Modeling Fishery Regulation & Compliance: A Case Study of the Yellowtail Rockfish

Or, prediction is hard!!

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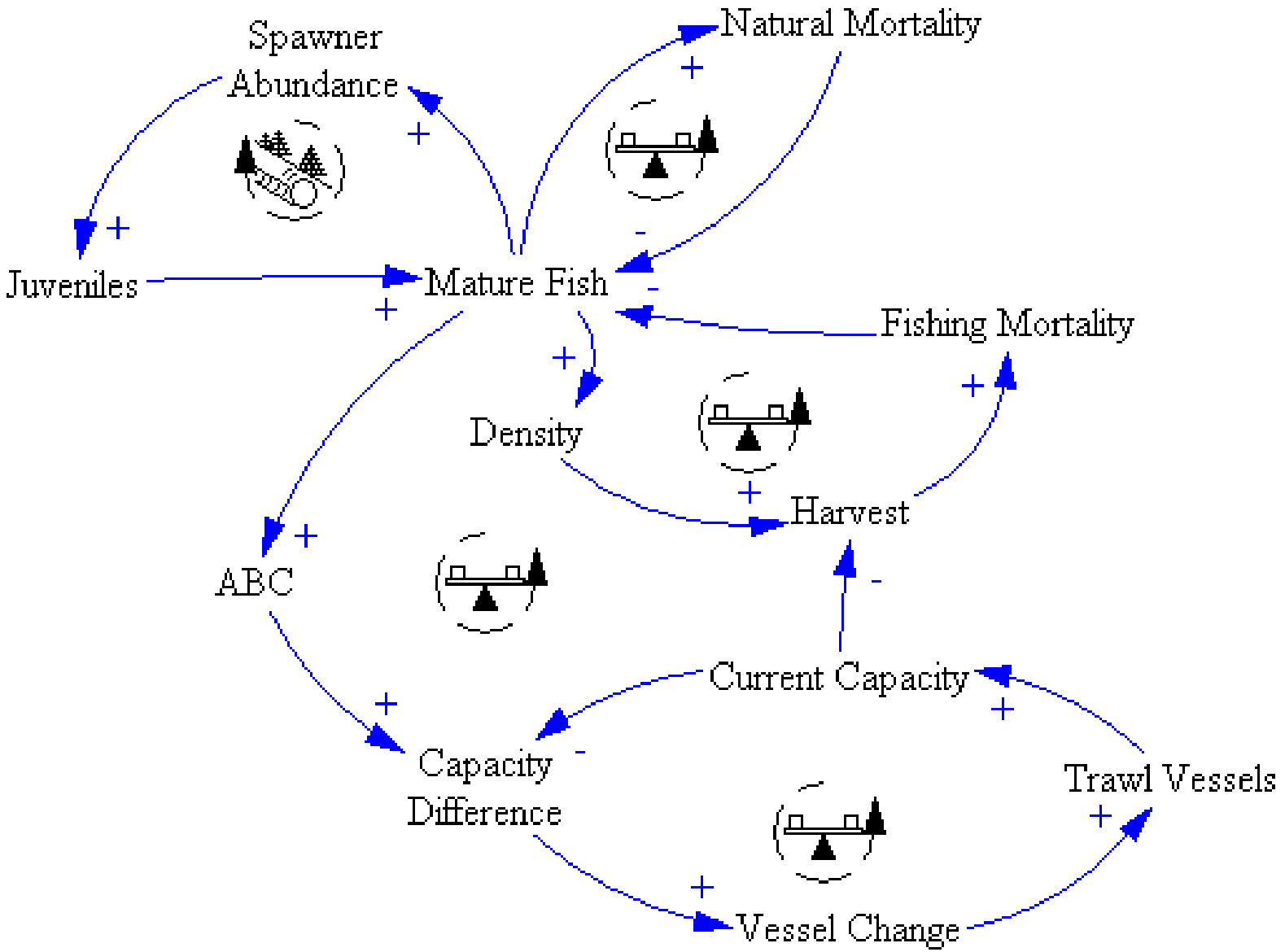
Purpose and Significance

- To determine predictive utility of models of fisheries regulation and compliance
- Why? Because fish populations have dropped dramatically in recent decades, and
- In January, 2000, the West Coast ground fish fisheries were declared a federal disaster
  - Poor ocean health? Too many vessels?
  - Higher fishing efficiency (CPUE)?
  - Low fisher compliance?
- Need more sustainable fishery mgmt policies

