Application of An Index Method (AIM) to Data Rich Situations: Can Simple Methods Capture Major Features of Complex Assessments?

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Information Content of Data

- Fishery assessments depend on detection of relationship between population and removals
- At a minimum, would like to answer the following questions,
  - What level of exploitation will maintain the status quo?
  - What level of exploitation is necessary to increase probability of population growth?
  - What levels are expected to result in population decline?

> "…we have concluded that the control charts based on the same principles as those used in the quality control of manufacturing processes could, if suitably developed, be a most useful tool for this purpose."
>
> *Beverton and Holt 1957*

Two Pieces of Data

- Time series of catch
  - Can use landings if that's all you have

- Time series of relative abundance (index)
  - Fishery independent survey
  - CPUE

Create relative F and replacement ratio

Relative F

$$relF_t^{\,C} = \frac{C_t}{\left(\frac{I_{t-1} + I_t + I_{t+1}}{3}\right)} \qquad relF_t^{\,L} = \frac{C_t}{\left(\frac{I_{t-2} + I_{t-1} + I_t}{3}\right)}$$

where $relF_t$ = relative F at time t

C_t = catch or landings of stock s at time t (weight)

I_t = index of abundance at time t (weight)

Replacement Ratio

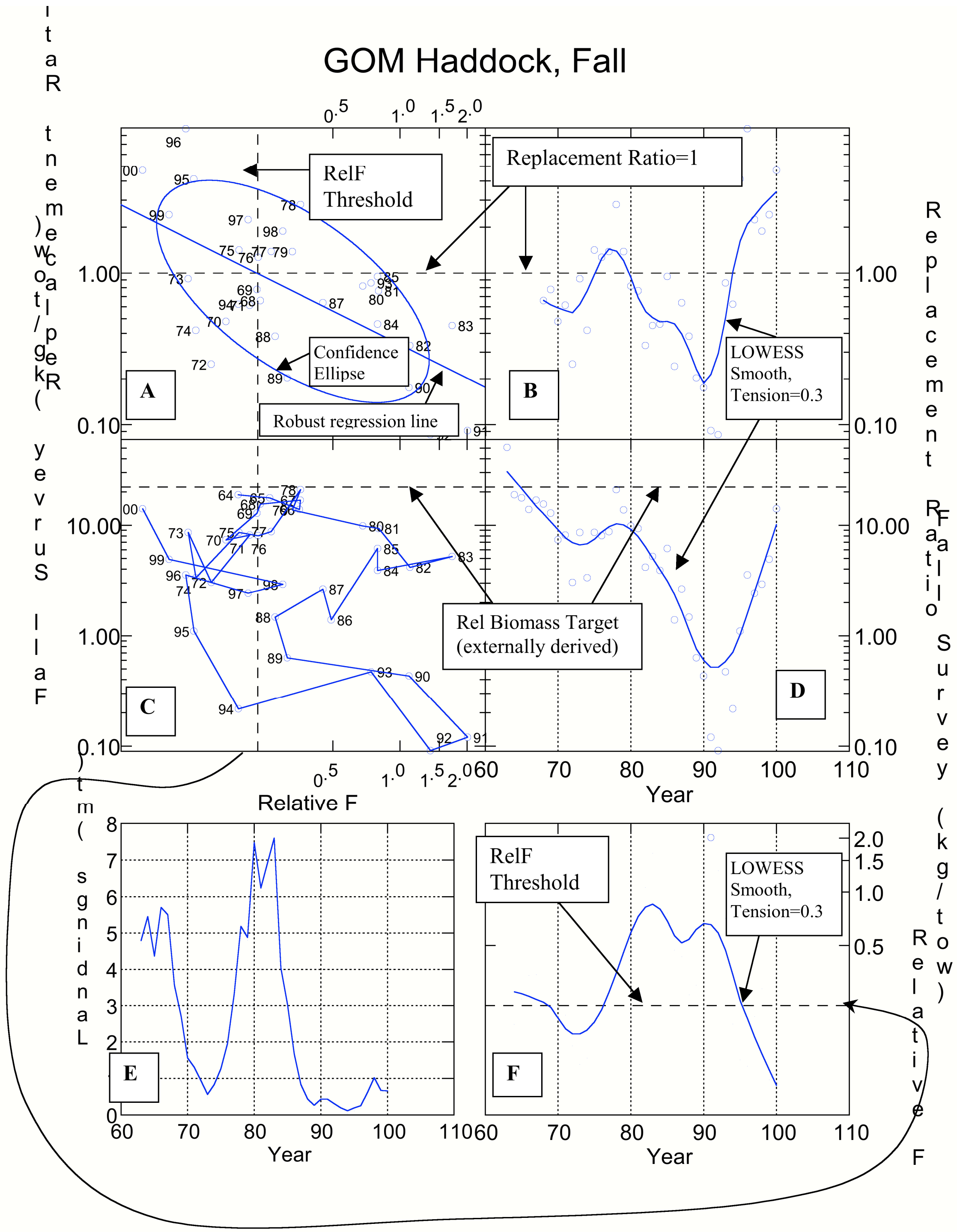
Derivation starts with basic biology, then does some simple algebra to produce

$$\Psi_t = \frac{B_t}{\alpha B_{t-1} S^1 W_1 + \alpha B_{t-2} S^2 W_2 + \alpha B_{t-3} S^3 W_3 + \ldots + \alpha B_{t-(A-1)} S^{A-1} W_{A-1} + \alpha B_{t-A} S^A W_A}$$

Next substitute $I_t = qB_t$ and make some simplifying assumptions to end with

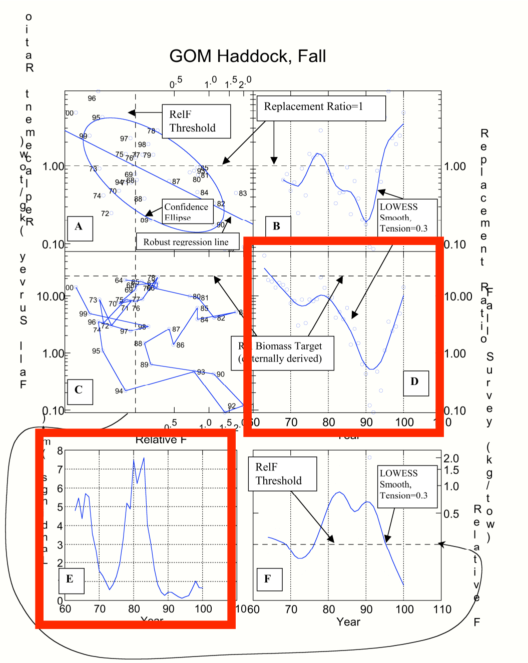
$$\Psi_t = \frac{I_t}{\sum_{j=1}^{A} \frac{I_{t-j}}{A}}$$

When the replacement ratio is greater than one the population is growing; and vice versa.

