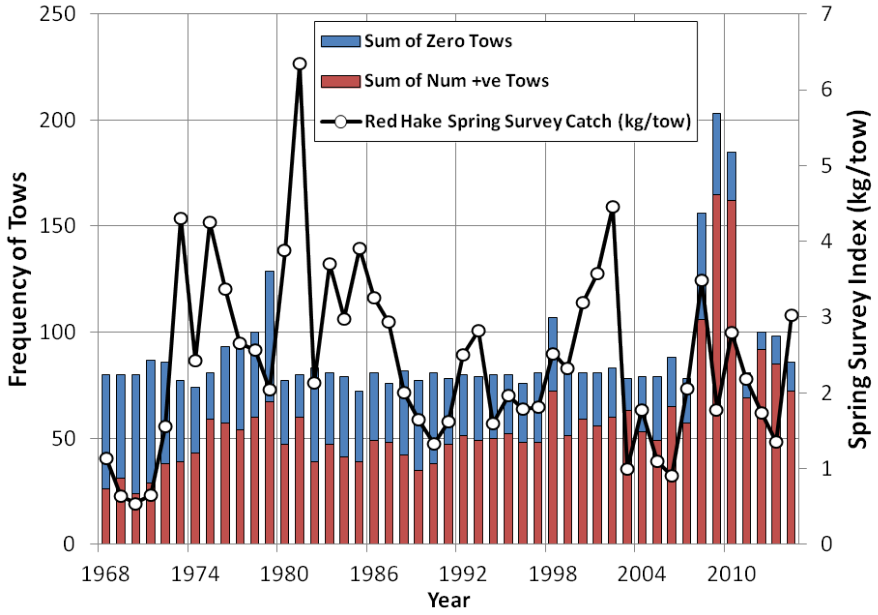


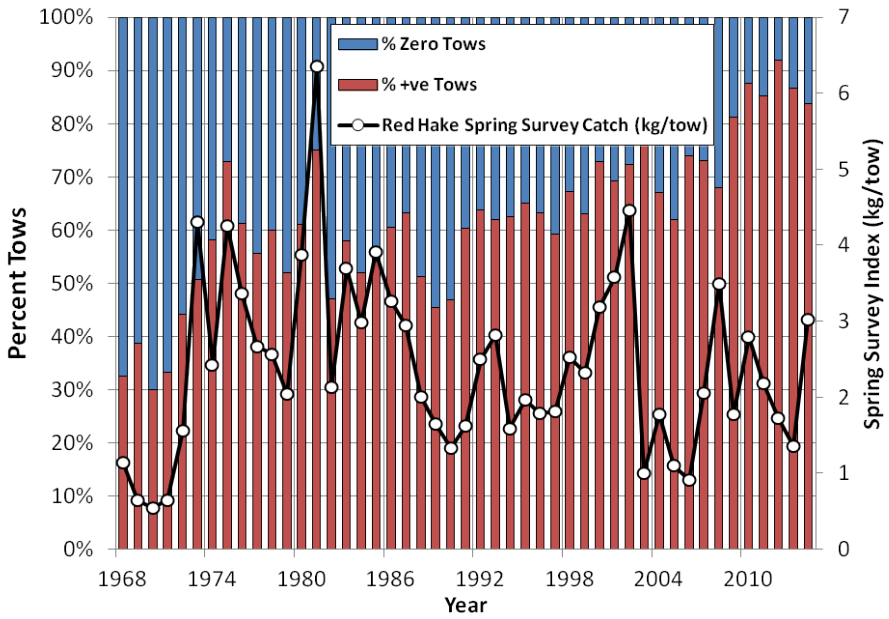




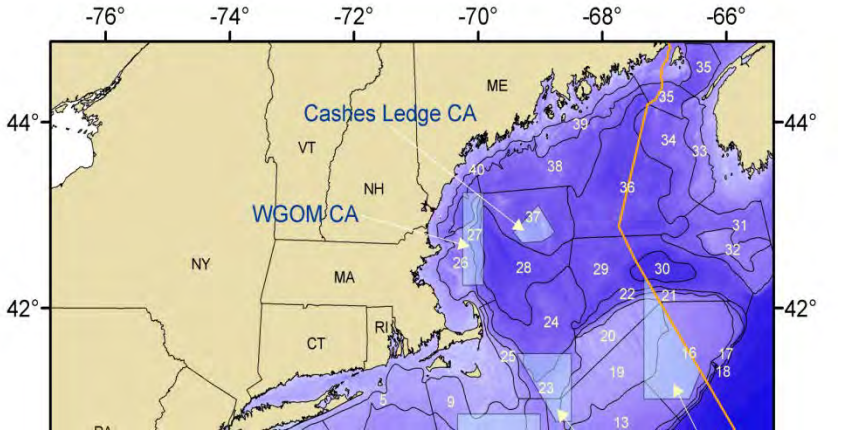


Proportion +ve Red hake tows vs. Survey Catch

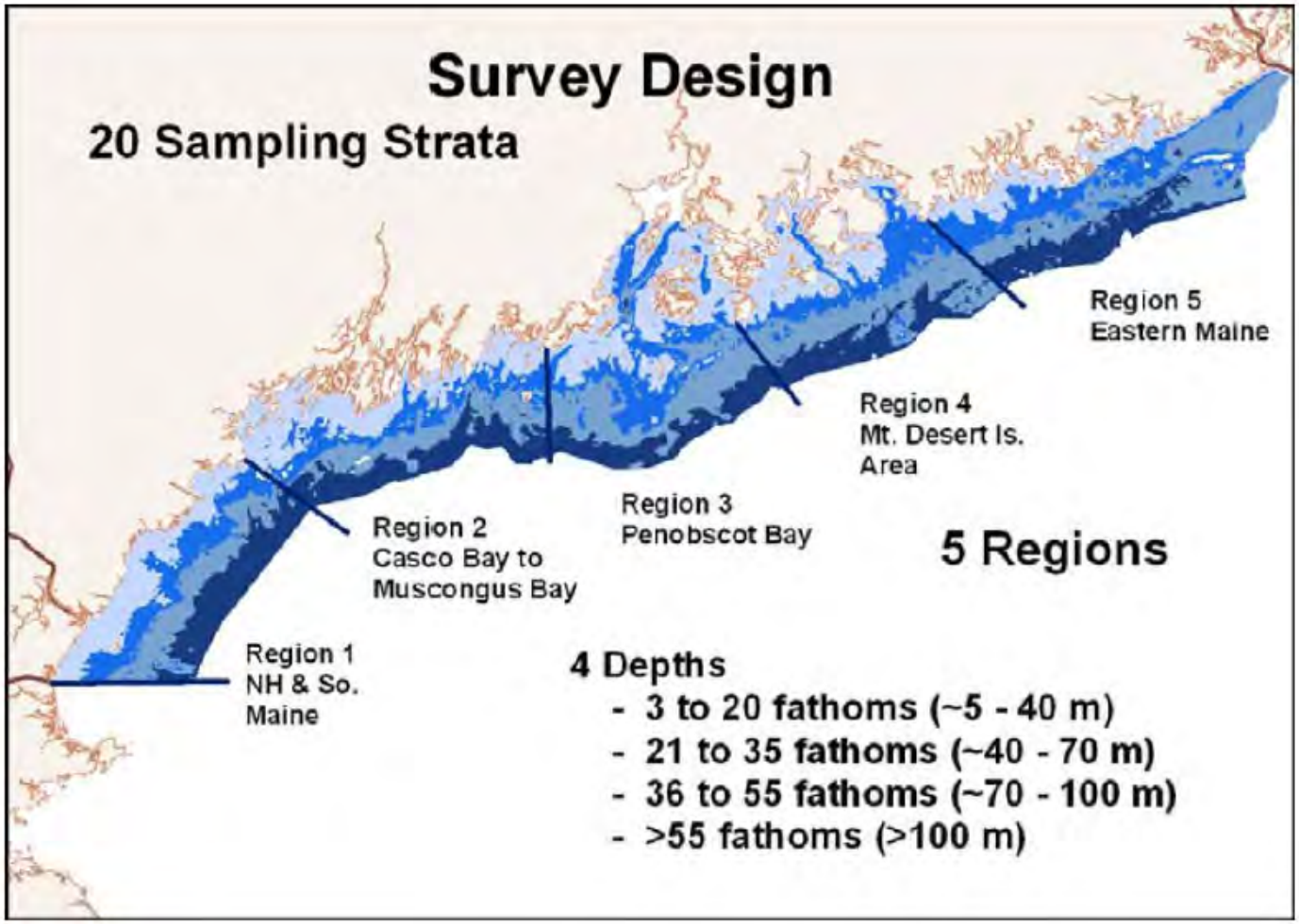




- Summary represents northern strata (20-40) for red hake 68-14
- Increased +ve tows for red hake in recent decade
- Index remains relatively low in spite of red hake availability to the survey

