

SAW 55 WG
Gulf of Maine Cod
Experience with Risk Assessment

Data:	27 – 31 August
Modeling:	15 – 19 October
Reference Points:	29 Oct – 2 November

Definitions

- Risk

- Chance of something happening that will negatively impact achievement of objective
- Consequences (Impacts) x their probability given management decision

- Risk Analysis

- Risk Assessment: Evaluate risks
- Risk Management: Compare decisions: Utility Analysis (relative acceptability of outcomes)

**We are doing (somewhat) Risk Assessment
Need tools to aid Risk Management**

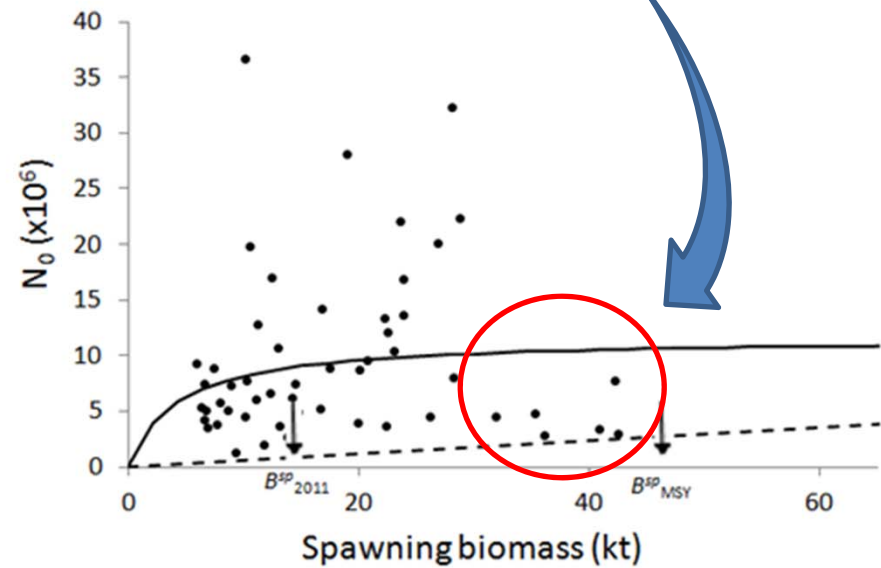
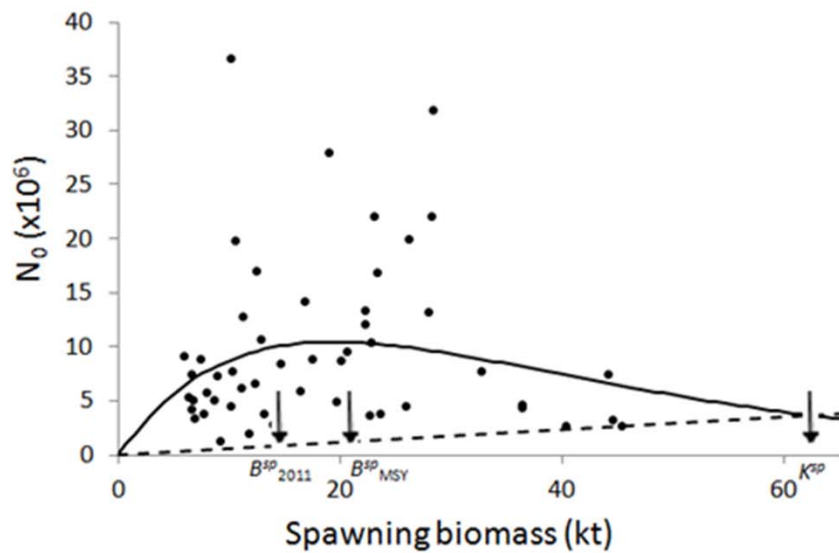
SAW 55

Assessment Models & Issues Considered

Component	Data/Parameter	Options
Age / Year	Start Year	1932 with internal SR vs. 1982 with SPR proxies
	End Year	2011 vs. 2012
	Start & end age	Age 0 vs. 1 & 9+
Fishery	Error in catch	CV = 0.05
	Selectivity blocks	Four (Pre-1982, 1982-88; 1989-2004; 2005-2011)
	Selectivity at age	Flat-topped vs. Domed
Survey	Aggregate index	Numbers vs. biomass
	Bigelow/Albatross calibration	Estimated internally vs. externally
	Error in proportions at age	Multinomial vs. Sqrt (p)
	Weightings in OF	Square of Sums vs. Sum of Squares
	Selectivity at age	Flat-topped vs. Domed
Biology	Natural Mortality	M = 0.2 vs M ramp