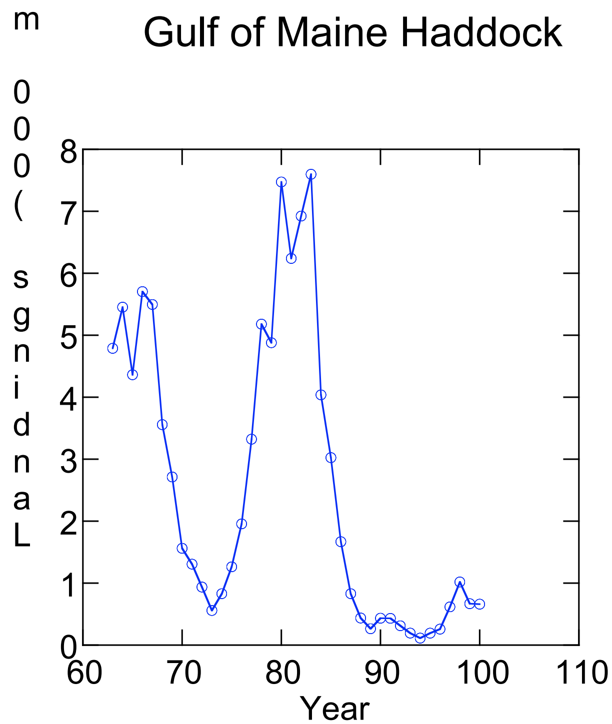


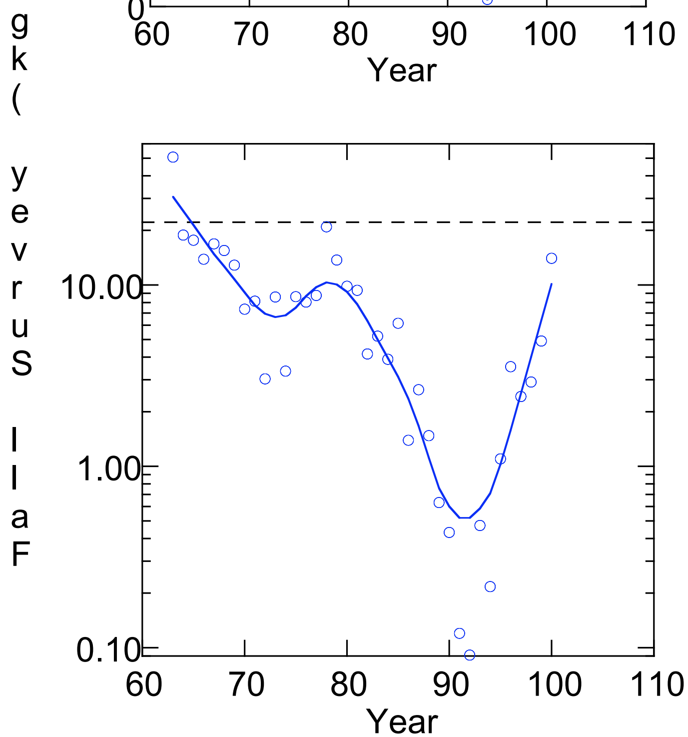
2 pieces of data
x
2 derived ratios
=
6 Panel Plots

(new math)