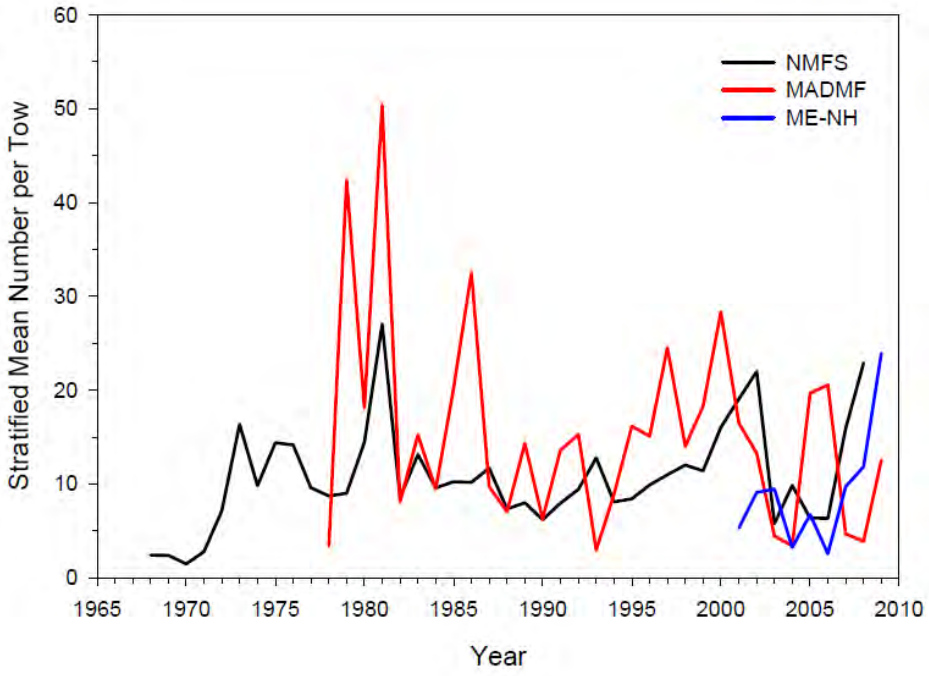


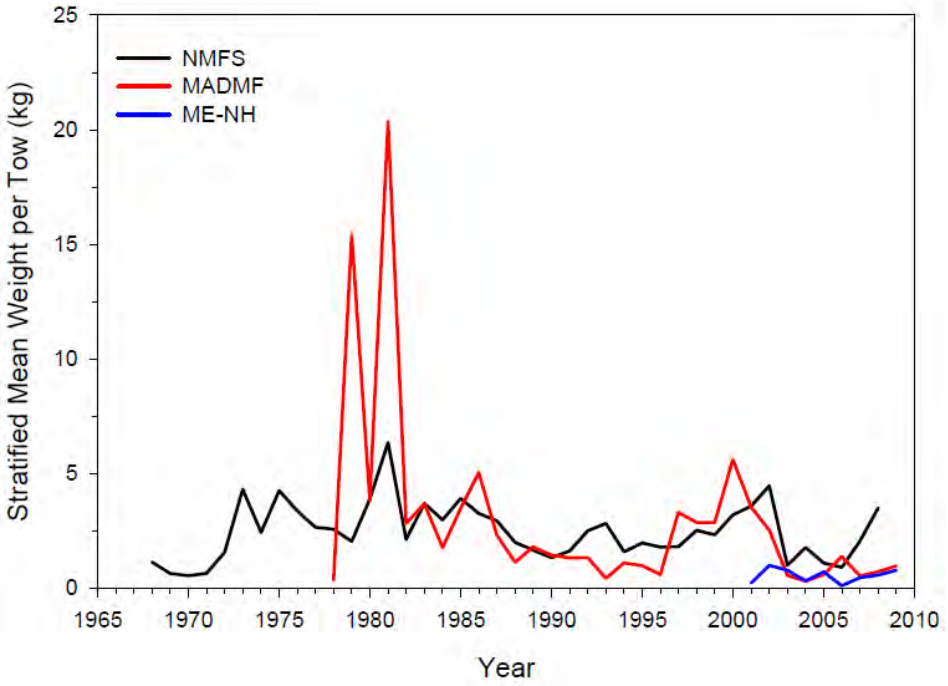
SARC 51 – Groundfish Inshore survey
Maine-New Hampshire



Map from Sherman et al. 2005

Northern Red hake Trawl Surveys explored during Benchmark Assessment (SARC 51 HWG)

