Stock Assessment and Population Modeling

SC DNR Crustacean Workshop

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Goals

- What is an assessment and why are they done
- Key principles of finfish assessments
- Challenges posed by crustacean life history

Stock Assessment?

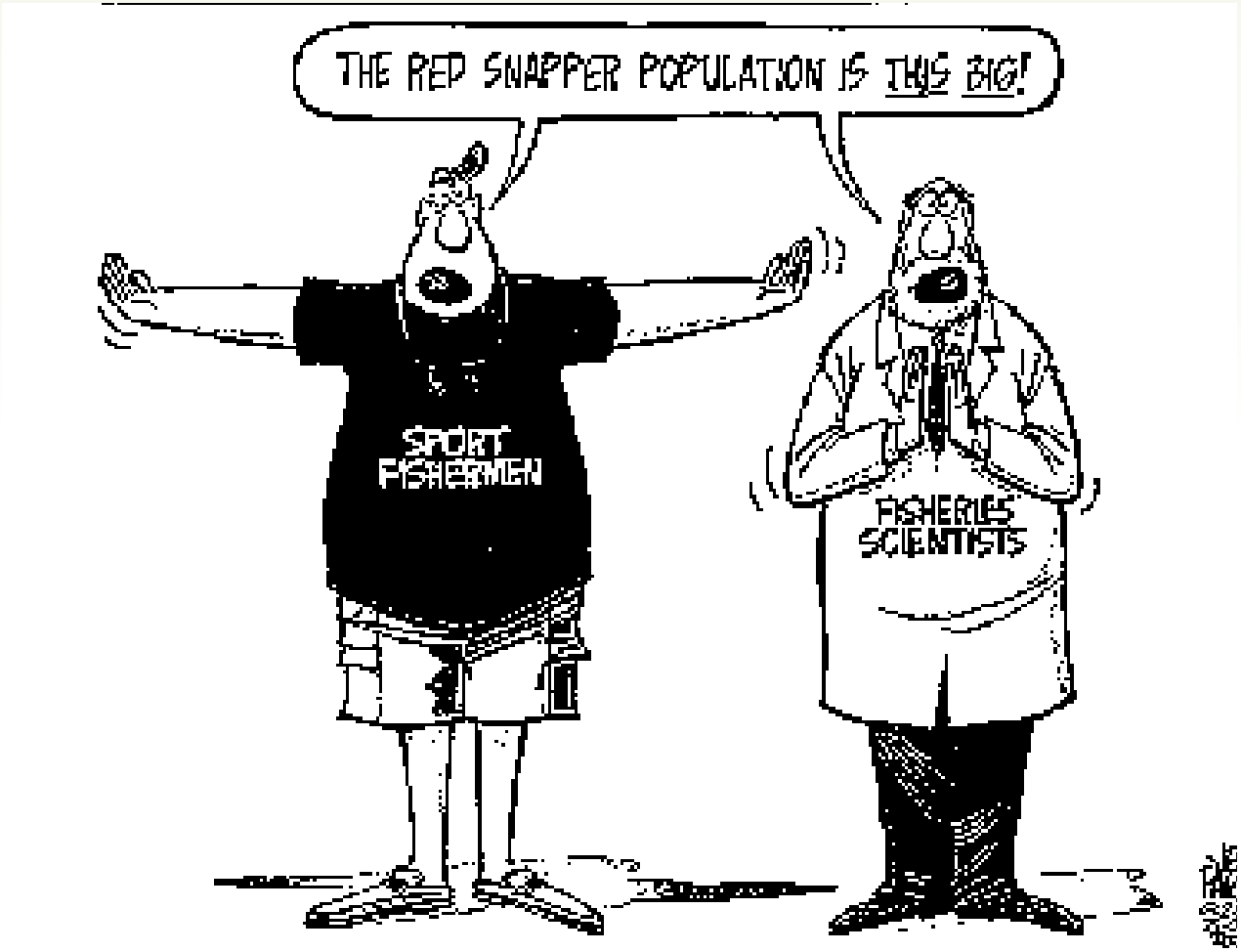
What did you catch today?

Stock Assessment?

Stock Assessment?