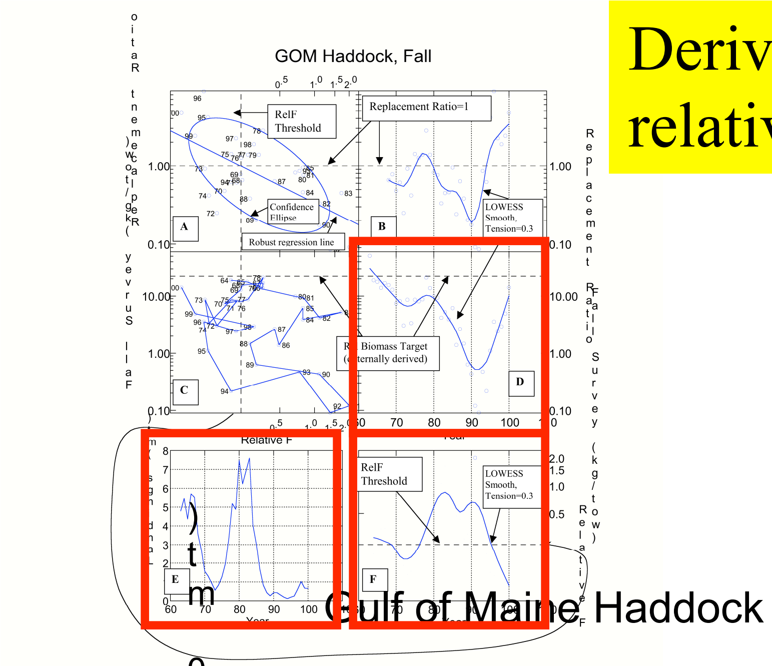


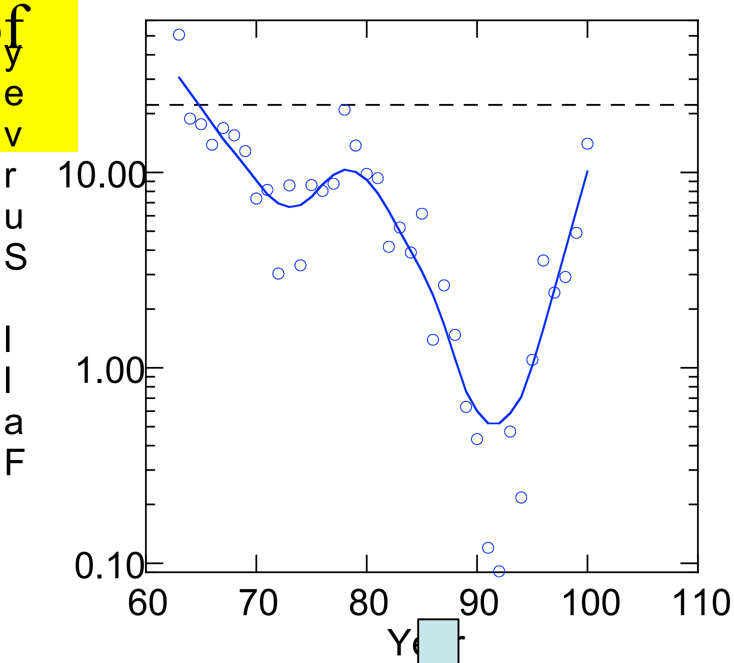
Initial Data: Landings and Survey

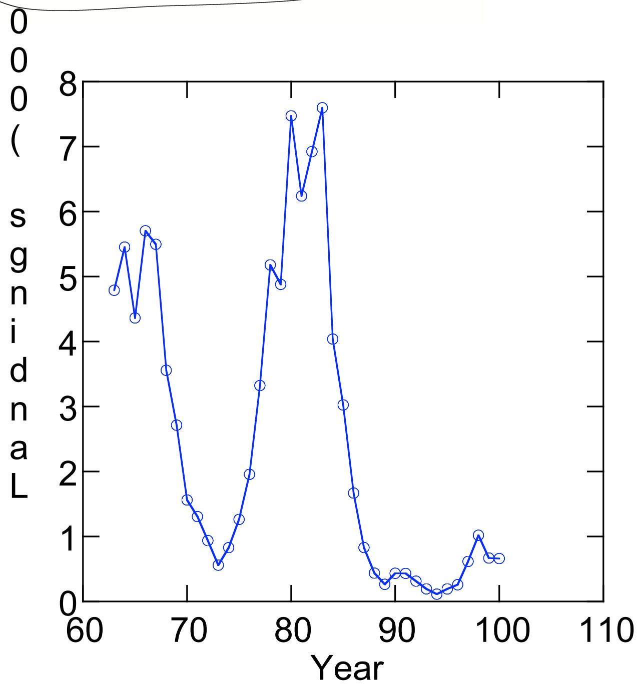


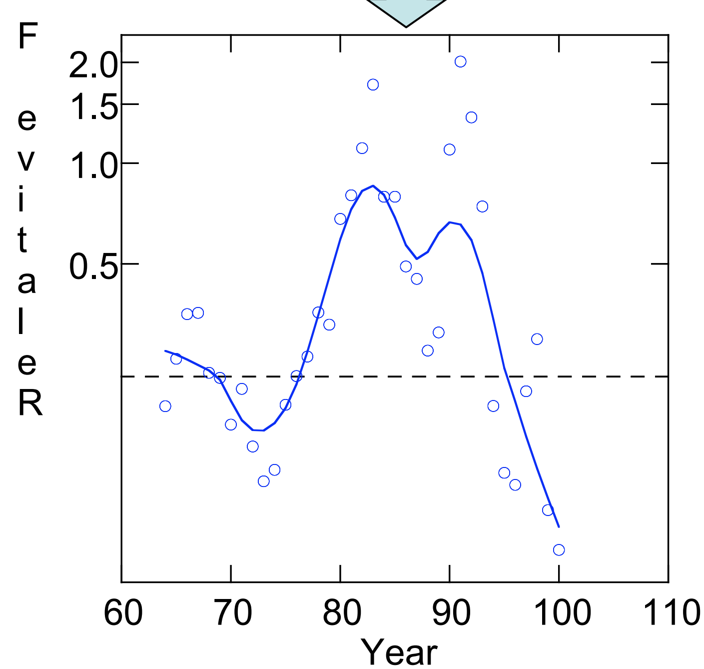


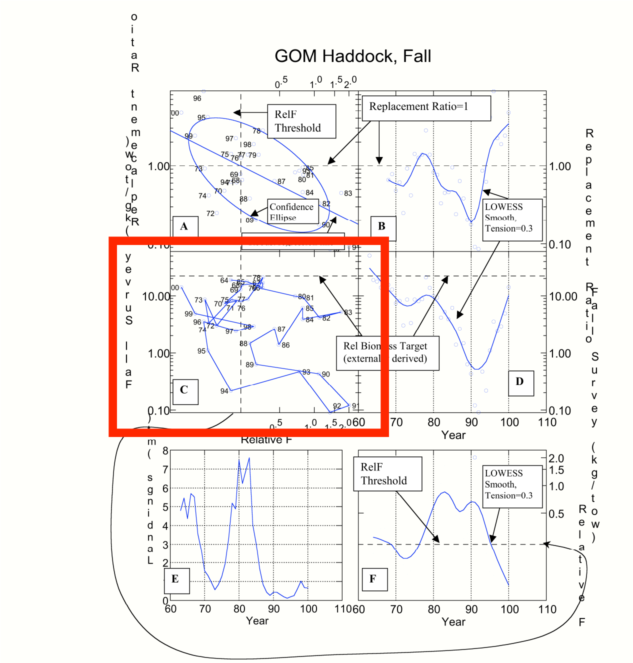
Derivation of relative F





