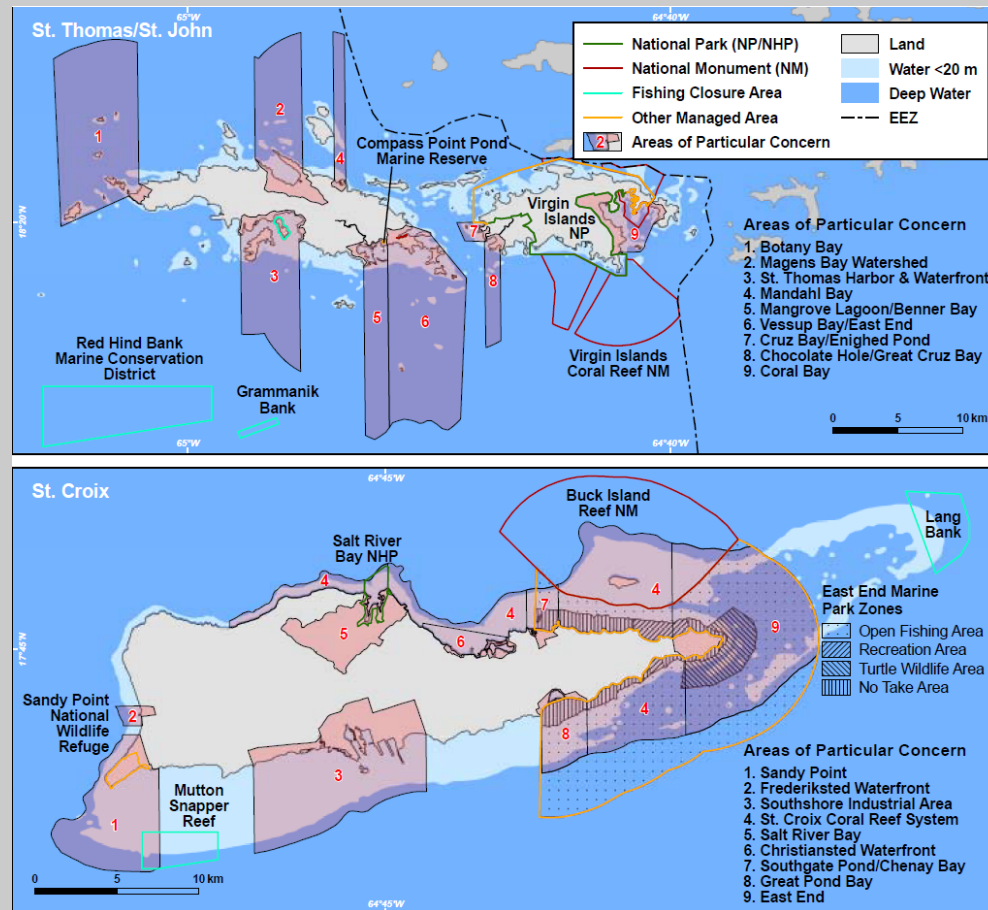


Marine Reserves and Fisheries Management



Exploring Tools for Improving Management of Data Poor Stocks Workshop
23-24 February 2011

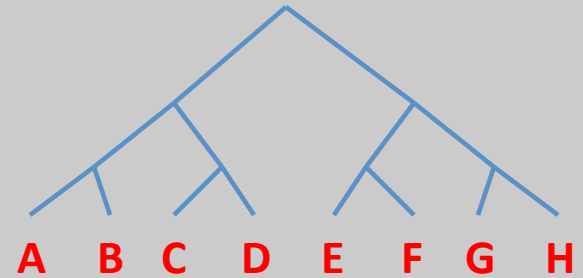
Jono Wilson

Use of Marine Reserves in Fisheries Management

- **Reserves to estimate natural mortality and/or fishing mortality**
 - Buxton 1993. Environmental Biology of Fishes
 - Smith et al. 1998. Canadian Journal of Fisheries and Aquatic Sciences
 - Attwood 2003. African Journal of Marine Science
 - Punt and Methot 2004. American Fisheries Society Symposium
 - Willis and Millar 2005. Ecology Letters
 - Taylor and McIlwain 2010. Marine Ecology Progress Series
 - Macpherson, Garcia-Rubies, and Gordo 2000. Marine Biology
- **Reserves as reference areas**
 - Wilson *et al.* 2010. Marine and Coastal Fisheries: Mgmt., Dynamics and Ecosystem Science
 - McGilliard *et al.* 2010. ICES Journal of Marine Science
 - Babcock and MacCall 2011. Canadian Journal of Fisheries and Aquatic Science