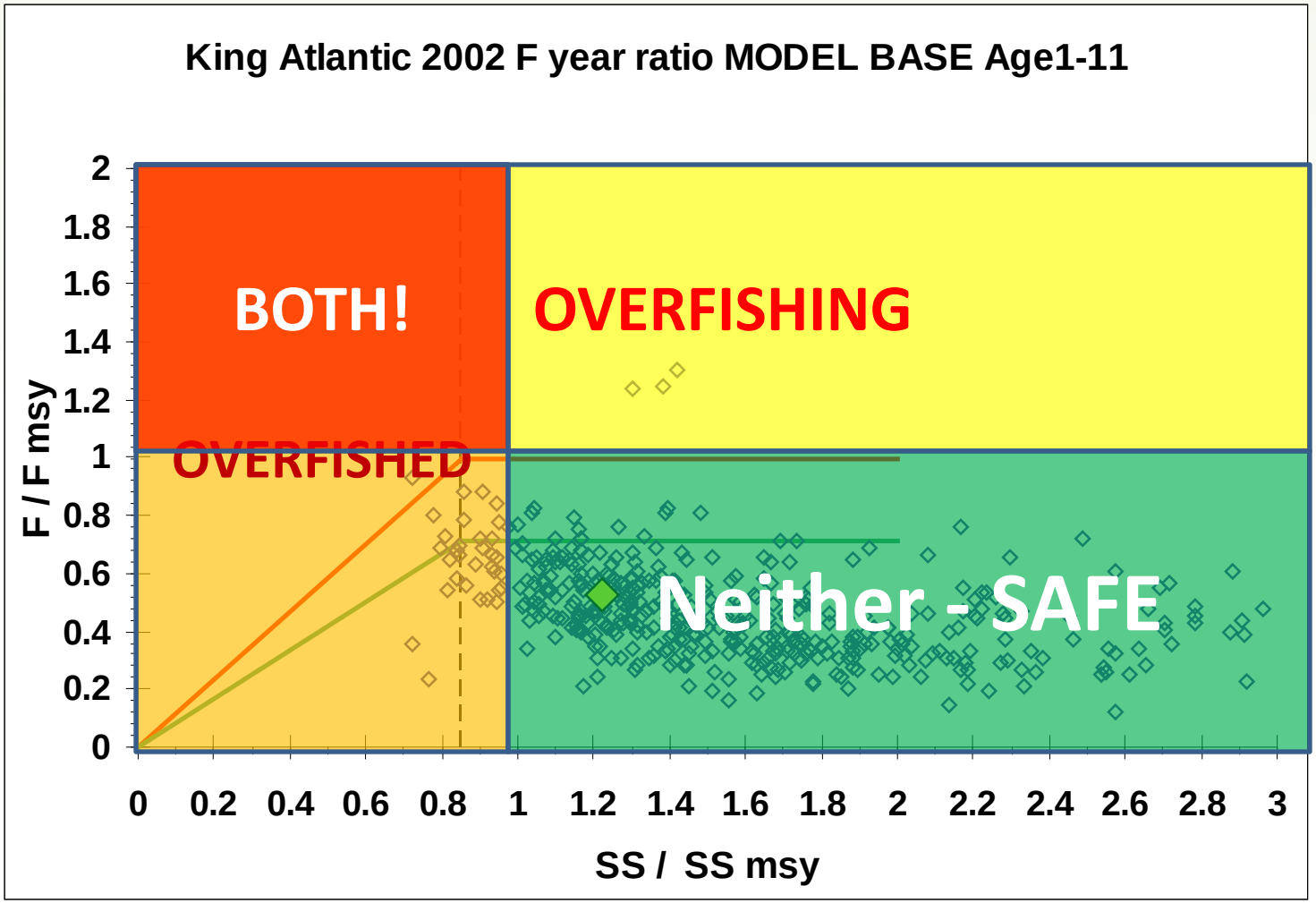
What will you get to catch today?

Far too often…



WHY ASSESS STOCKS?

Why: Stock STATUS

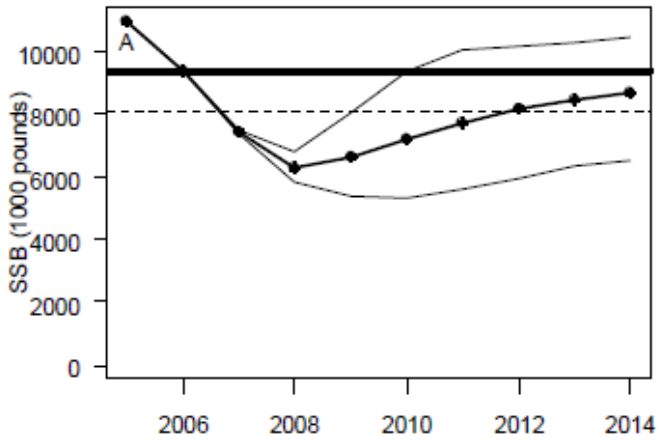


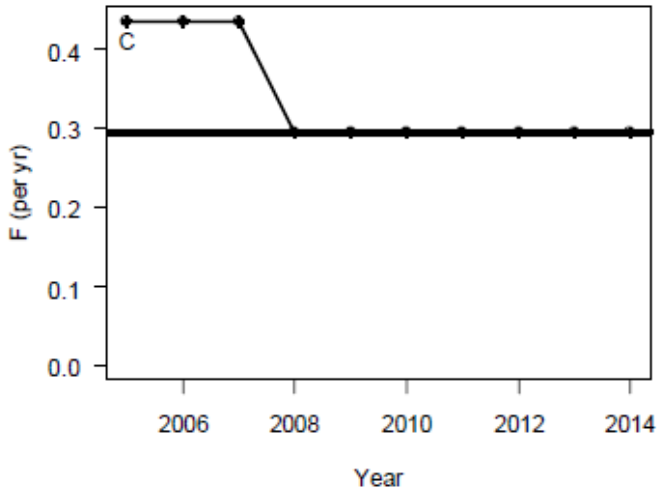
Why: Fishing Level Recommendations

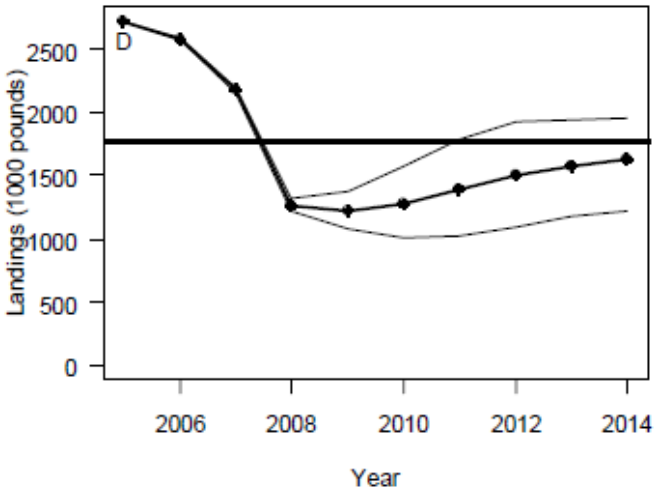
Black Sea Bass Status and Fishing Level Recommendations

Criteria	Deterministic	Probabilistic
Overfished evaluation	No (SSB/SSBmsy=1.03)	68% MCB runs above SSBmsy
Overfishing evaluation	No (F/Fmsy=0.66)	93% MCB runs below Fmsy
MFMT	0.61	0.71 (median)
SSBmsy (1E10 eggs)	256	241.277 (median)
MSST (1E10 eggs)	159	149.085 (median)
MSY (1000 lb)	1,780	
Y at 75% Fmsy (1000 lb)	1,756.45	
ABC Control Rule Adjustment	10%	
P-Star	40%	
OFL (1000 lb)	1,780 (MSY)	2,433 (2013 L+D) 2,194 (2014 L+D) 1,973 (2015 L+D)
ABC Recommendation (list by year if appropriate) (1000 lb)		2,258 (2013 L+D) 2,102 (2014 L+D) 1,921 (2015 L+D)

Why: Management Options



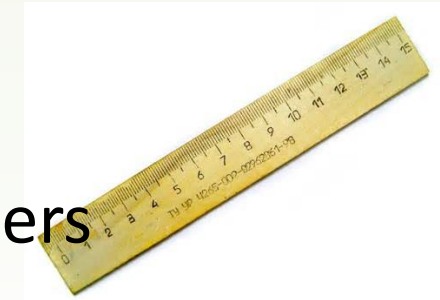




What is a Stock Assessment?