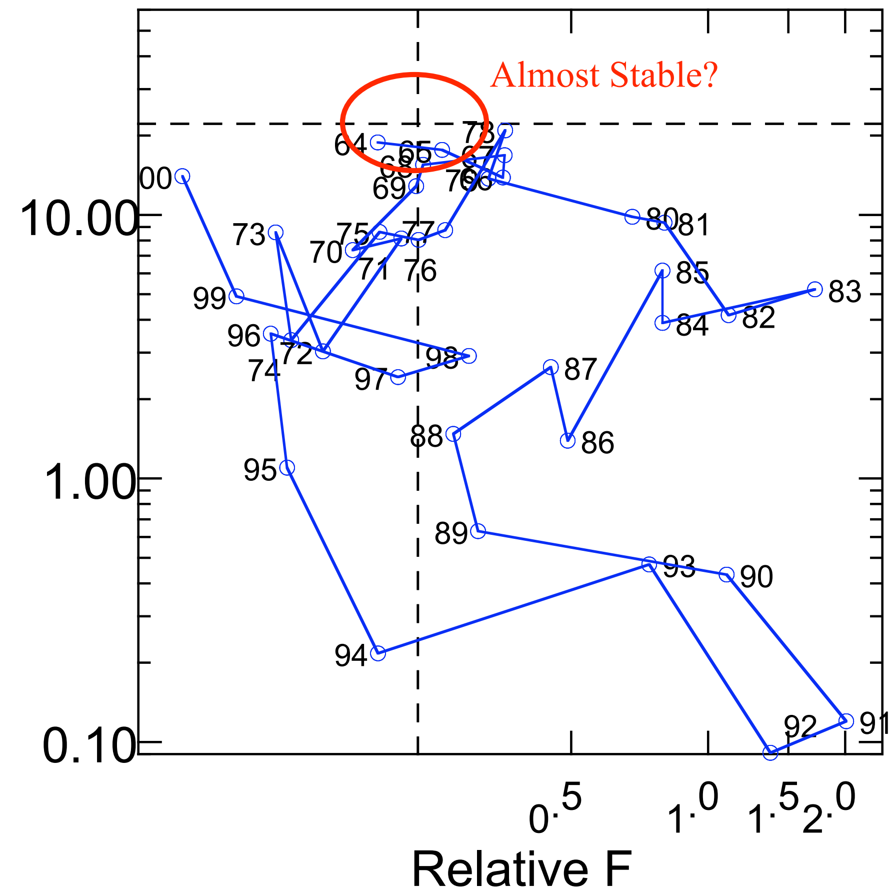




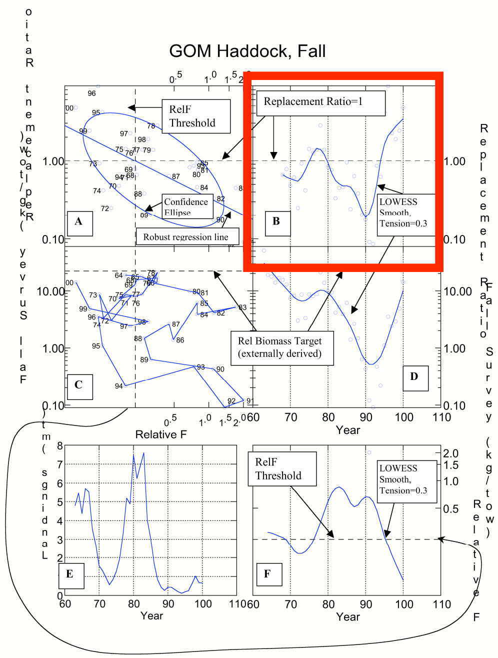


Phase-plane Survey vs relative F

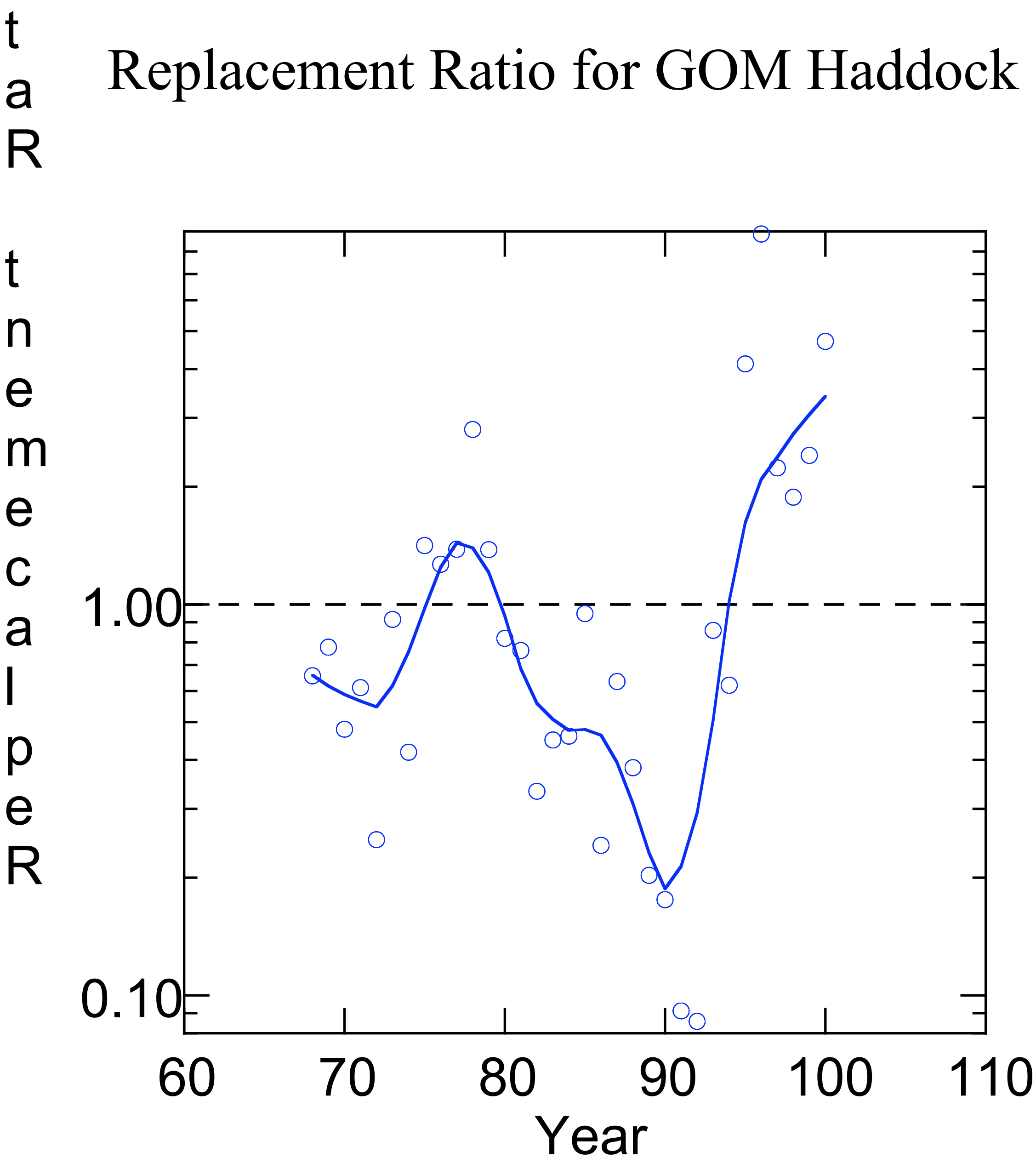
Gulf of Maine Haddock, Fall Survey

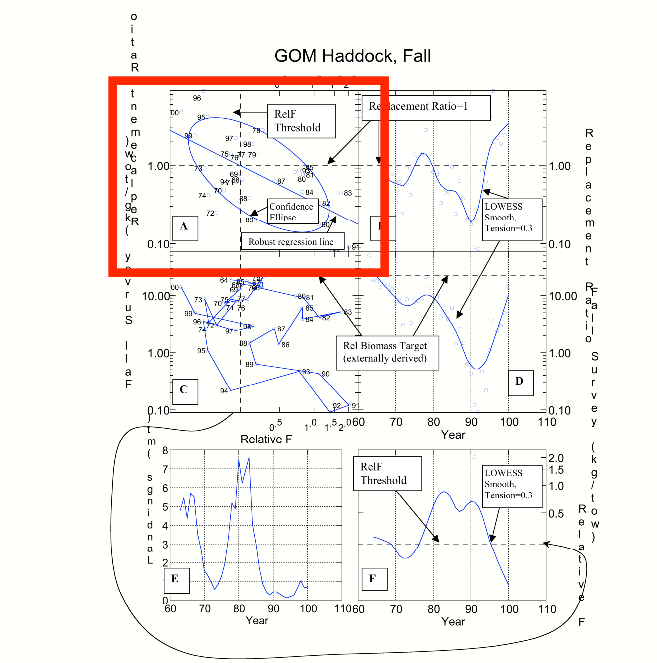


Note that the recovery path is generally different that the depletion path.