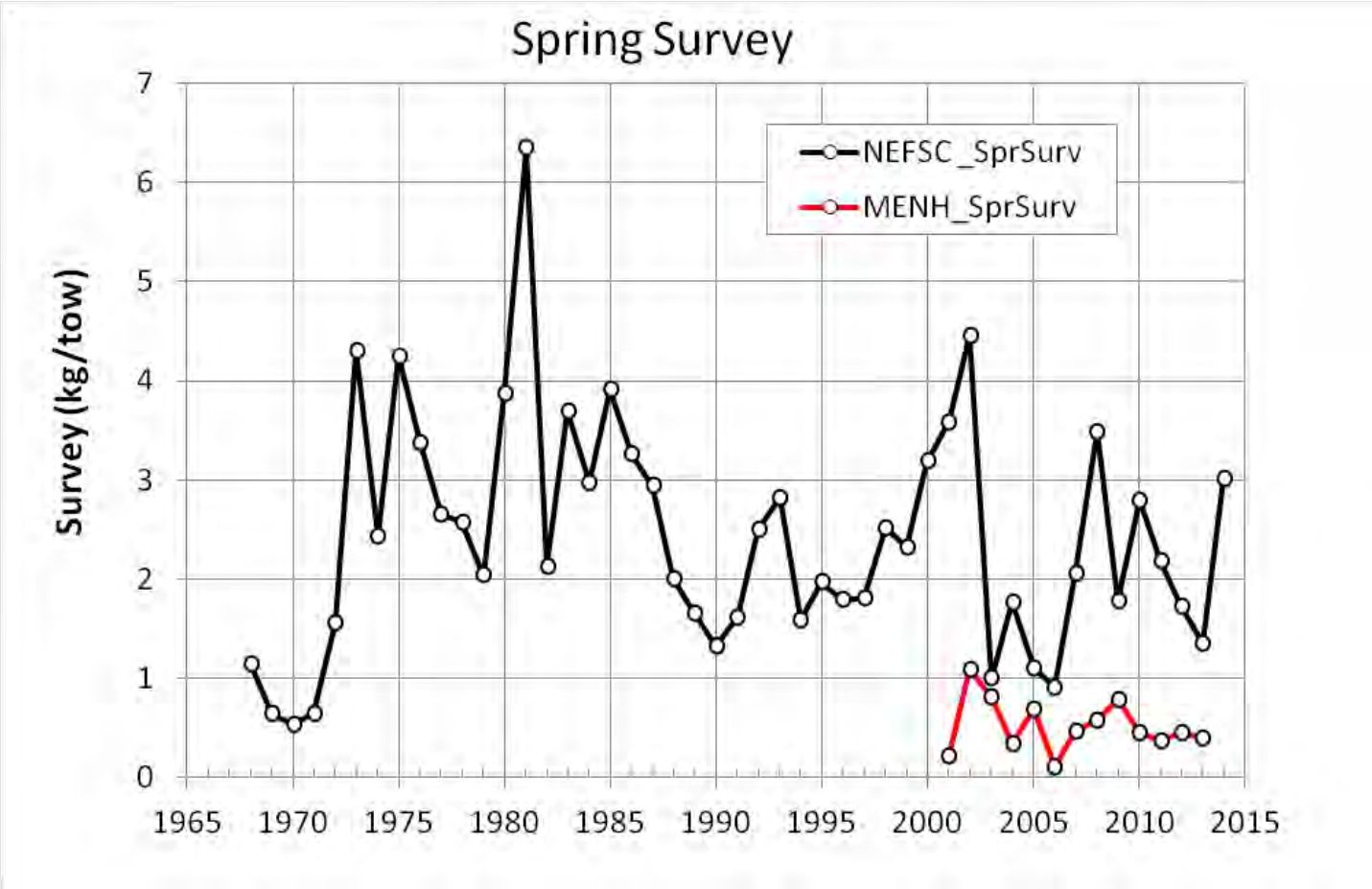




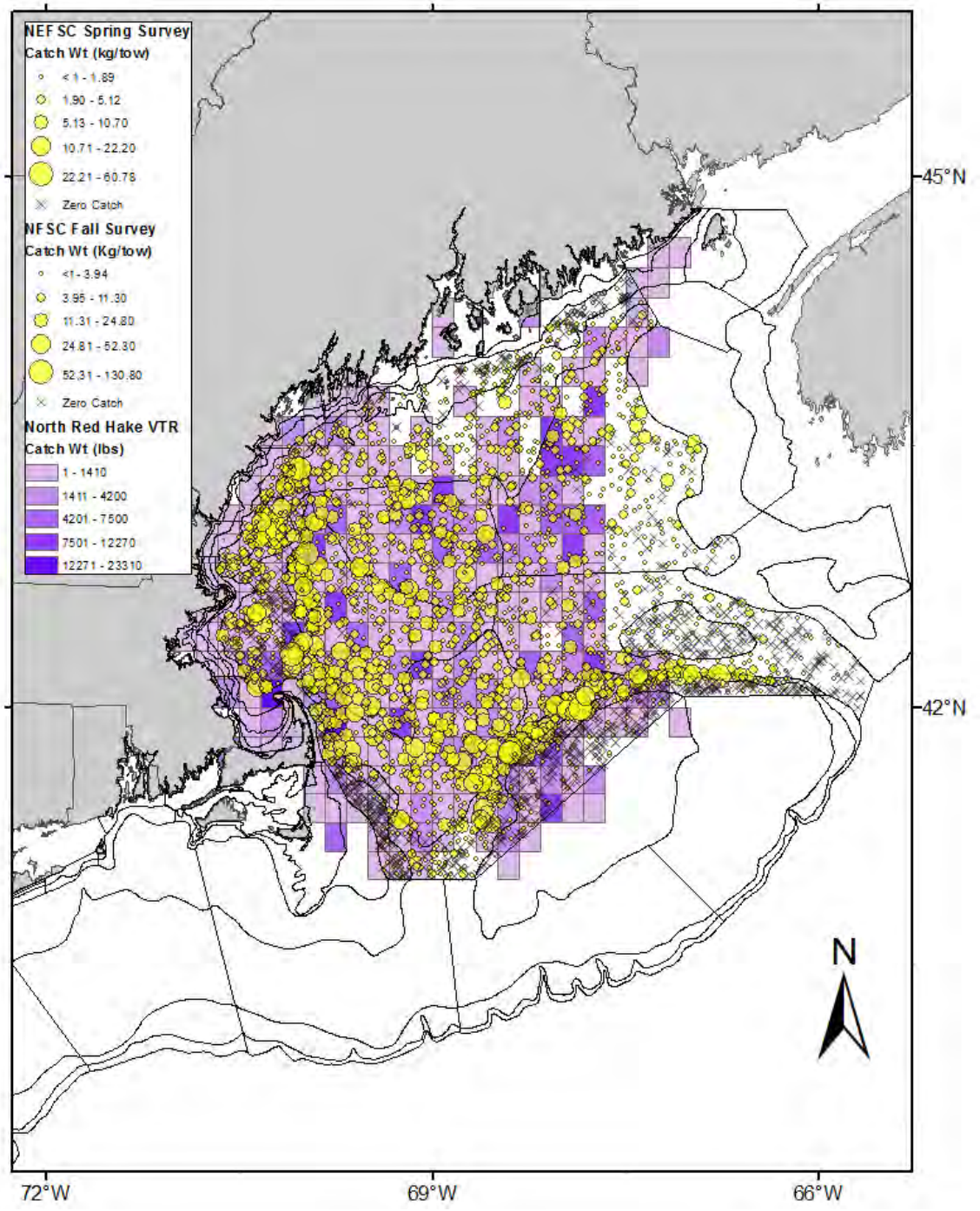
- Scale of the catches and trends between the ME-NH inshore state survey and NEFSC BTS appears to be consistent.