Process of conducting analyses on a population to **QUANTITATIVELY**

- provide values to management parameters
- characterize the status of a stock
- ***PREDICT*** the response of the population to management ***CHOICES***



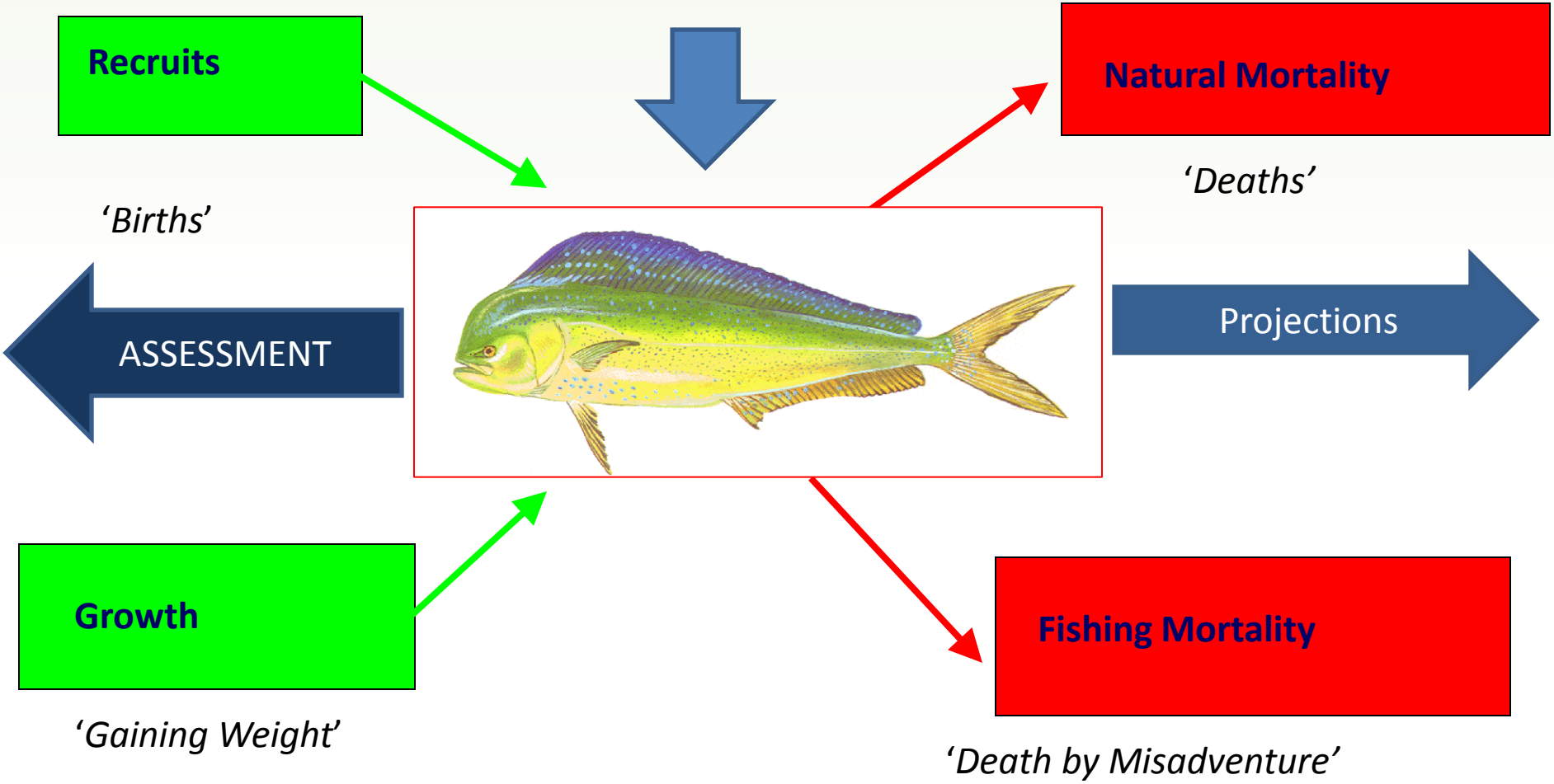
QUANTIATIVE, STATUS

PREDICT, CHOICES

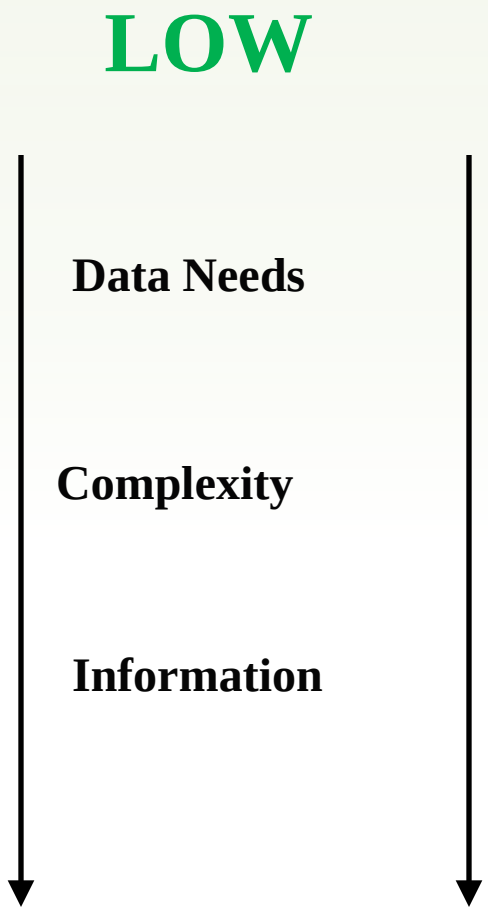
What an assessment does:

Finds the values for the boxes and arrows, over time

"THE STOCK"



Methods



- Trends Analysis
- CPUE
- Catch Curve (age or length)
- Biomass & Production
- Mark-Recapture, Tag Return
- Catch-Age
- Multi-species & Ecosystem

Finfish Modeling Principles

BASIC INPUTS

IMPORTANCE OF AGE DATA

STOCK AND RECRUITMENT

Data

SAFIS

Standard Atlantic Fisheries Information System

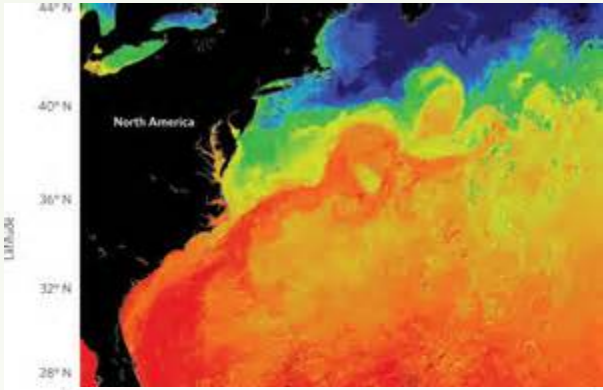
Created By The Partners Of The ACCSP

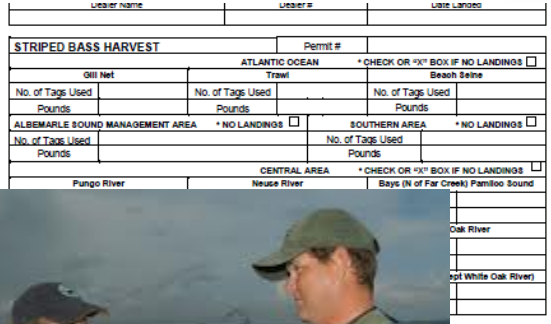
ECOSYSTEM

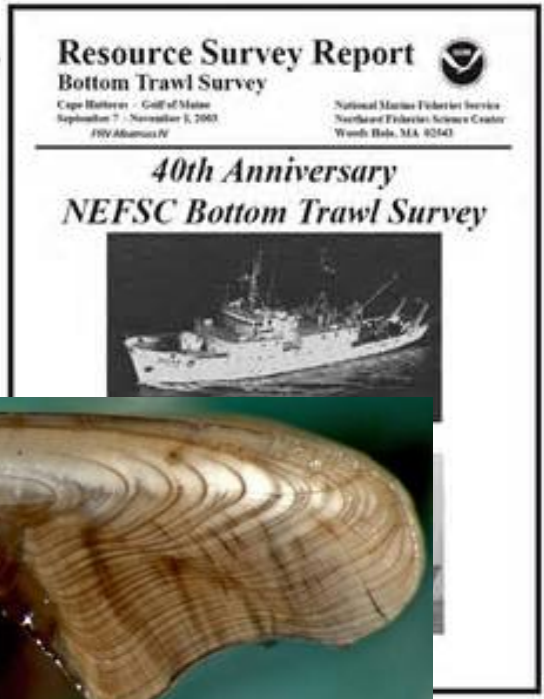
CATCH

SURVEY

BIOLOGICAL







Fisheries is all about counting kills

- Fish population models are primarily based on dead fish back in time.

How foresters find out how many trees are in their plot

How fisheries scientists find out how many fish are in their stock

30 tons of logs

Assessment Principles

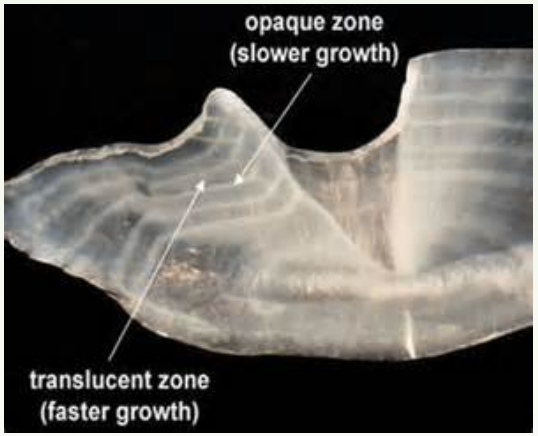
The particulars of 'how' are complicated, but there are a few generalities

- Decline in abundance over age and time reflects mortality rate
- Amount of catch (i.e., what is removed from the population over time) reflects abundance and biomass (for constant effort and effectiveness)
- Surveys increase insight into recent past (incomplete cohorts) and how fishery interacts with the population (selectivity).

State of the Art, Today

- Statistical Catch at Age Model
  - Catch at age
  - Auxiliary data such as surveys
  - Life history traits
  - Fishery traits (selectivity, regulation changes)
  - Uncertainty in inputs
  - Assumptions of the past
  - Ecosystem variables, possibly
  - non-linear (iterative) solutions
  - Everything modeled simultaneously