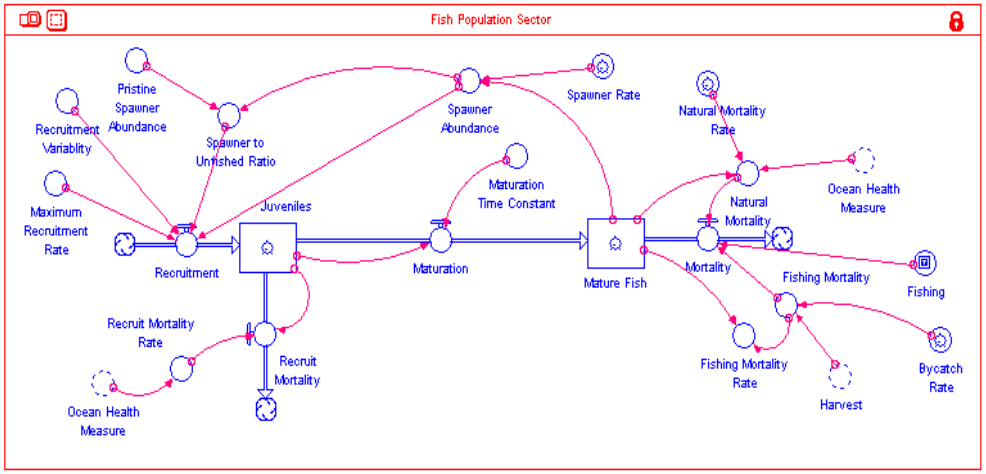
Background

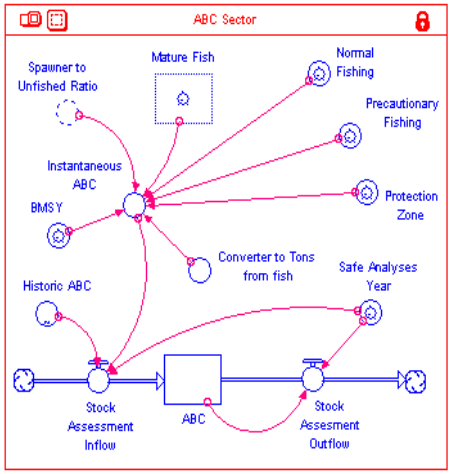
- Prior research modeled Pacific Yellowtail fishery population, vessels, harvest (Model I)
- But model fit to historical data was poor
  - Puzzling fisheries data (possibly wrong?)
- Model did help explain system structure and dynamics, and did help find leverage points
- Model was not well-suited to prediction
- Several model improvement opportunities were documented in the prior work

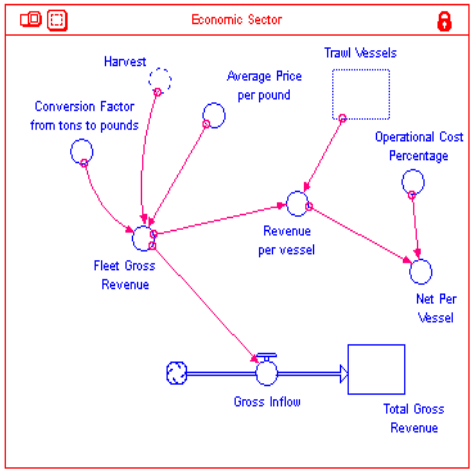
Loop Structure for Model I

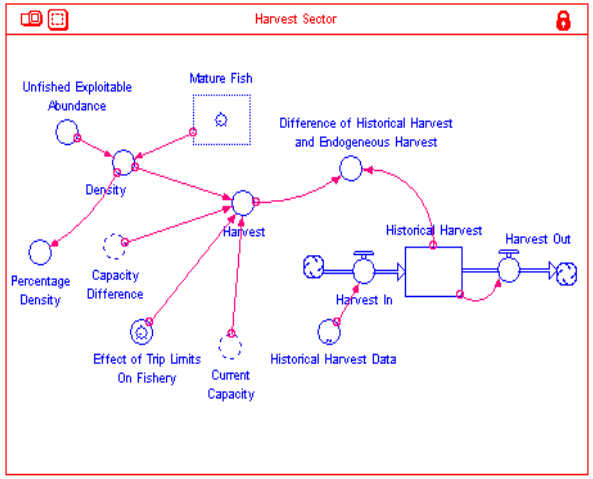


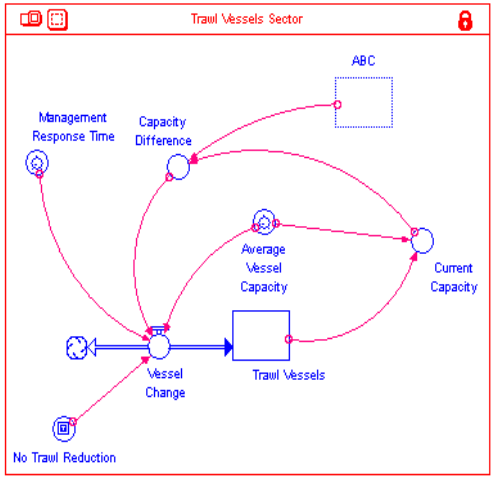
Model I Flow Diagram (yikes!)