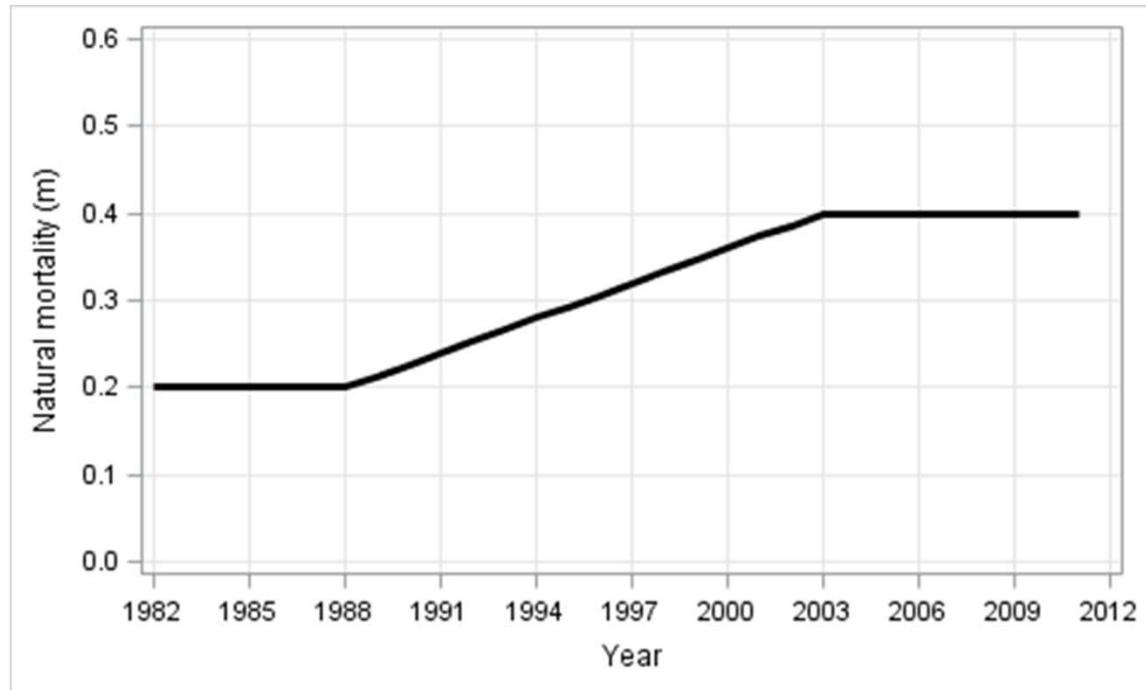
Main Issue 1

- Use of pre-1982 data to determine stock – recruit relationship
 - Influence of 1960s year-classes



Main Issue 2

- $M = 0.2$
- Change in Natural Mortality since mid-1980s?



Assessment Options

- Lack of consensus on which model should serve as basis for current stock status & management advice
 - Difference in support for models small & debated at length
- ‘Newly proposed model’ that of each lead scientist
 - ASAP: Proxy based RPs (1982 – present) & $M = 0.2$
 - SCAA: SR based RPs (1932 – present) & M ramp
- Support for & against SR data uncertainty & M developed
 - Similar to qualitative ‘Weight of Evidence’ approach of SAW 54; did not explicitly assign weight to each model

e.g. M Ramp Model Pros & Cons

- Pros

- Reduced retrospective pattern
- Objective function lowest (by 8-10 log-likelihood points compared to $M = 0.2$)
- Consistent with tagging if >50% reporting rate (2003-2006); $M > 0.4$ suggested
- In 4X, increased M (tagging data and peer-reviewed assessment (model-driven))

- Cons

- Diet composition data do not support M ramp
- Flat M profiles (for 2003-2011 with $M = 0.1$ through 0.6); sensitive to split year
- Conditions in 4X may not apply to GOM
- Earlier tagging studies did not incorporate movement; M's from these studies should not be compared
- No change in maturity-at-age, suggesting no change in M
- Meta-analysis (life history relationships) suggest $M = 0.2$ without time trend
- If reporting rate < 50% on high reward tags, $M < 0.4$