Age is the foundation

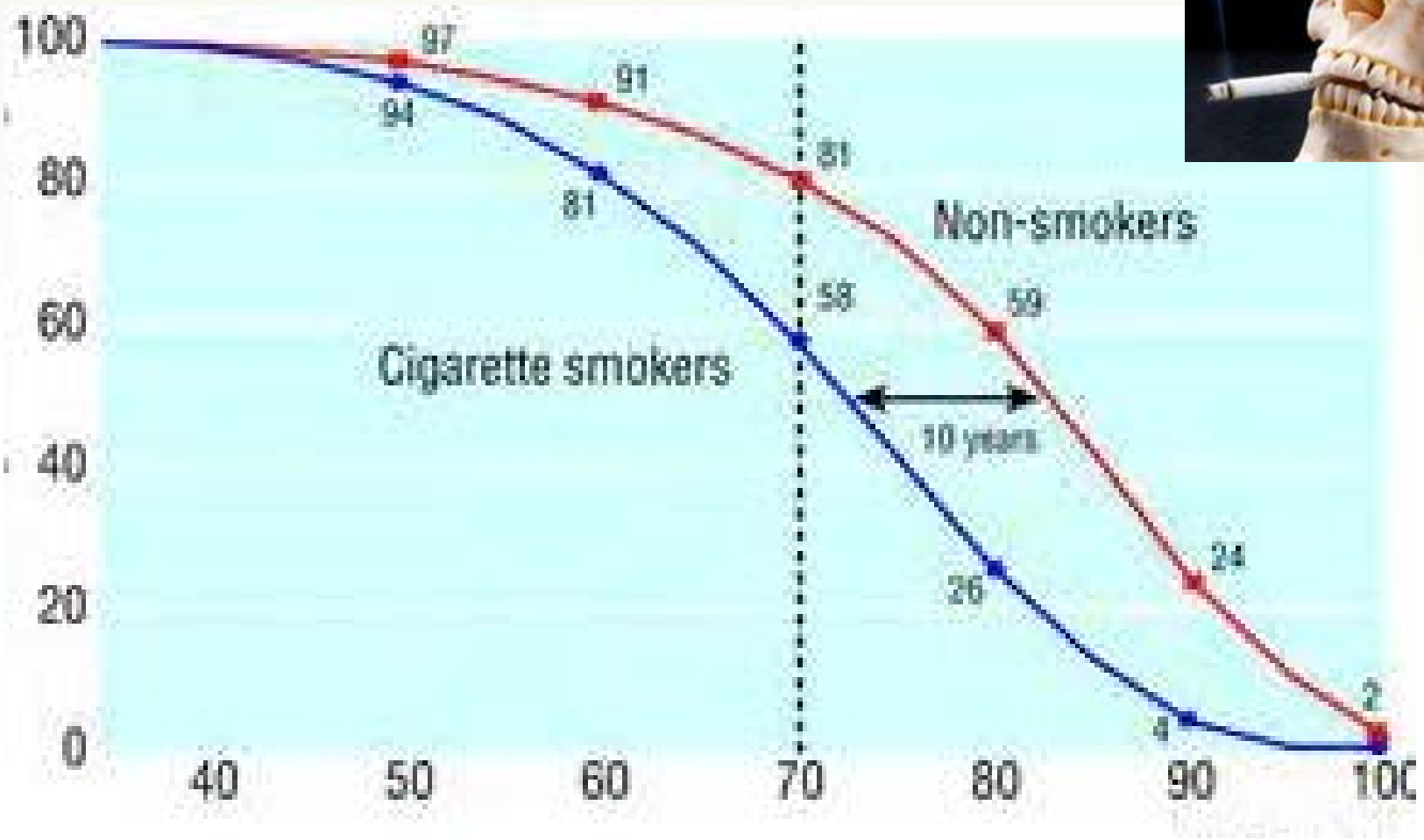


- The **Cohort**….or Year Class…

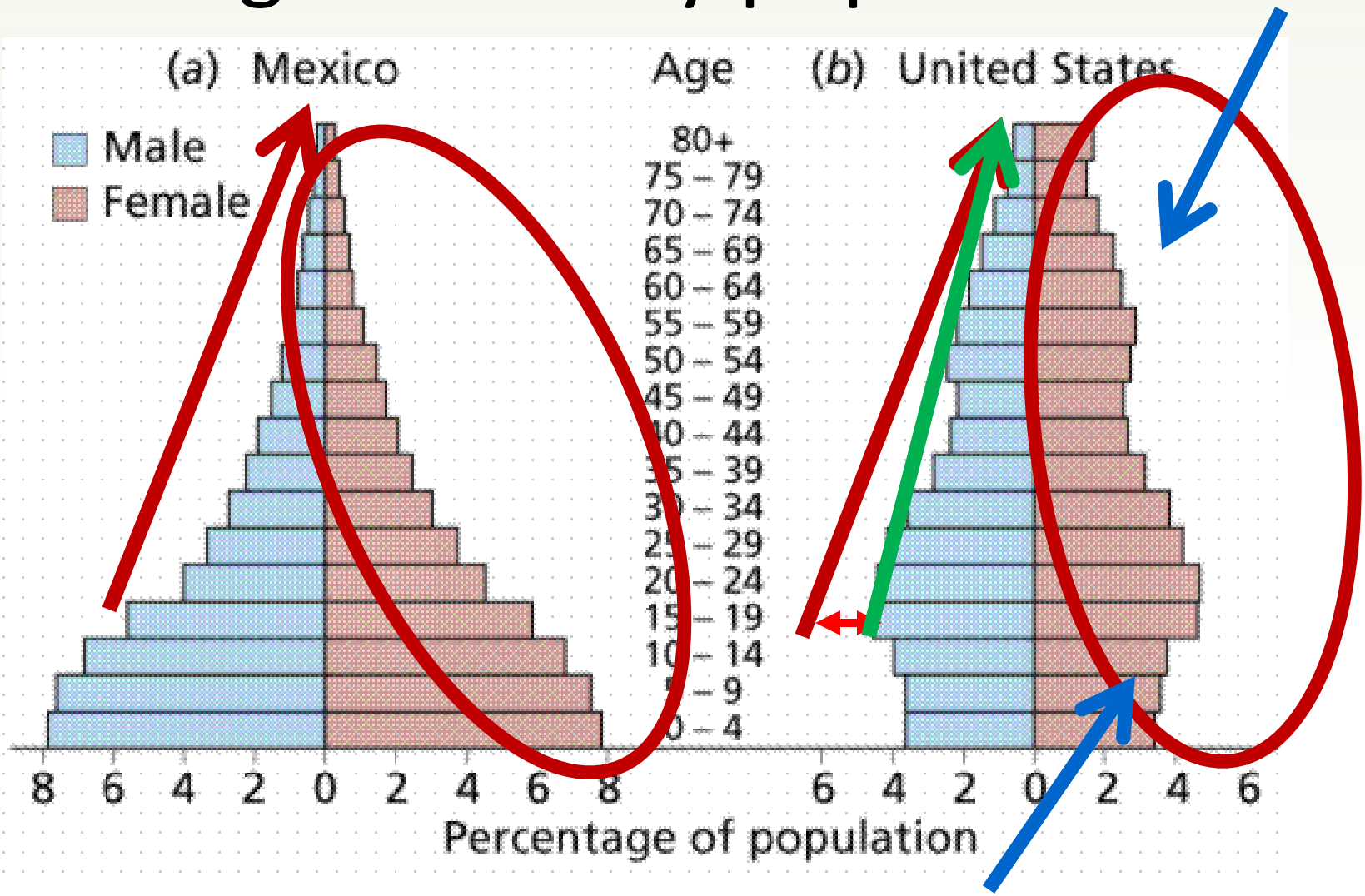
ALL THE FISH BORN IN A YEAR

We are interested in their fate over time, because that provides the information to support the assessment calculations

Age tells about death rates

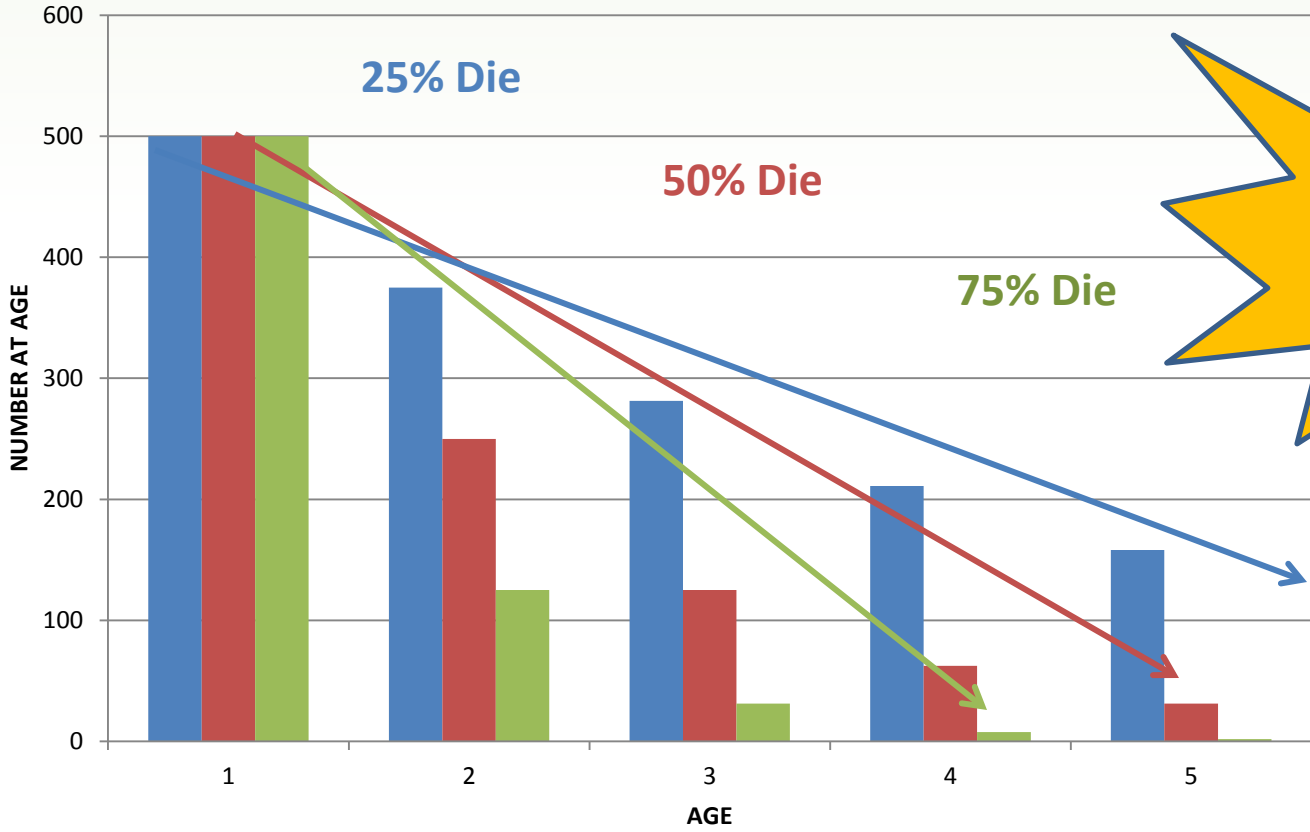


N at age….For any population



How this relates to Assessments

- The rate at which numbers drop as the cohort ages reveals the mortality rate for catch based assessments.



This is why age data are so critical

TRACKING COHORTS

These are the "completed" cohorts – know all I will every know

Incomplete Info = Uncertain Info

YEAR	1	2	3	4	5	6
1982	0.0	38.5	27.8	8.9	4.8	2.6
1983	0.0	26.6	32.8	14.9	6.2	3.4
1984	0.0	107.7	6.4	25.1	19.8	3.3
1985	11.9	85.5	32.7	2.5	1.8	0.8
1986	0.0	56.5	10.8	6.6	0.0	0.5
1987	0.0	41.8	18.2	15.8	5.4	0.3
1988	0.0	21.1	15.3	12.9	13.3	2.9
1989	0.0	17.8	14.8	11.9	4.6	0.5
1990	0.0	**53.0**	10.7	7.7	3.2	0.7
1991	0.0	16.1	**51.2**	5.1	1.5	0.3
1992	0.0	0.4	29.7	**24.5**	0.4	0.2
1993	0.0	0.2	8.2	38.8	13.1	0.9