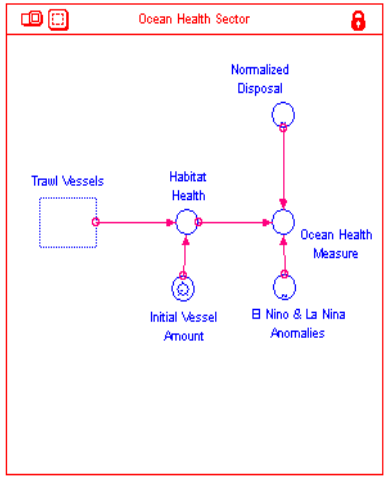


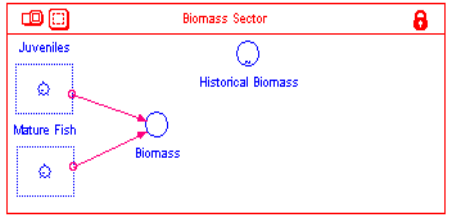


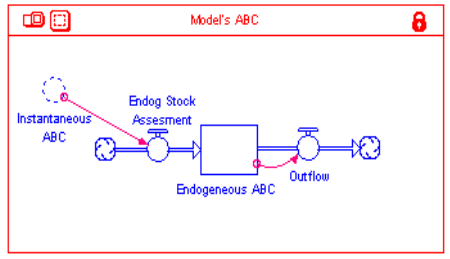




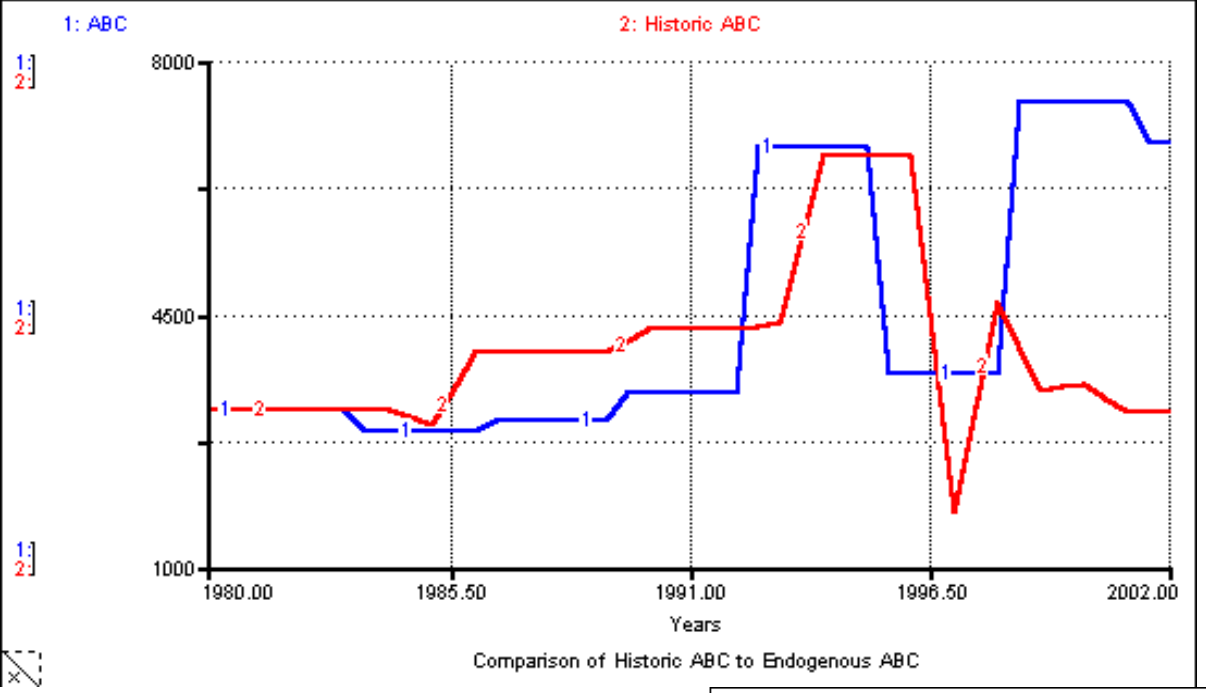




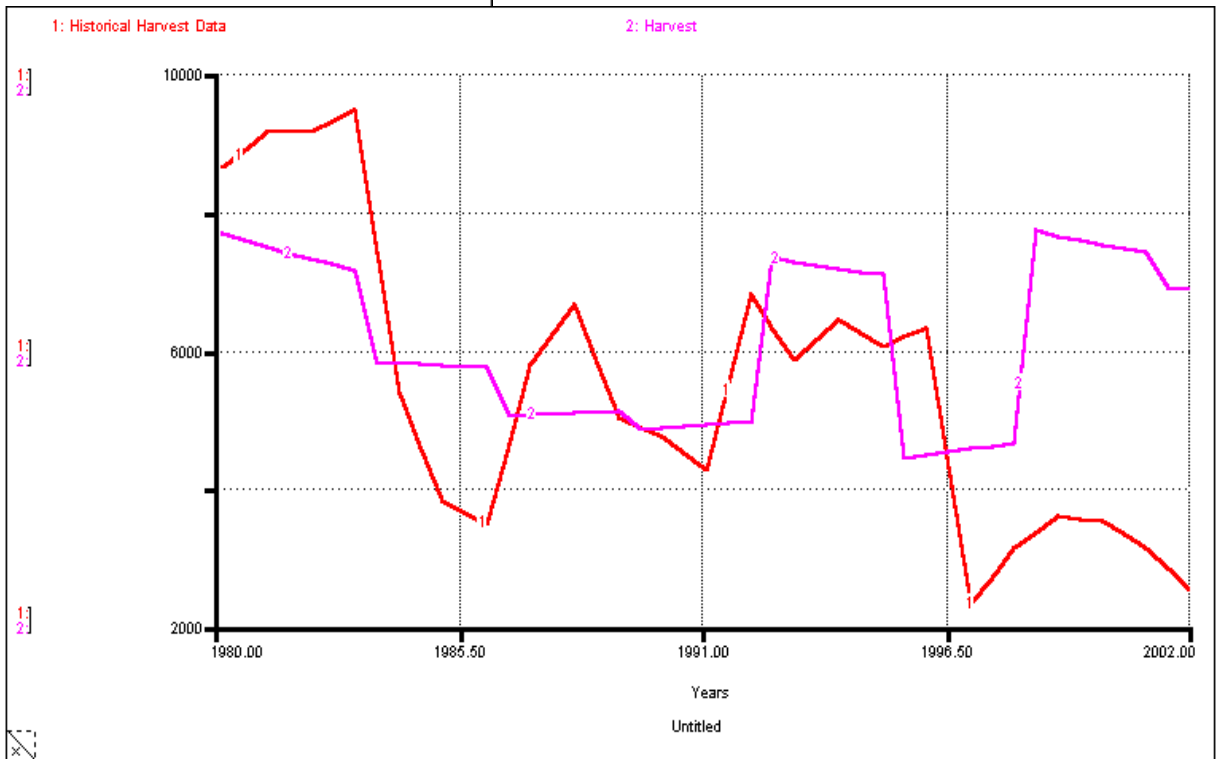




Reported Model I Results



Biomass not reported because it was obviously wrong…

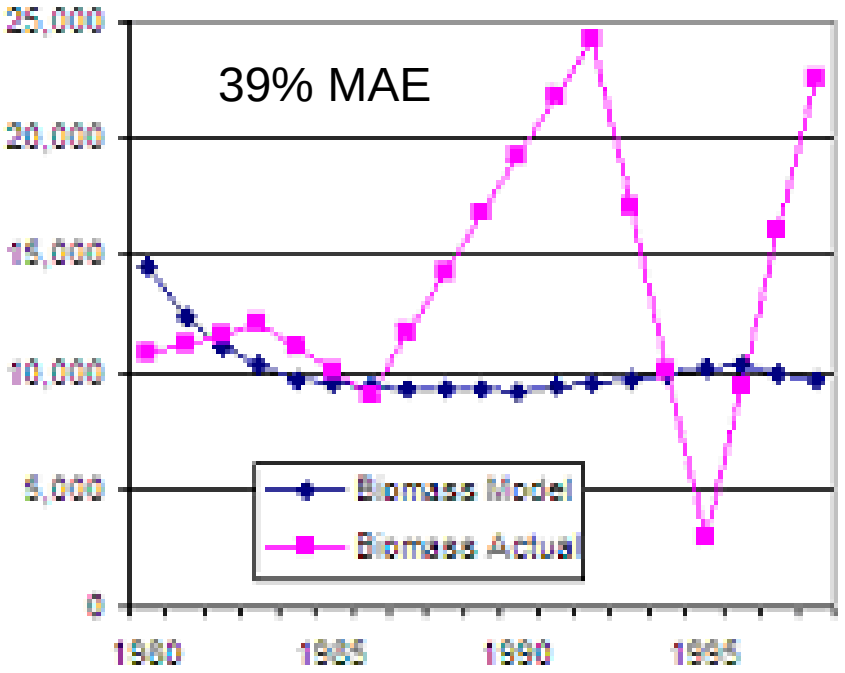


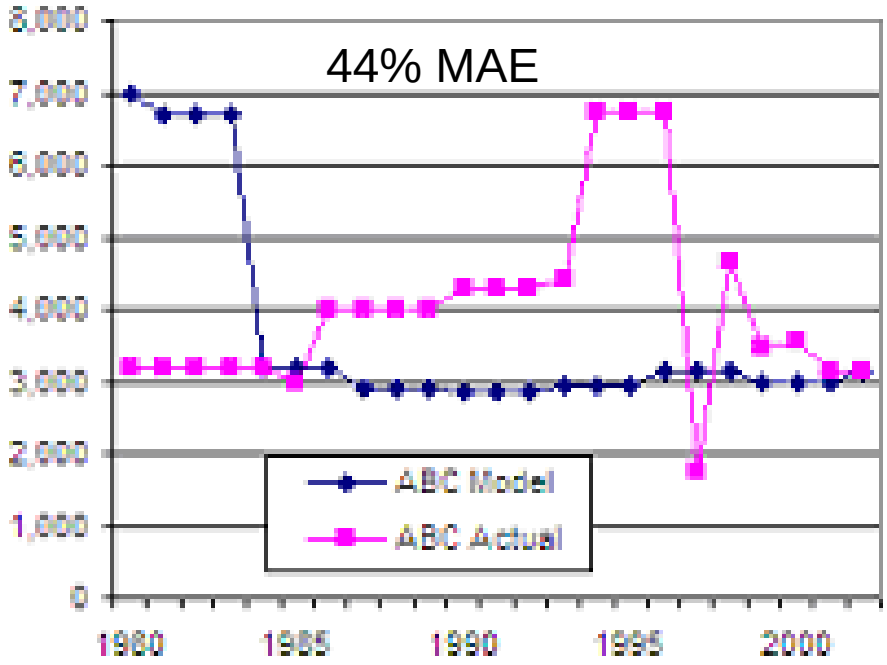
Present Research Approach

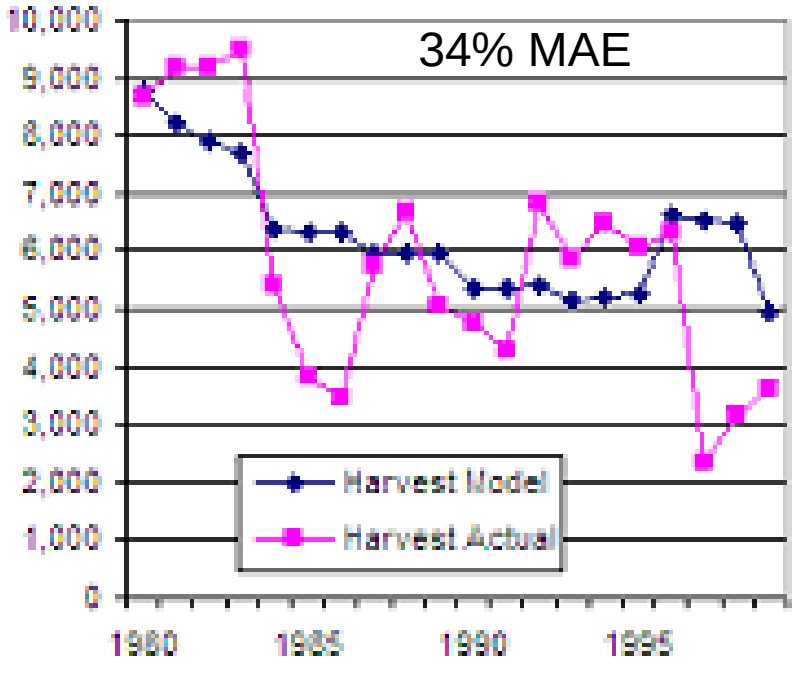
1. Fix error and extract predictions from Model I
   - For *biomass, acceptable bio. catch (ABC), and harvest*
2. Then, consider previously suggested model improvements
3. And re-review Model I logic to identify further issues
   - Especially regarding the fishery regulation logic and assumptions about fisher compliance
4. Revise logic to address 2 & 3 → create Model II
   - To better calculate (endogenously) the regulatory aspects of the fishery (*ABC* determination in particular)
5. Make predictions using Model II
6. Obtain new fishery data (2001-2006)
   - Collected by fisheries agencies since earlier work
7. Compare predictions from both models w/new data

Model I Revised Best Fit

A biomass units conversion error was corrected, which changed the ABC so that it was modeled as “unprotected” in 1990-1994. This ended up leading to harvest values close to actual.