Marine reserve-based decision tree

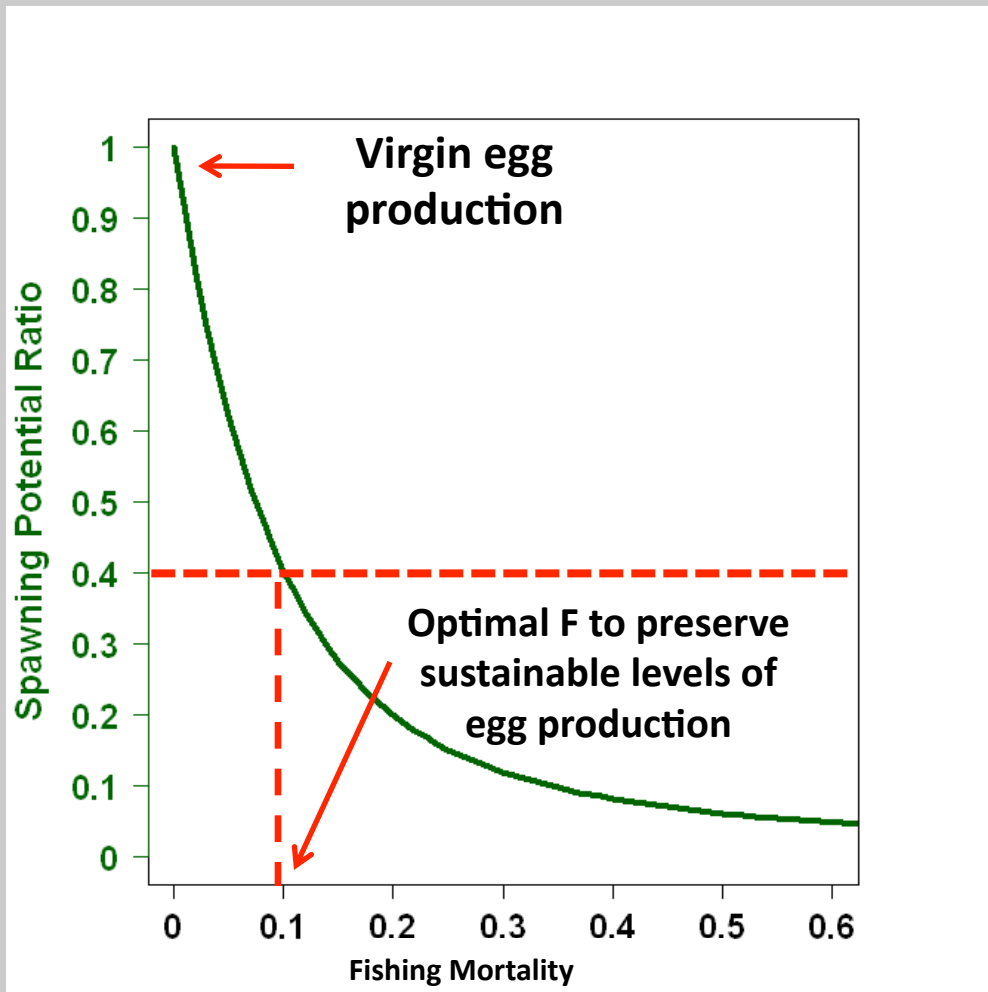
- Calculates recommended catch levels
- Invites collaboration
- Adaptive
- Transparent
- Applicable at many spatial scales