Terminal Year Uncertainty

7 completed COHORTS in this MATRIX. 12 years data

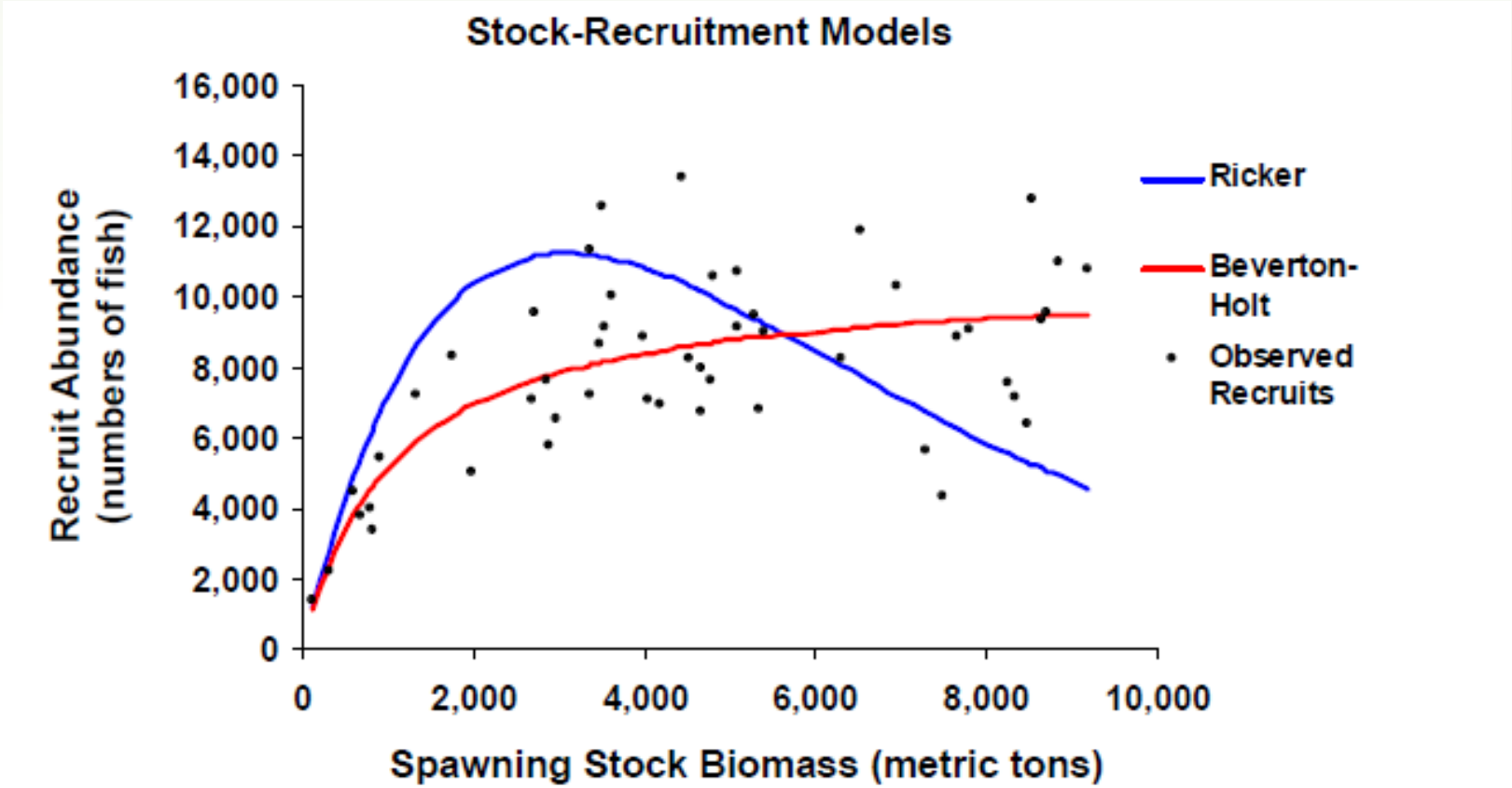
Stock and Recruitment

Another principle of conventional or finfish assessments –

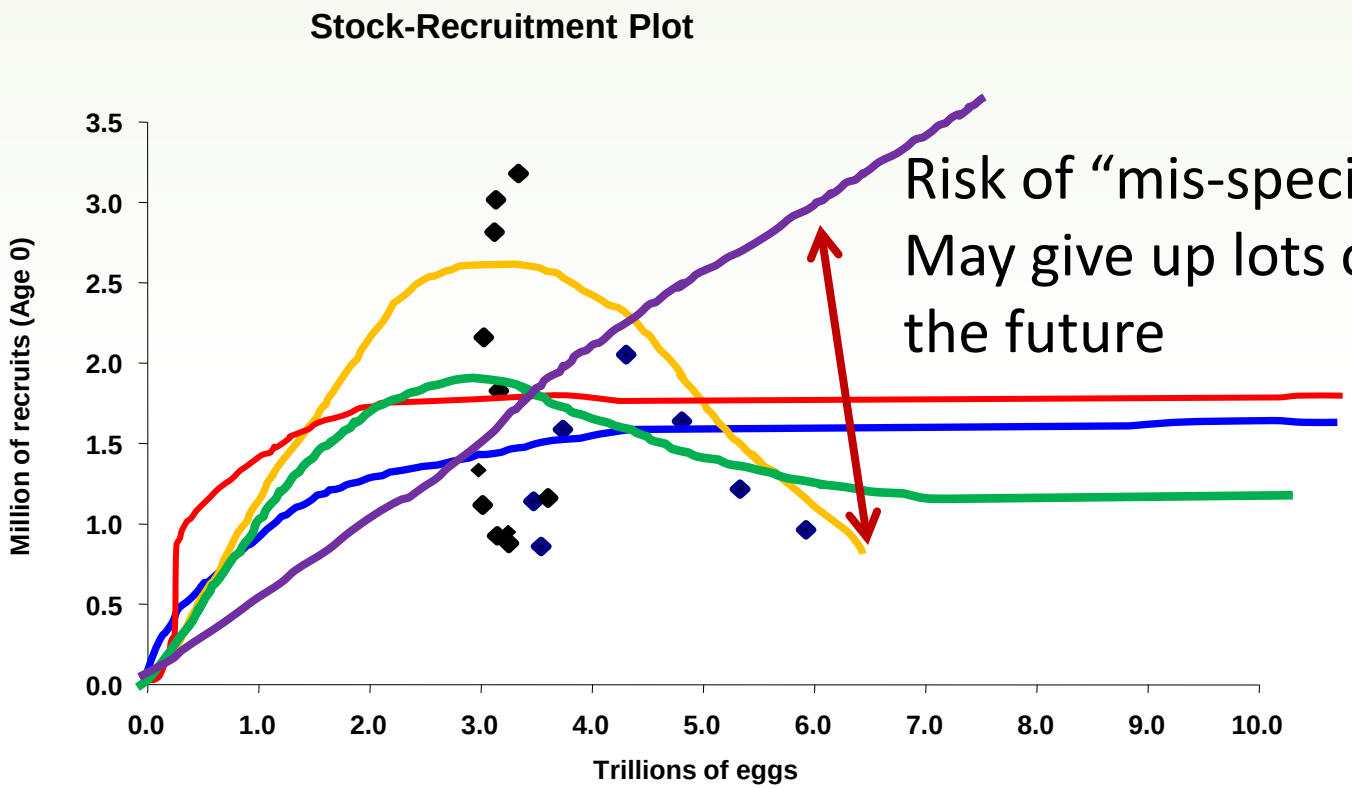
There is a relation between the number of parents and the number of offspring, and there is some critical level of parents that should be retained to ensure future productivity.