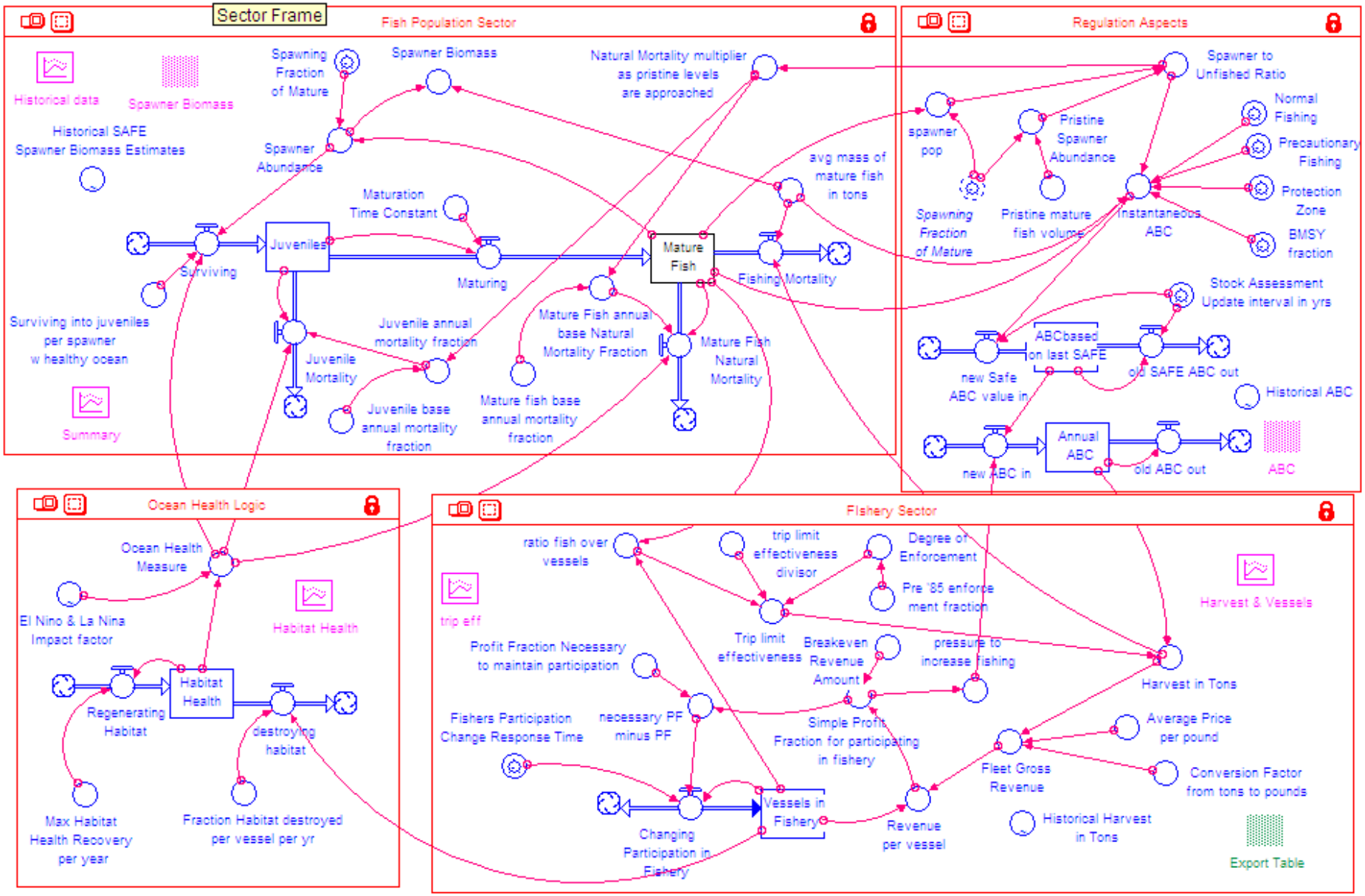


Logic Changes in Model II

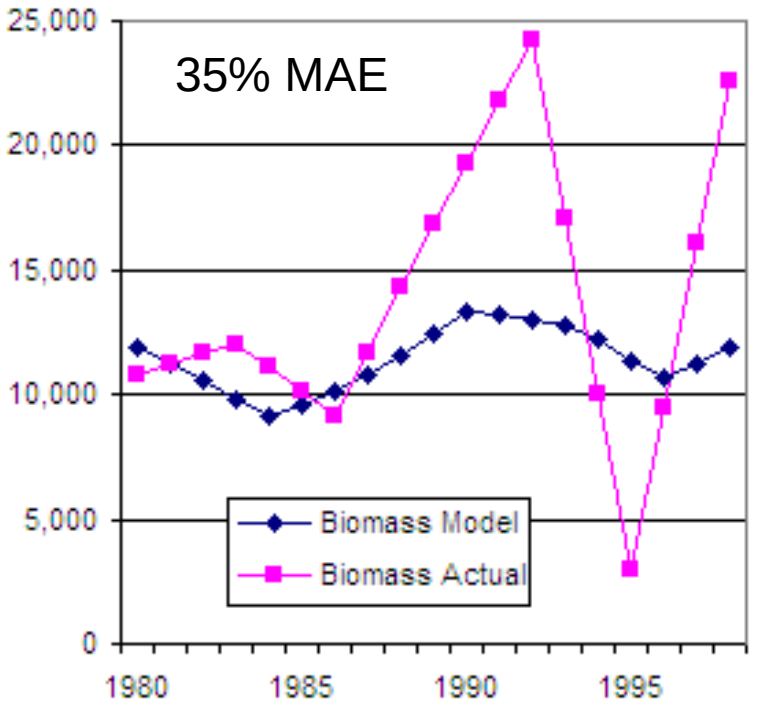
- Dynamic trip limits
- Connected the economic side of the system back to other aspects of the model
- Improved how ocean health impacts fish