- Implies that red hake is likely not more abundant inshore relative to offshore habitats

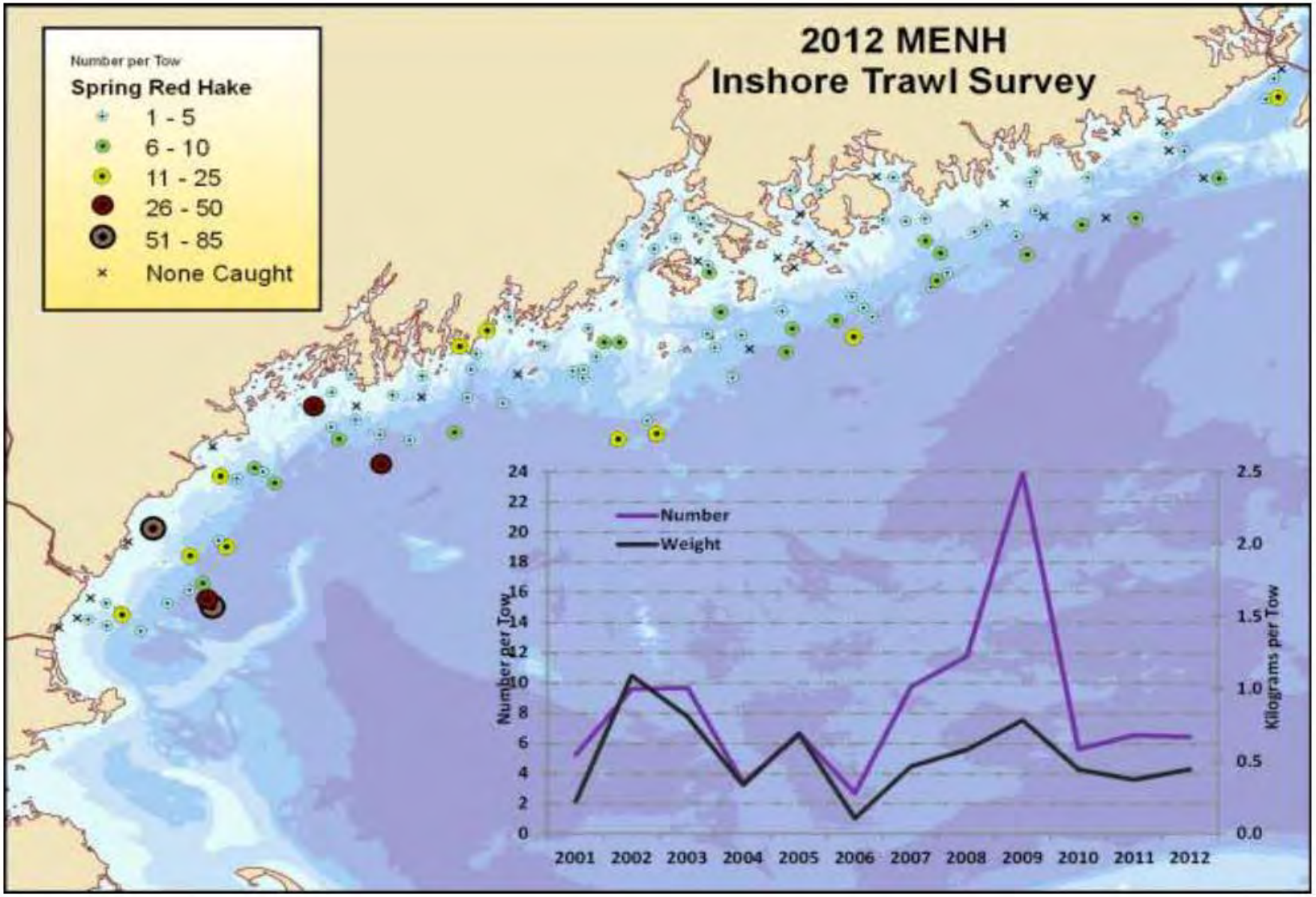
NEFSC Spring Survey Vs. Inshore ME-NH State Survey 1968-2013(4)



Northern Red hake Spatial Coverage (1994-2014)