Consequence Analysis

- Risks associated with 2013 – 2015 projections (at 75% F_{MSY}) under competing assumptions of state of nature
 - i.e. if true state is $M = 0.2$ & 1982 – present productivity, what are consequences of setting catch based on alternative (3) states of nature
- 2012 catch provided by NEFMC Groundfish PDT
- Projections only until 2015
 - Longer term consequences beyond current terms of reference

Risk Assessment

Consequence = Stock Indicator in relation to Reference Point

Pr (consequence) = 50%

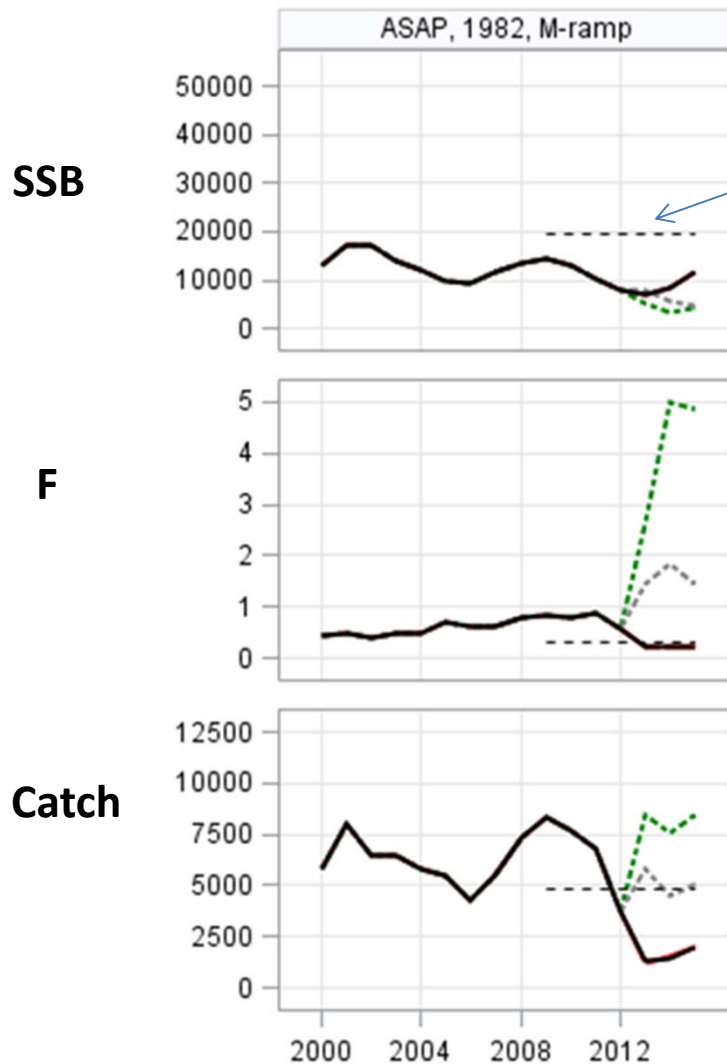
Consequence Analysis

- 16 scenarios of SSB, F & Catch
- ‘True State of Nature’ x Basis of Management Action

			True State of Nature			
			Proxy (1982+)		Stock – Recruit (1932+)	
			M 0.2	Mramp	M 0.2	Mramp
Basis of Management Action	Proxy (1982+)	M 0.2	Correct	Mis-spec	Mis-spec	Mis-spec
		Mramp	Mis-spec.	Correct	Mis-spec	Mis-spec
	Stock – Recruit (1932+)	M 0.2	Mis-spec	Mis-spec	Correct	
		Mramp	Mis-spec	Mis-spec	Mis-spec	Correct