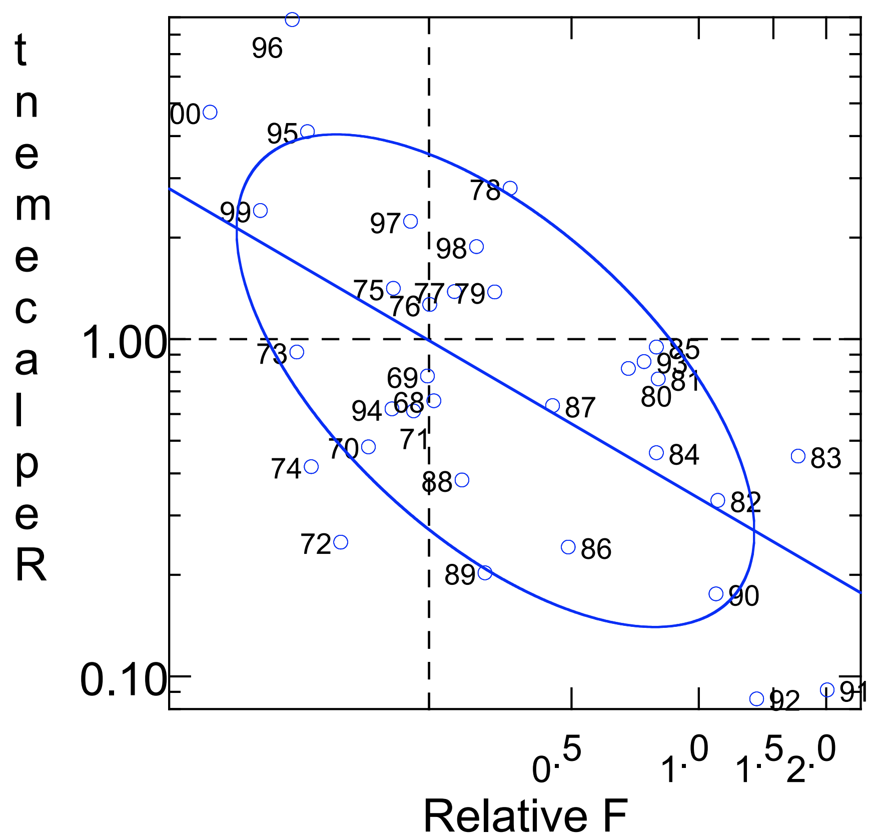


Replacement Ratio for GOM Haddock



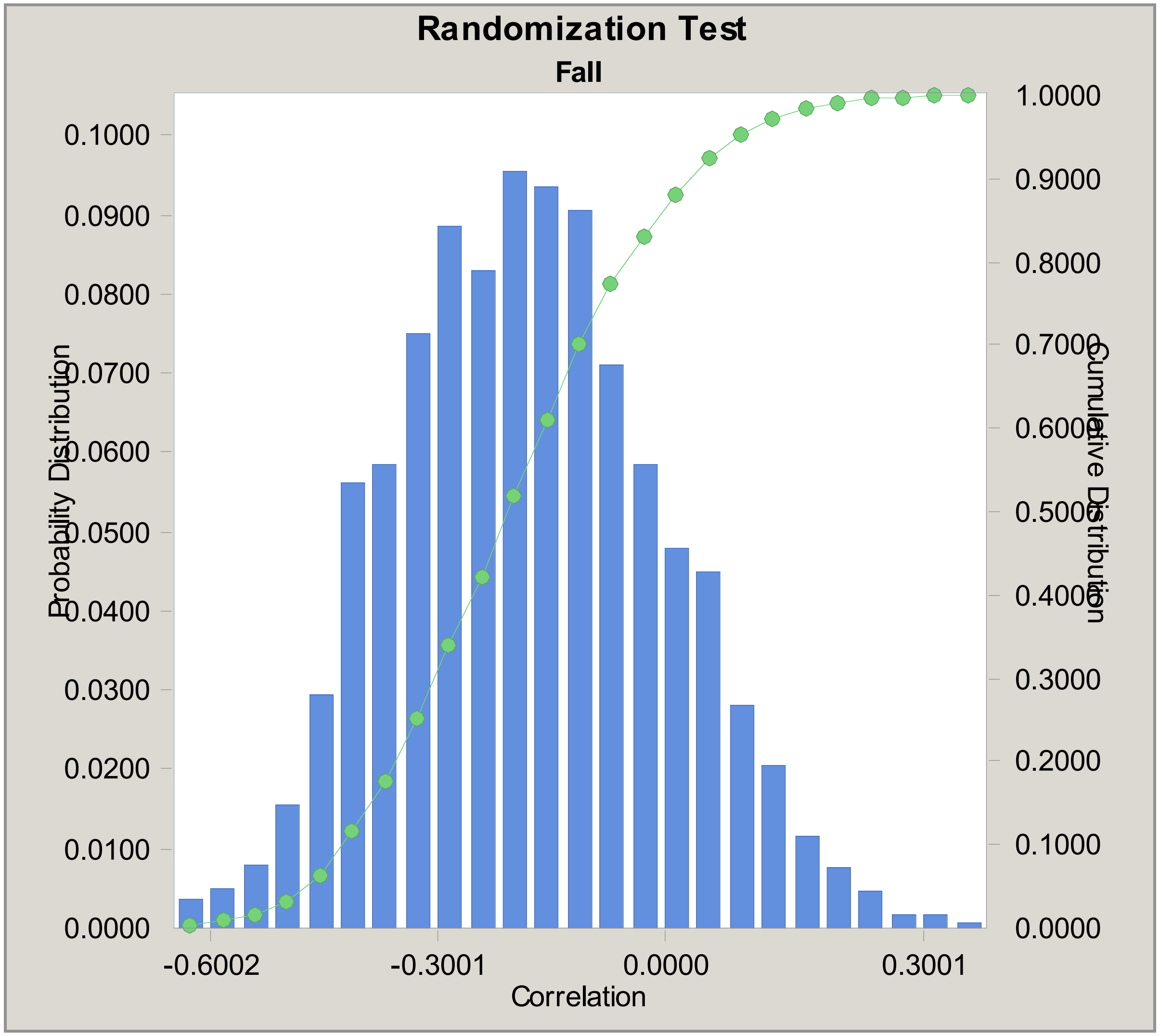


Gulf of Maine Haddock, Fall Survey

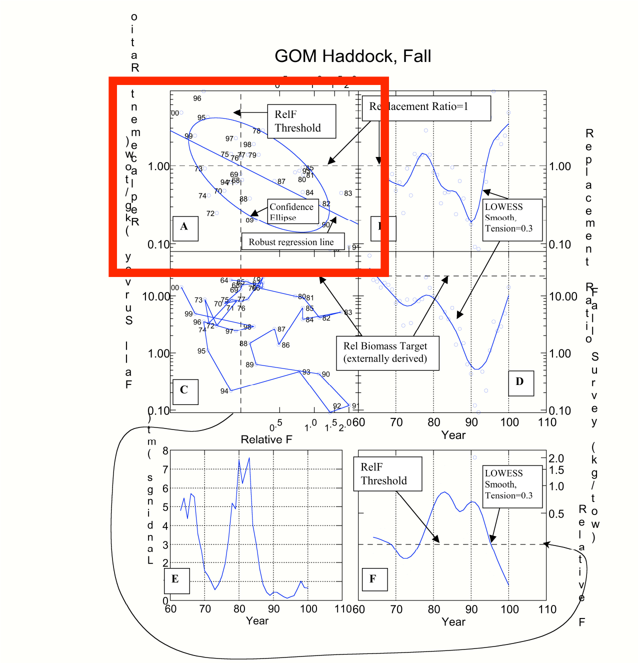


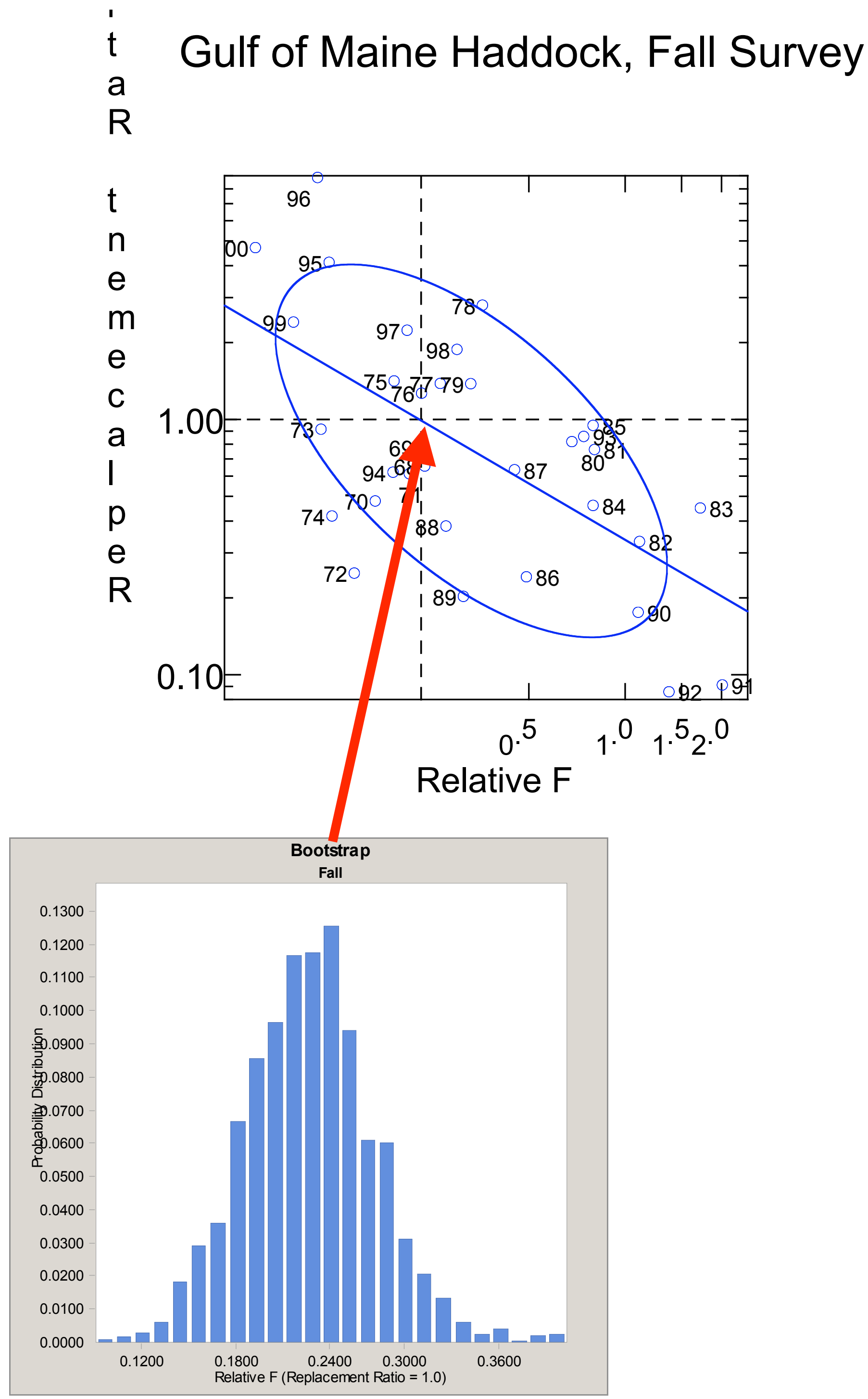
Negative correlation between replacement ratio and relative F is expected. Is it greater than expected due to chance alone?

Construct the sampling distribution of correlation coefficient using randomization techniques.



Observed Correlation between
Replacement ratio and relative F =-0.632
Prob(Corr<-0.632)<0.001





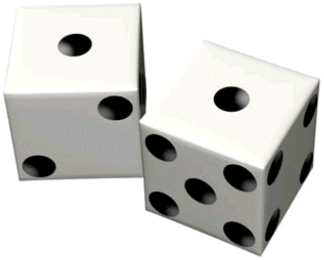
Use bootstrapping to estimate uncertainty in relative F at replacement.

Status Determination

- Current relF vs $relF_{threshold}$: overfishing
- Current index vs $index_{threshold}$: overfished
  - Need external info, $relF_{threshold} = MSY/index_{threshold}$

		Age-based Assessment	
		Overfishing	Not Overfishing
AIM	Overfishing	5	1
	Not Overfishing	1	5