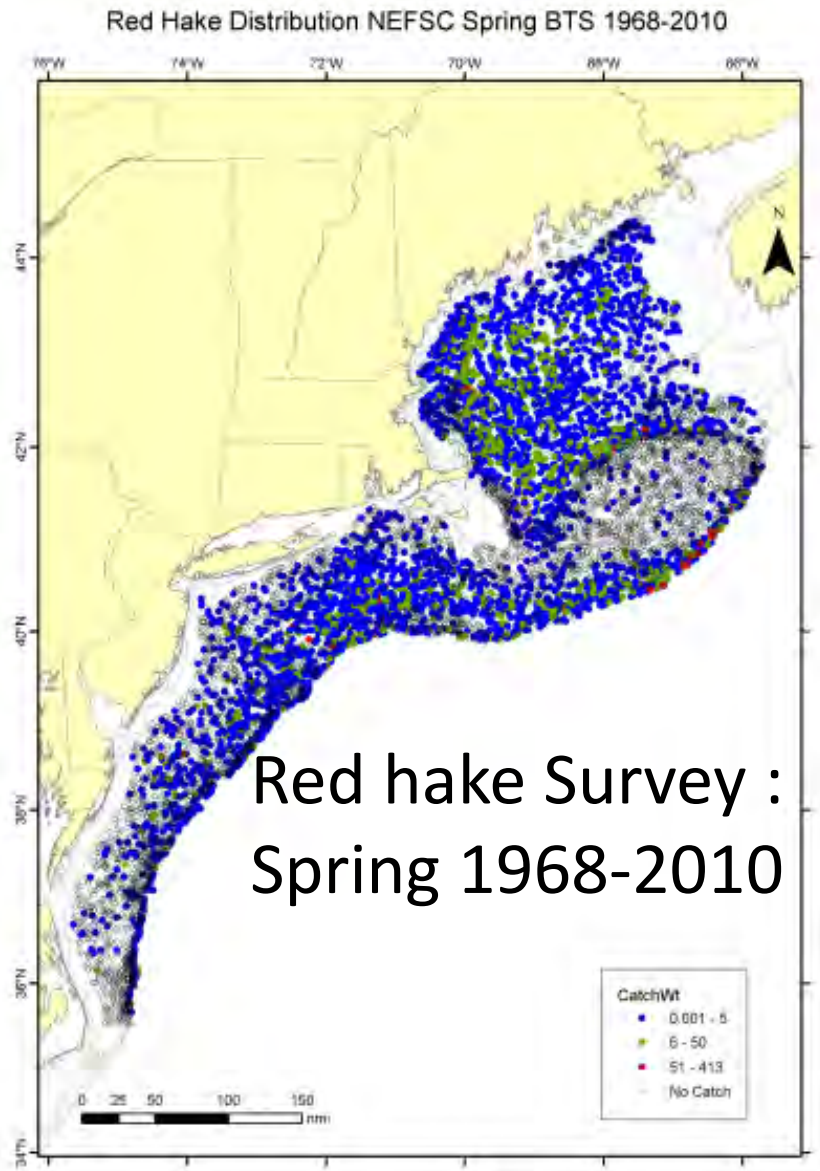


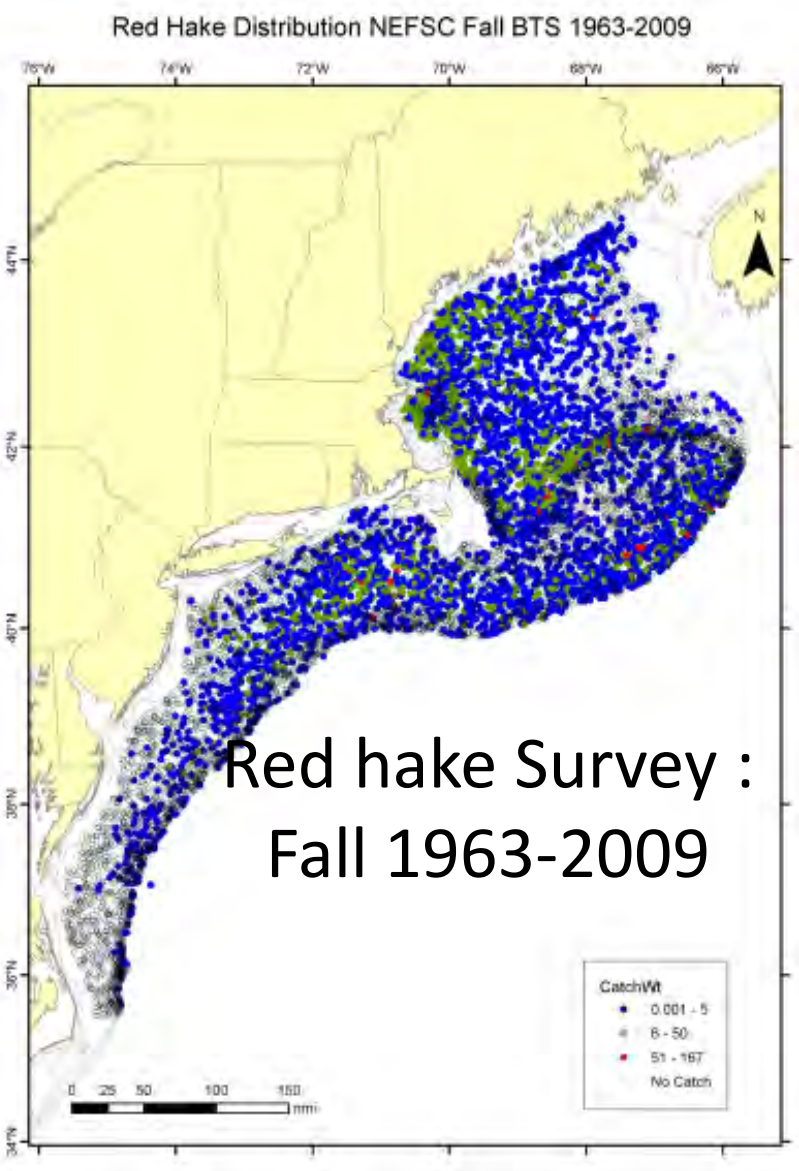
Inshore Maine-New Hampshire State Survey