State of Nature x Management Action

State of Nature

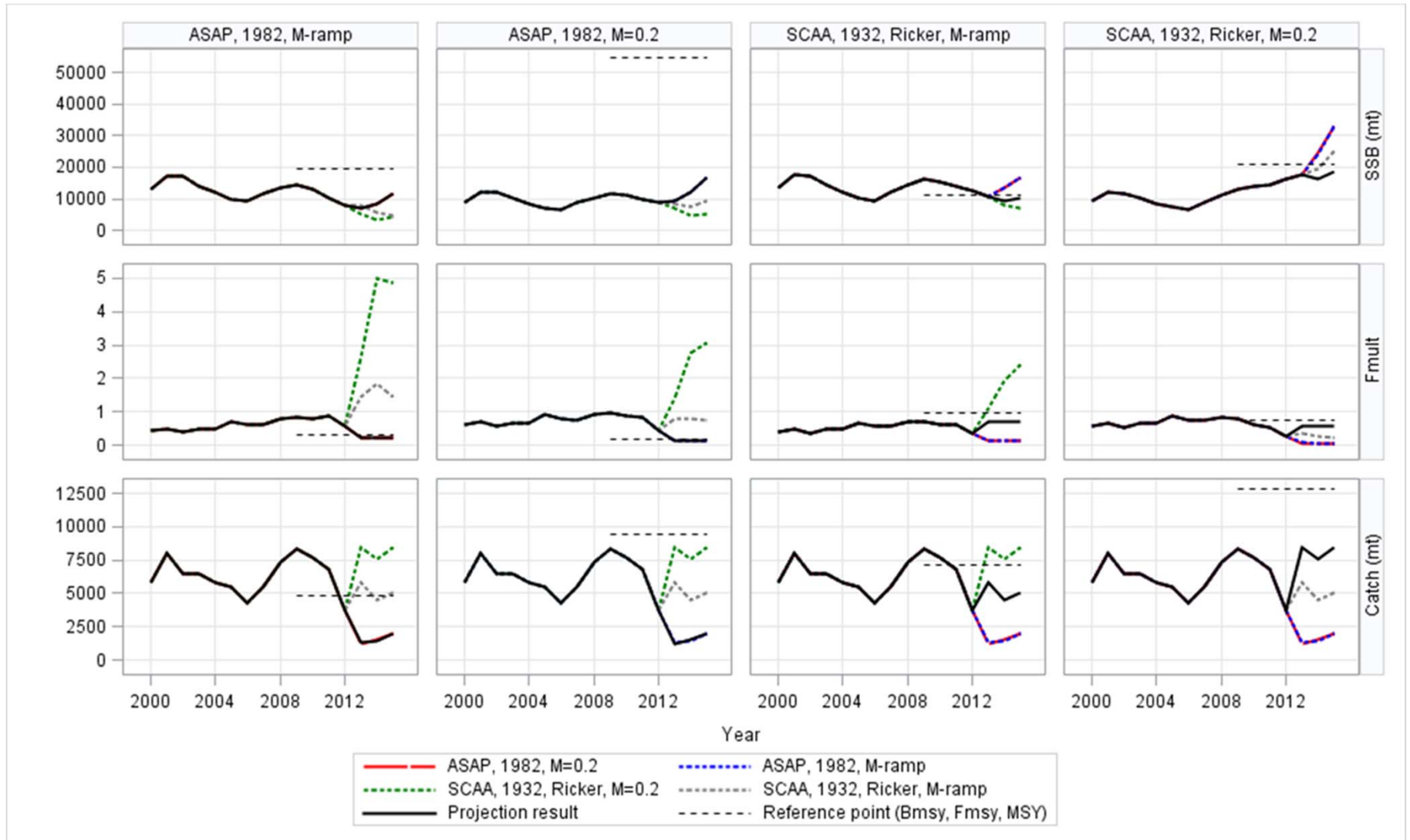


RPs

Lines of stock Indicators under different states of nature

- Solid = 'True' state
- Green = SCAA & M = 0.2
- Grey = SCAA & M ramp
- Red = ASAP & M = 0.2
- Blue = ASAP & M ramp

All States & Actions



Summary of Consequences (Risks)

- Mis-specification of stock-recruit dynamics has greater implications for management actions during 2013 – 2015 than mis-specification of natural mortality
- Mis-specification of natural mortality inconsequential (short-term but not long-term) if stock-recruit dynamics conform to SPR considerations but are more of an issue when recruitment is based on SR function