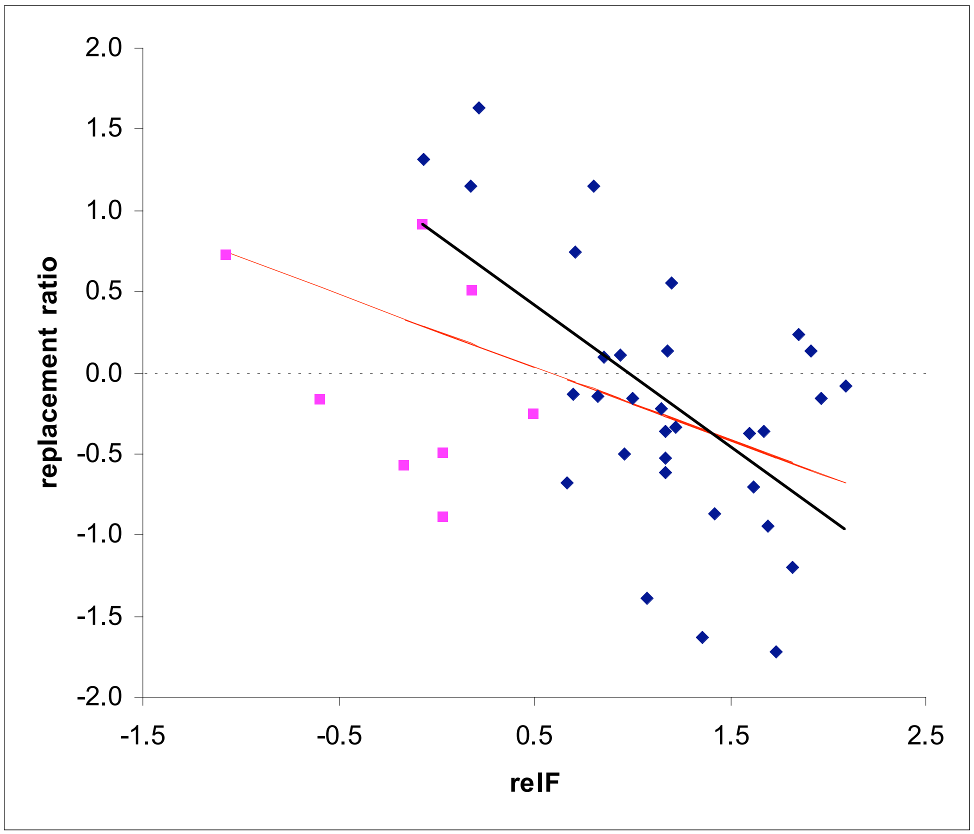
Odds ratio 25

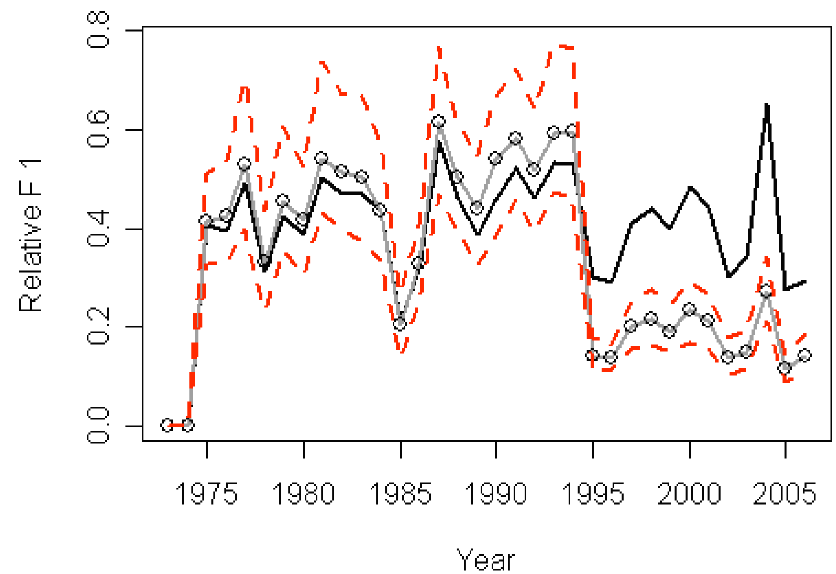


		Age-based Assessment	
		Overfishing	Not Overfishing
AIM	Overfishing	9	2
	Not Overfishing	3	8

Odds ratio 12

Nonstationarity





Simple models can fail when complex models fail

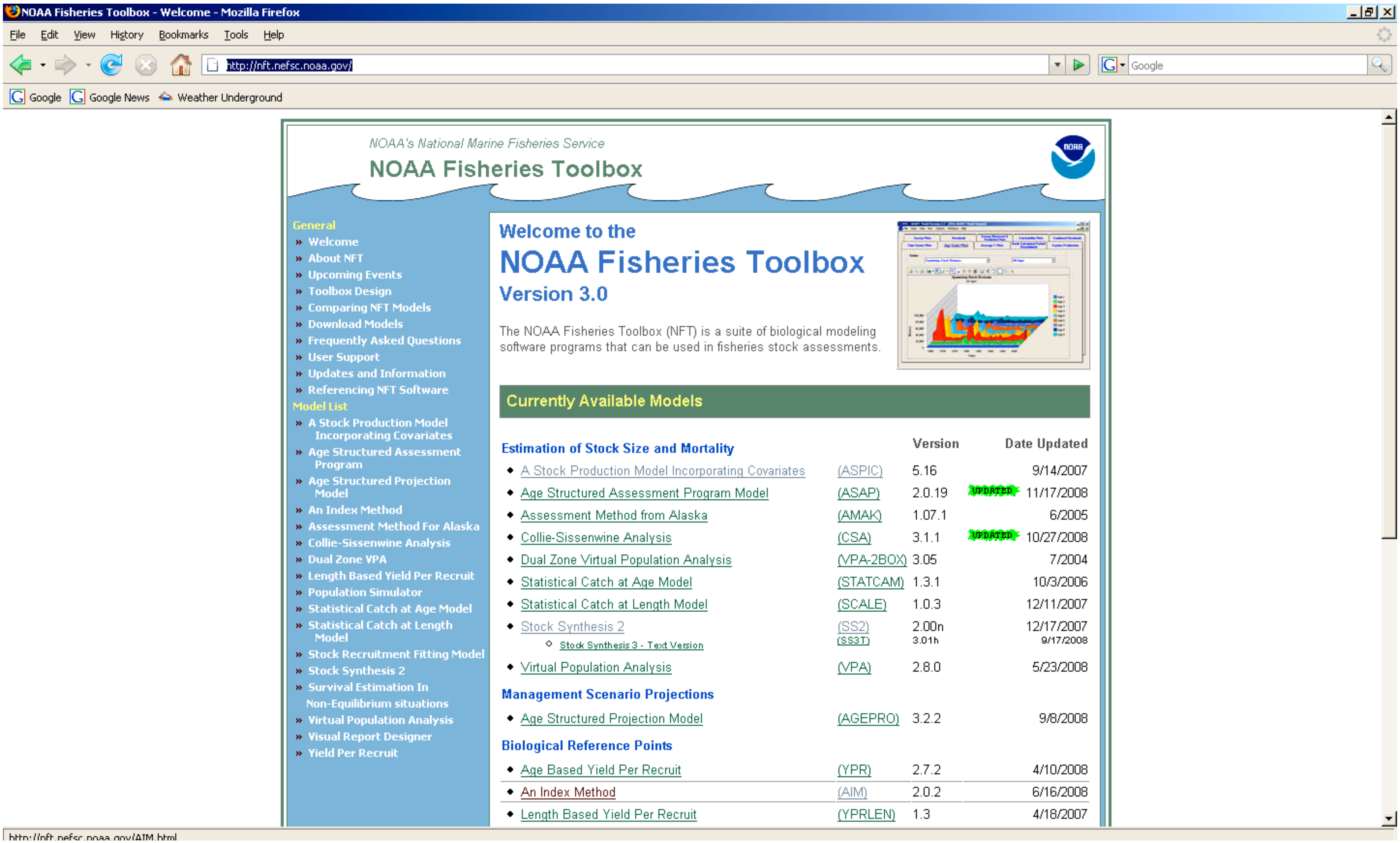
What Else Can Go Wrong?

- Infinite number of replacement levels
- Time series only heavily over or under fished
  - Will still get an estimated $relF_{threshold}$, but may not be optimal
- Strong recruitment pulse can cause positive relationship between relF and replacement ratio
- Too much noise in catch or index can result in non-significant relationship between relF and replacement ratio
- Catch may not be major influence on abundance

What Isn't Needed

- Biology
  - M
  - Longevity
  - Maturity
- Fishery
  - Selectivity
- Index
  - Catchability coefficient
- Large amount of time to conduct analysis

http://nft.nefsc.noaa.gov/



NOAA Fisheries Toolbox - Welcome - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://nft.nefsc.noaa.gov/

Google Google News Weather Underground

NOAA's National Marine Fisheries Service

NOAA Fisheries Toolbox

General

- Welcome
- About NFT
- Upcoming Events
- Toolbox Design
- Comparing NFT Models
- Download Models
- Frequently Asked Questions
- User Support
- Updates and Information
- Referencing NFT Software