Red Hake Stock Structure

- The basis for the two stock definition was established at SAW 2 largely based on the analogy with silver hake
- No morphometrics or genetic analyses on population structure has been conducted.
- Explored at the last 2010 Benchmark Assessment (TOR3)
- Evaluated various life history characteristics (i.e. distribution, growth and maturity)
- Conclusion at last benchmark: available evidence was equivocal as to whether red hake should be considered a single or multi-stock population.

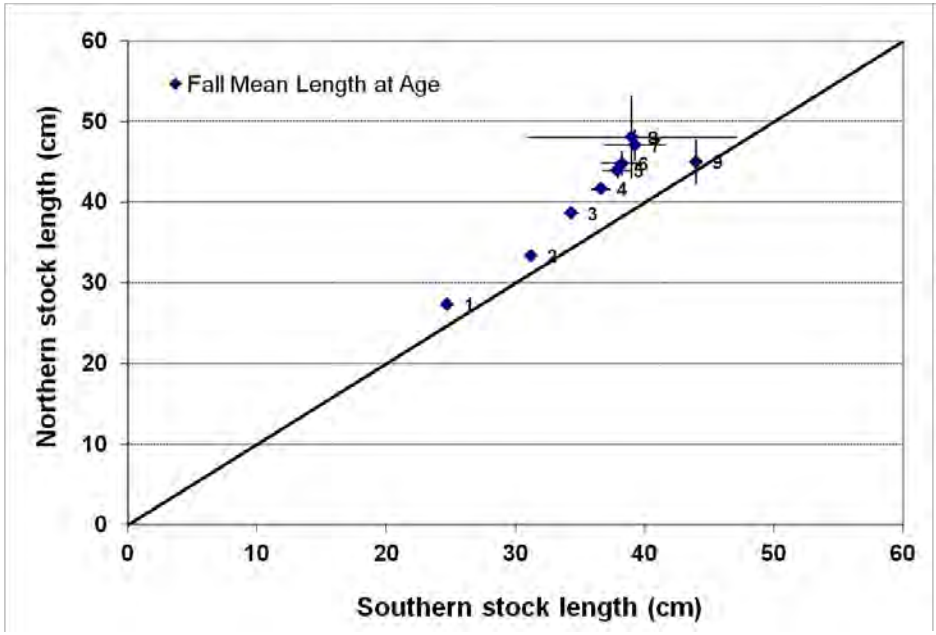


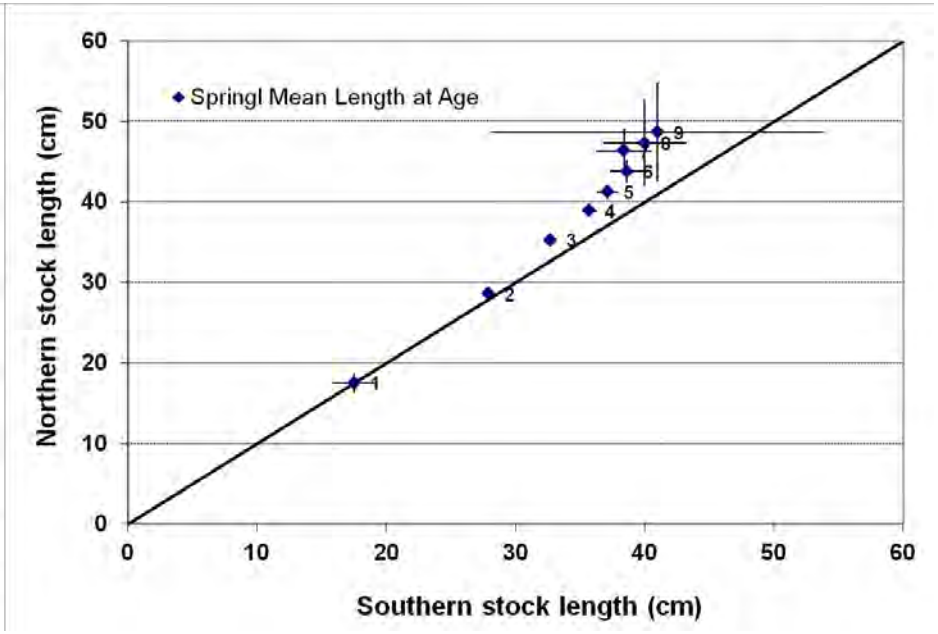


- Spring-Summer: move to shallow water to spawn
- Fall begin migration to deeper water and in Winter – move offshore to deep waters in GOM and along edge of C.Shelf along SNE and GBK
- Likely mixing occur on GBK, but degree of mixing and movement is unknown