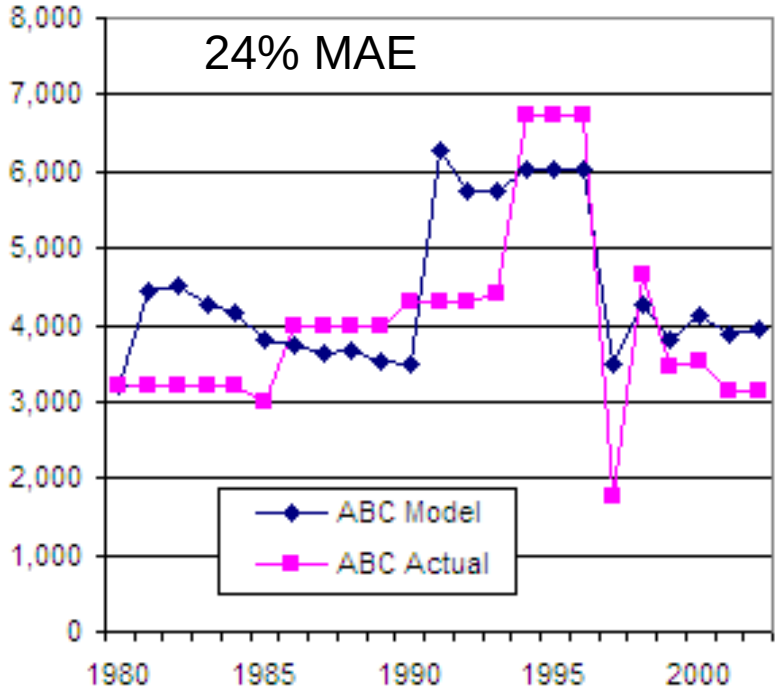
- Added endogenous logic for ABC
- Improved how ocean health is calculated
- Simplified and improved spawning logic
- Simplified and improved harvest logic
- Adjusted logic for natural fish death to reflect the impact of natural carrying capacity