Stock – Recruitment Relationship

Stock Recruit - Theory



Stock- Recruit Reality



Risk of "mis-specification"? May give up lots of yield in the future

How to deal with…..

That's why we are here, right???

Crustacean Challenges

- Age ?!?
- Time Series Considerations
  - Does last year's population and catch tell me anything about this year?
- Stock Recruitment Concepts Apply ?
- Management Foundation?
  - Are low catches or high catches better indicators of the need for population concern?

NEFSC – Northern Shrimp

- Hemaphroditic, live to age 5
  - mature males at age 2.5, female at age 3.5
- Discrete fall spawning period
- Initial assessments just catch and survey
- Catch at length model applied
  - include biological (developmental stage)
- Provides annual estimates

NC Blue Crabs

- Dr. Eggleston and Students at NCSU
- Max age of around 5
- Multiple surveys, capture various life stages
- Cohort models, Stock Recruit relationship
  - catch at age, surveys

SEFSC – Gulf Pink Shrimp

- Stock Synthesis using surveys, catch, growth
  - Catch by Month in 8 count categories
- MONTHS treated as YEARS in the model
- Catch at Size rather than age

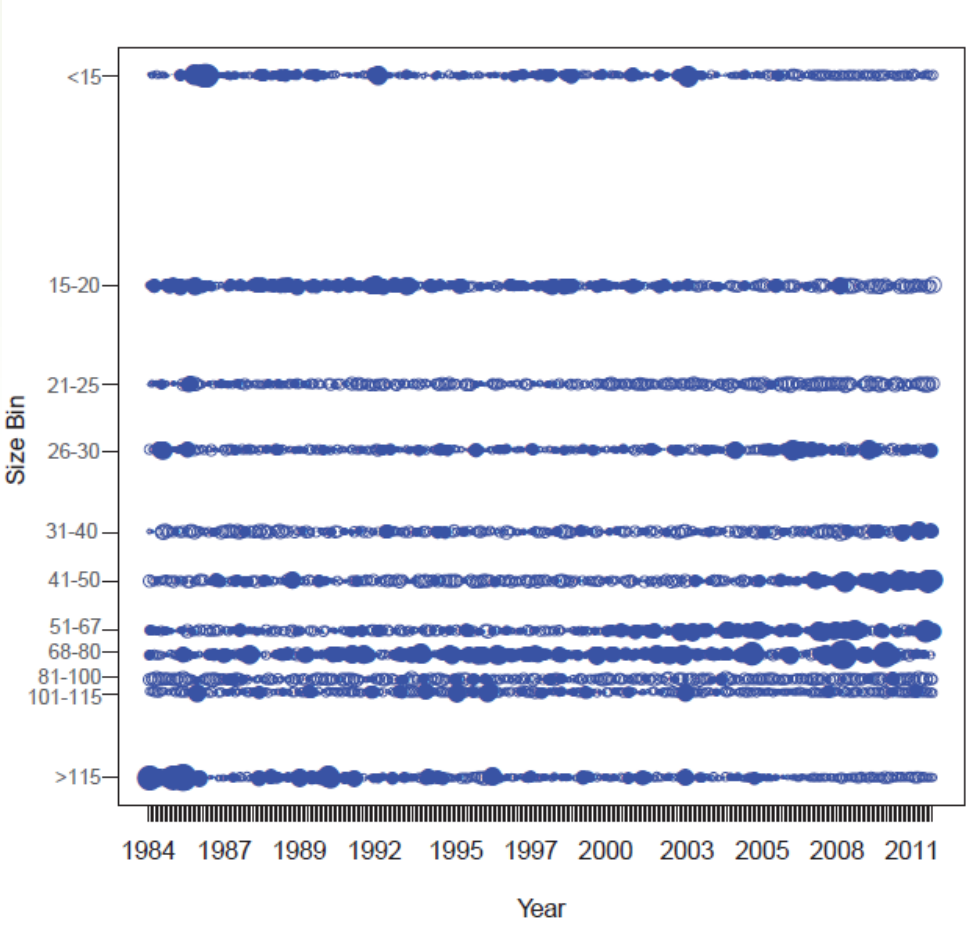


Figure 4.3.2. Residual fits for the commercial pink shrimp fishery, 1984-2011.