Red hake growth pattern

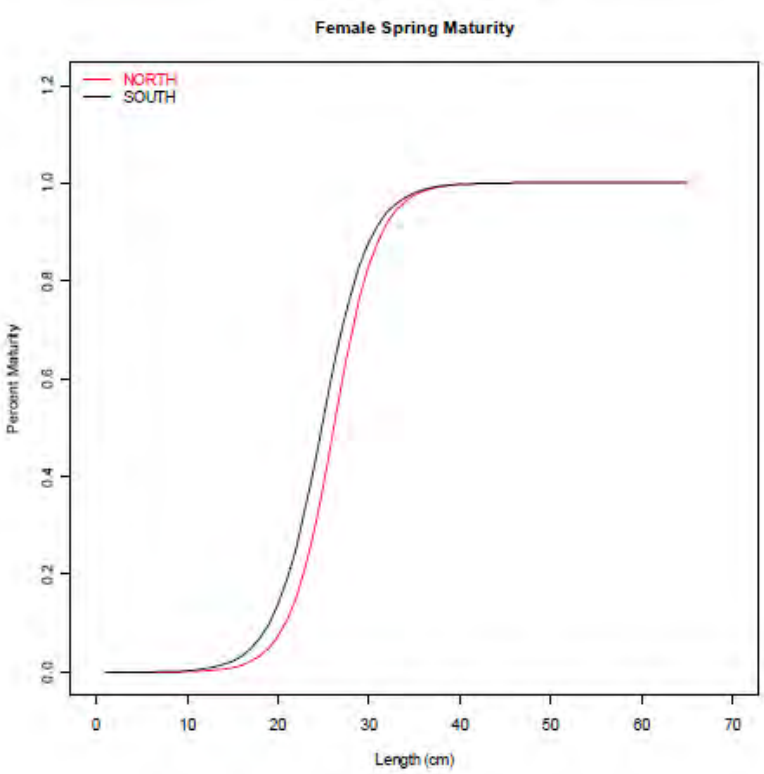
Mean Size at age

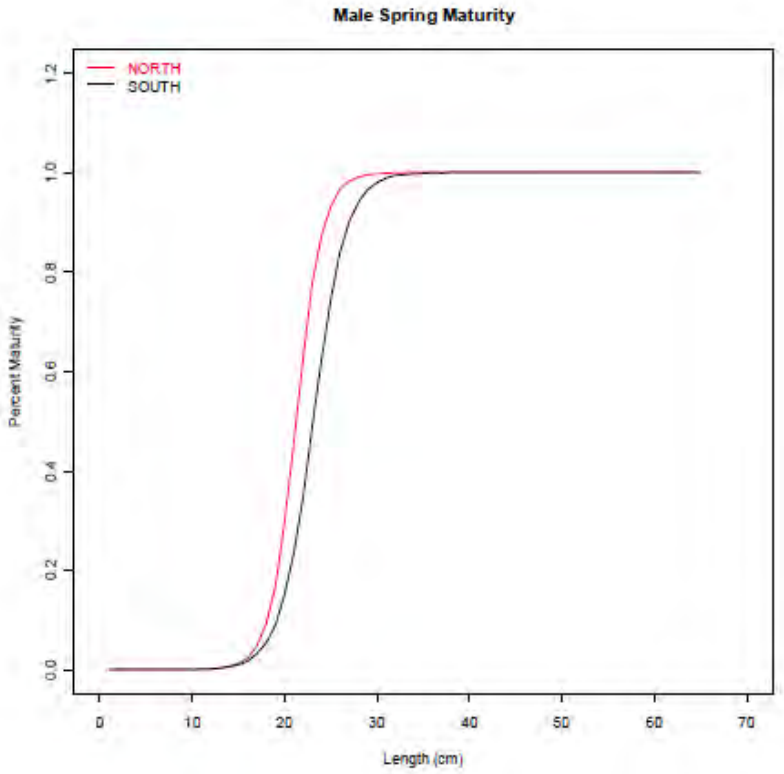




- Age data only available (1975-1985)
- Similar growth rates until about ages 2-3
- While older and larger red hake in the northern stock would argue for separate stocks, there appears to considerable uncertainty in the interpretations of red hake ages in the northern stock due to otolith anomalies (i.e. prominent checks that blur distinction between annular zones)

Red hake Size at maturity





Slight difference in size at maturity between stocks and also by sex.
Females maturing at smaller sizes in the north
Vice-Versa for males.

Summary (1)

- Concentration of catches of inshore red hake over the last decade do not appear to be substantially greater than offshore population
- NEFSC Survey show fairly consistent sampling frequency in the GOM in spite of fixed gear interference and bad bottom topography
- Concentration of catches appear to be occurring in the offshore region of the GOM
- Review through the benchmark process

Summary (2)

- There is uncertainty in the red hake stock structure and this research recommendation was identified at the last benchmark assessment.
- Currently, no new evidence suggests a revision in the current stock definition
- Research on red hake stock structure using otolith microchemistry is in progress
- A revision in stock structure will require an independent peer review process