2013 Status (Decision Table)

			State of Nature			
			ASAP, 1982 start		SCAA, 1932 start, Ricker	
			M=0.2	M ramp	M=0.2	M ramp
Basis of Management Action	ASAP, 1982 start	M=0.2	Overfished, overfishing is not occurring	Overfished, overfishing is not occurring	Not overfished, overfishing is not occurring	Not overfished, overfishing is not occurring
		M-ramp	Overfished, overfishing is not occurring	Overfished, overfishing is not occurring	Not overfished, overfishing is not occurring	Not overfished, overfishing is not occurring
	SCAA, 1932 start, Ricker	M=0.2	Overfished, overfishing is occurring	Overfished, overfishing is occurring	Not overfished, overfishing is not occurring	Not overfished, overfishing is occurring
		M-ramp	Overfished, overfishing is occurring	Overfished, overfishing is occurring	Not overfished, overfishing is not occurring	Not overfished, overfishing is not occurring

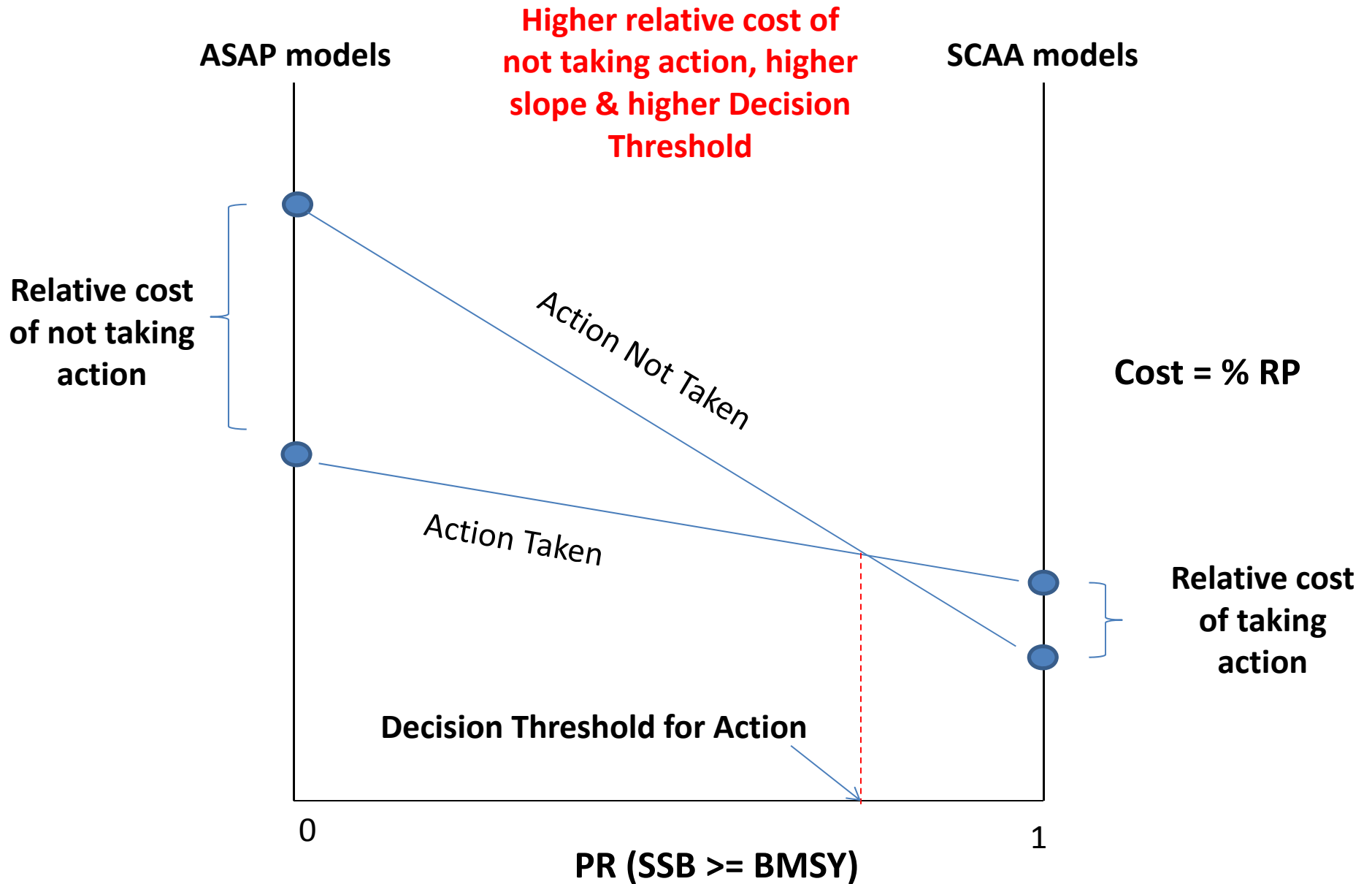
What did we learn?