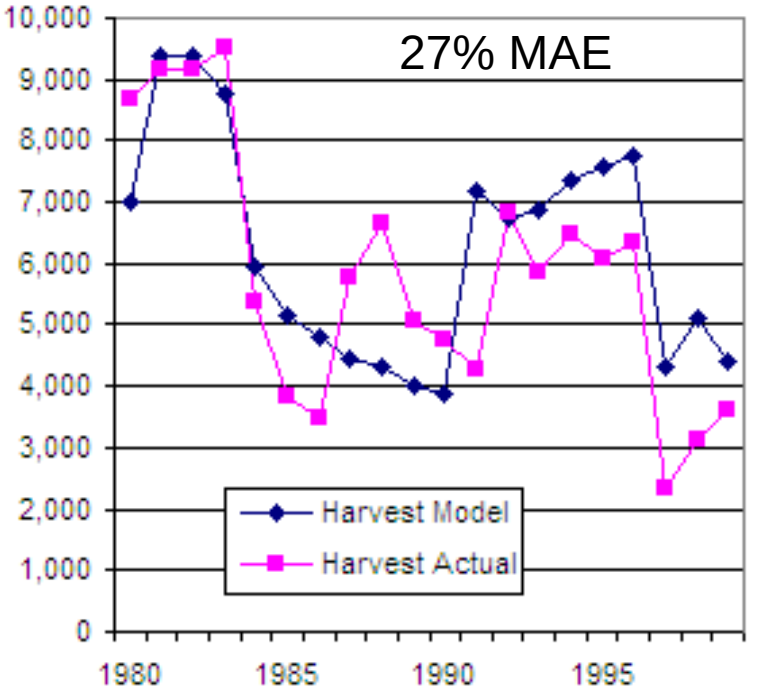
Model II Flow Diagram



Model II Best Fit Results



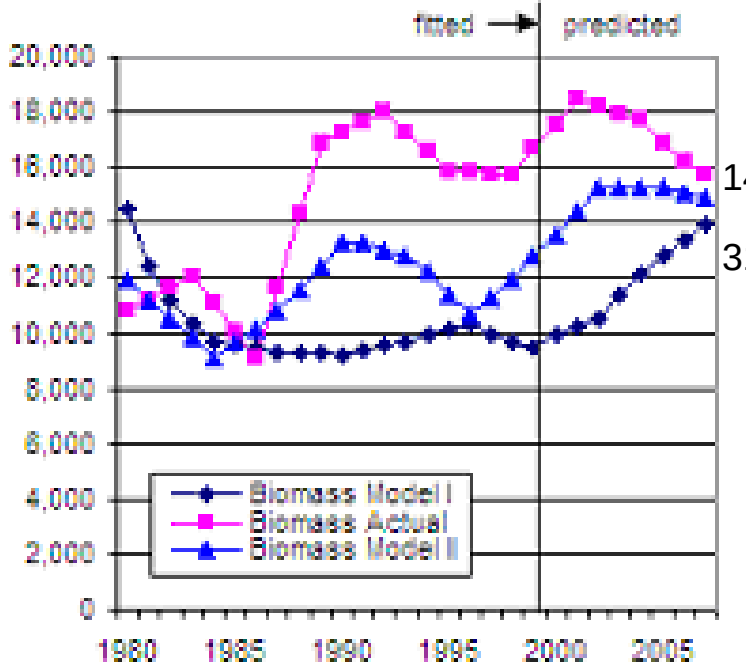




Model II Best Fit Parameter Values

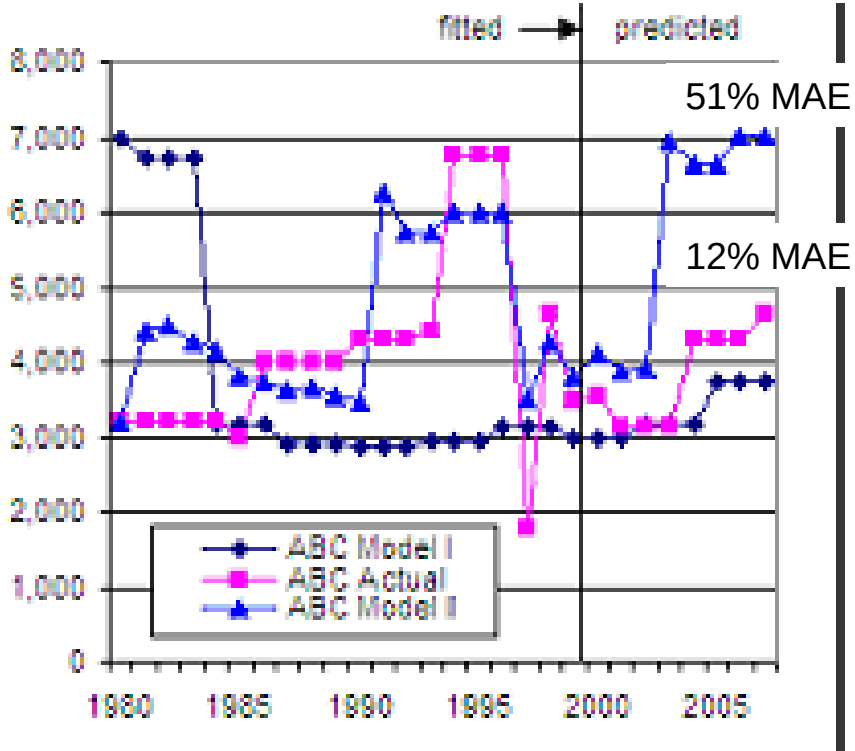
Parameter	**Plausible Range**	**Baseline Value**	**Final Value**
Surviving into juveniles per spawner w/healthy ocean	1 - 5	3	3.5
Recruit base annual mortality fraction	.1 - .3	.2	.23
Initial value for Mature Fish	20 – 30M	23.5M	27M
Pre '85 enforcement fraction	.5 - .8	.7	.7
Fishers Participation Change Response Time (Yrs.)	2 – 5	3	3
trip limit effectiveness divisor (fish/vessel)	200 – 300K	250K	250K

Model I & II Predicted vs. Actual Values



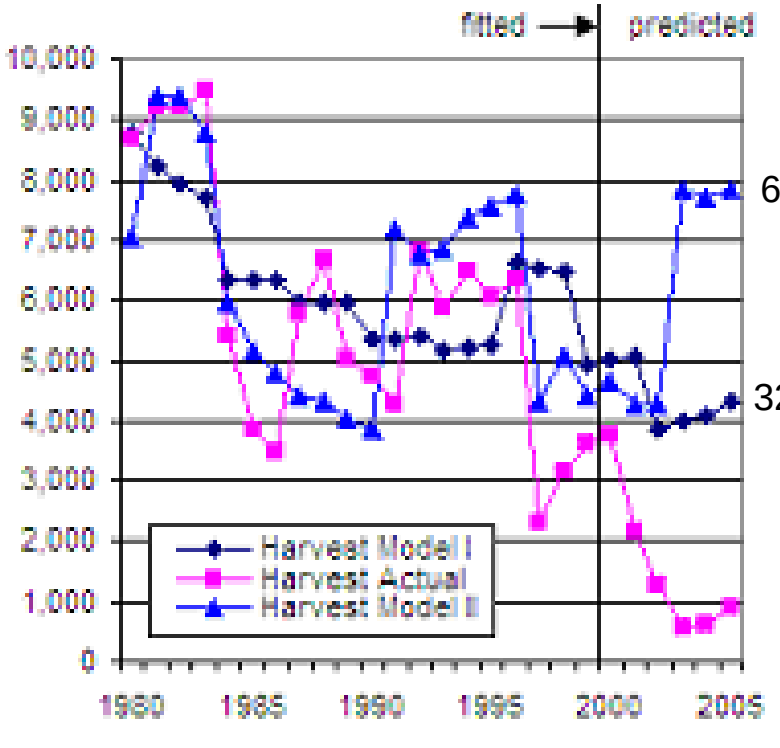
14% MAE

31% MAE



51% MAE

12% MAE



601% MAE

323% MAE

Discussion

- Yellowtail harvest was curtailed after 2002
  - For totally exogenous reasons
    - Another [co-mingled] fishery was in jeopardy and had to be shut down
    - Forcing the shutdown of the Yellowtail fishery as well, even though it was actually healthy
- Prediction is a very challenging!
- This case typifies the challenges associated with predicting *anything* in the real world!
- More work is needed to create truly robust models of fishery regulation and compliance
- Goal of finding sustainable policies not yet achieved