Model List

- A Stock Production Model Incorporating Covariates
- Age Structured Assessment Program
- Age Structured Projection Model
- An Index Method
- Assessment Method For Alaska
- Collie-Sissenwine Analysis
- Dual Zone VPA
- Length Based Yield Per Recruit
- Population Simulator
- Statistical Catch at Age Model
- Statistical Catch at Length Model
- Stock Recruitment Fitting Model
- Stock Synthesis 2
- Survival Estimation In Non-Equilibrium situations
- Virtual Population Analysis
- Visual Report Designer
- Yield Per Recruit

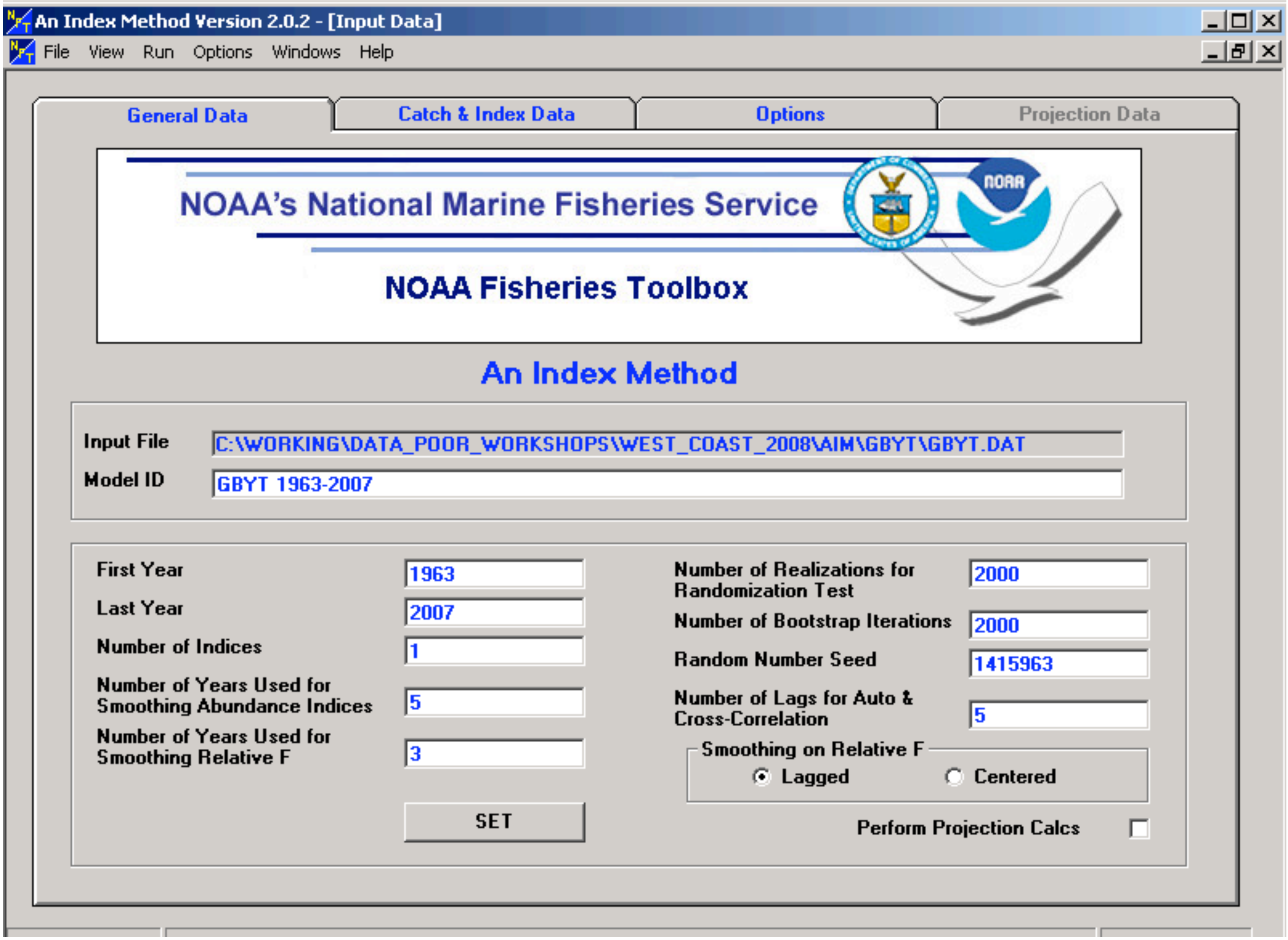
Welcome to the
NOAA Fisheries Toolbox
Version 3.0

The NOAA Fisheries Toolbox (NFT) is a suite of biological modeling software programs that can be used in fisheries stock assessments.

Currently Available Models

Estimation of Stock Size and Mortality		Version		Date Updated
A Stock Production Model Incorporating Covariates	(ASPIC)	5.16		9/14/2007
Age Structured Assessment Program Model	(ASAP)	2.0.19	UPDATED	11/17/2008
Assessment Method from Alaska	(AMAK)	1.07.1		6/2005
Collie-Sissenwine Analysis	(CSA)	3.1.1	UPDATED	10/27/2008
Dual Zone Virtual Population Analysis	(VPA-2BOX)	3.05		7/2004
Statistical Catch at Age Model	(STATCAM)	1.3.1		10/3/2006
Statistical Catch at Length Model	(SCALE)	1.0.3		12/11/2007
Stock Synthesis 2	(SS2)	2.00n		12/17/2007
Stock Synthesis 3 - Text Version	(SS3T)	3.01h		9/17/2008
Virtual Population Analysis	(VPA)	2.8.0		5/23/2008
Management Scenario Projections				
Age Structured Projection Model	(AGEPRO)	3.2.2		9/8/2008
Biological Reference Points				
Age Based Yield Per Recruit	(YPR)	2.7.2		4/10/2008
An Index Method	(AIM)	2.0.2		6/16/2008
Length Based Yield Per Recruit	(YPRLEN)	1.3		4/18/2007

http://nft.nefsc.noaa.gov/AIM.html


An Index Method Version 2.0.2 - [Input Data]
File View Run Options Windows Help
General Data
Catch & Index Data
Options
Projection Data
NOAA's National Marine Fisheries Service
NOAA Fisheries Toolbox
An Index Method
Input File
C:\WORKING\DATA_POOR_WORKSHOPS\WEST_COAST_2008\AIM\GBYT\GBYT.DAT
Model ID
GBYT 1963-2007
First Year
1963
Last Year
2007
Number of Indices
1
Number of Years Used for Smoothing Abundance Indices
5
Number of Years Used for Smoothing Relative F
3
SET
Number of Realizations for Randomization Test
2000
Number of Bootstrap Iterations
2000
Random Number Seed
1415963
Number of Lags for Auto & Cross-Correlation
5
Smoothing on Relative F
Lagged
Centered
Perform Projection Calcs

Suggestions for California

- Apply simple methods such as AIM to all stocks with available data
  - Some models won't work
    - Diagnostics might hint towards what went wrong to guide future data collection
    - Not much invested, so not much lost
  - Some models will work
    - Quick advice
    - Evaluate whether more data collection warranted
- Simple ≠ bad