- Management system not designed to address model uncertainty which can be large (Mohn, 2009: Fig 25.4)
- Consequence analysis informative to scientific community but not managers (communication issue)
 - Need better means & tools to communicate Risk

Risk Analysis Tools

- Methods to assign weights to alternative hypotheses
 - Quantitative & Expert Opinion (Bayesian?)
- Minimum levels of performance of stock indicators, not matter state of nature
 - If indicator above/below RP by x%, don't consider in analysis
- Marginal summaries
 - Aggregate risks across states of nature by management action
- Utility Analysis of management actions given uncertainty in states of nature
 - Goodman (2009) paper for example

Utility Function



Thanks!

$$M = 0.2$$

- Pros
 - None specifically identified (but see Cons to M ramp)
- Cons
 - Presence of retrospective pattern; however, transitory

M Ramp

- Pros

- Reduced retrospective pattern
- Objective function lowest (by 8-10 log-likelihood points compared to $M = 0.2$)
- Consistent with tagging if >50% reporting rate (2003-2006); $M > 0.4$ suggested
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- Cons

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SR –based RPs (1932 – present) - Pros

- Survey length (1963-1969) & age data (since 1970) provide info on late 1960s recruitment
- Alternative assumptions on commercial selectivity (pre-1982) make minimal differences to RP estimates
- Sensitivity analyses did not indicate qualitative differences in RPs
- Estimation takes into account of uncertainty in catch & sampling
- Estimates of SSB_{MSY} facilitated by longer time series; avoids use of SSB_{MSY} proxies
- Preference (small) for Ricker over BH
- Ricker-derived SSB_{MSY} estimate reasonably precise (CV ≈ 0.15); however, SSB_{2011} is more precise when BH model used
- Evidence for cannibalism seen in cod populations; however, no evidence for post-larval cannibalism in GOM or Georges Bank cod

SR – based RPs (1932 – present) - Cons

- SSB & recruits (1970 – present) same; 1960s data basis for SR relationships; no age composition data & fishery data most uncertain
- Little difference (LnL) between Ricker & BH models fits (1963 – 69 SR residuals); Ricker & BH residuals positive during 1977-87 (high catch)
- Simulations indicate propensity to fit SR domes when BH true; results depend heavily on scenario (e.g. length of time series) & may not apply
- Ricker- based F_{MSY} is greater than F_{MAX} ; expected when domed SR
- If productivity change over time, long-term RPs weighted average over time series which may not reflect current conditions

Proxy based RPs (1982 – present)

- Pros
 - Very high data density; estimates of survey, commercial & recreational catch-at-age & discards as well as biological information such as maturity & L/W relationships available
 - Biomass & reference points robust to wide range of model assumptions & uncertainties
- Cons
 - Insufficient contrast to estimate SR relationship, which necessitates use of F_{MSY} proxy
 - Uncertainties associated with choice of appropriate reference percent spawner per recruit

When Natural Mortality Mis-Specified

- Proxy RPs (ASAP)
 - Catch, SSB and F_{full} very similar
 - 2013 stock status overfished & overfishing not occurring
- SR RPs (SCAA)
 - Assuming M ramp when $M = 0.2$ is true results in lower than 'planned' F & catch & higher than 'planned' SSB
 - 2013 stock status is still not overfished & overfishing not occurring
 - Assuming $M = 0.2$ when M-ramp is true, results in higher than 'planned' F & catch & lower than 'planned' SSB
 - 2013 stock status is still not overfished but overfishing occurring

When Stock – Recruit Mis-Specified

- More severe consequences
- If Catch based on proxy RPs (ASAP) when SR true (SCAA models), F & catch lower than ‘planned’ & SSB higher than ‘planned’
 - No change in 2013 status
- If Catch based on SR RPs (SCAA) when proxy RPs true (ASAP), F & catch much higher than ‘planned’ & SSB lower than ‘planned’, particularly if M also assumed = 0.2
 - 2013 stock status is overfished and overfishing regardless of M