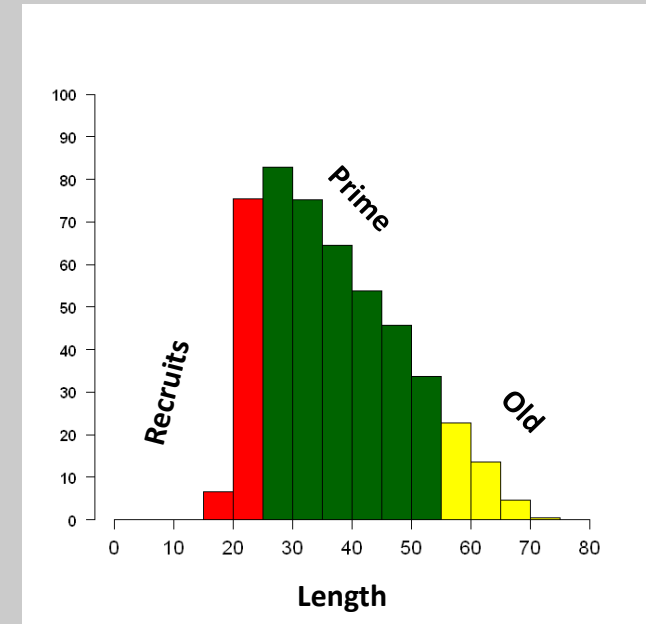
- Required Data Inputs
 - Representative scientific sampling program inside and outside of reserves
 - Length measurements
 - Measure of density (i.e. CPUE or SCUBA surveys)
 - Biological data (growth, maturity, fecundity, selectivity, natural mortality)

Spawning Potential Ratio

- Spawning Potential Ratio (SPR) = A measure of current egg production relative to virgin



Size structure at F50



Marine Reserve-Based Decision Tree

Level 1

Set initial ACL based on comparing CPUE of prime sized fish inside and outside of reserves



Level 2

Evaluate trend in CPUE (prime) in fished area over previous 5 years

rising

stable

falling



Level 3

Compare CPUE and proportion of old fish in catch to SPR40 levels



Level 4

Compare CPUE of young fish to SPR50 levels

make readjustment on initial ACL

Evaluate CPUE of young fish over past 5 years

make readjustment on initial ACL

Evaluate CPUE of young fish over past 5 years

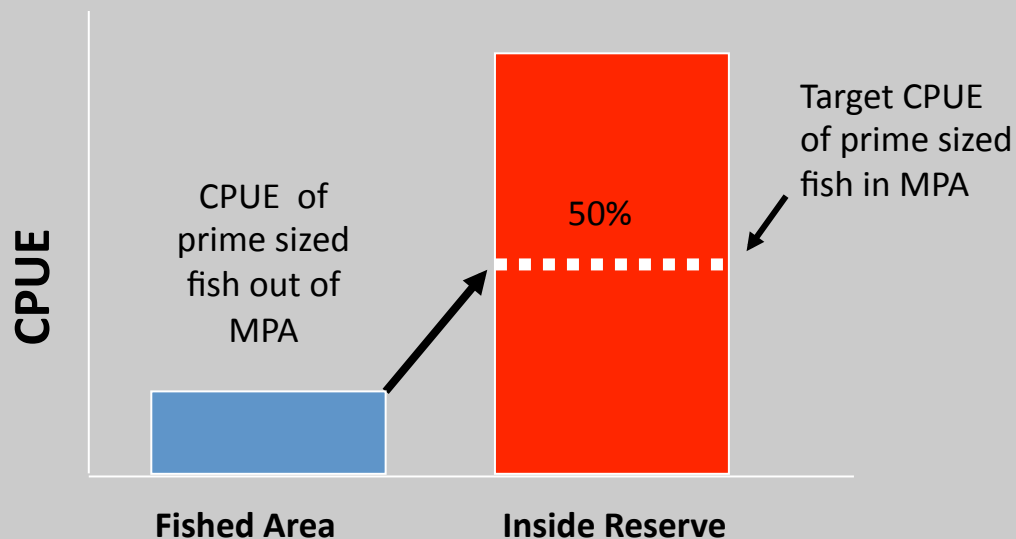
make readjustment on initial ACL



Marine Reserve-Based Decision Tree

Level 1

Set initial ACL based on comparing CPUE (prime) inside and outside of reserves



Considerations

- Phase-in period for first years of reserve establishment
- Rebuilding time period

Marine Reserve-Based Decision Tree

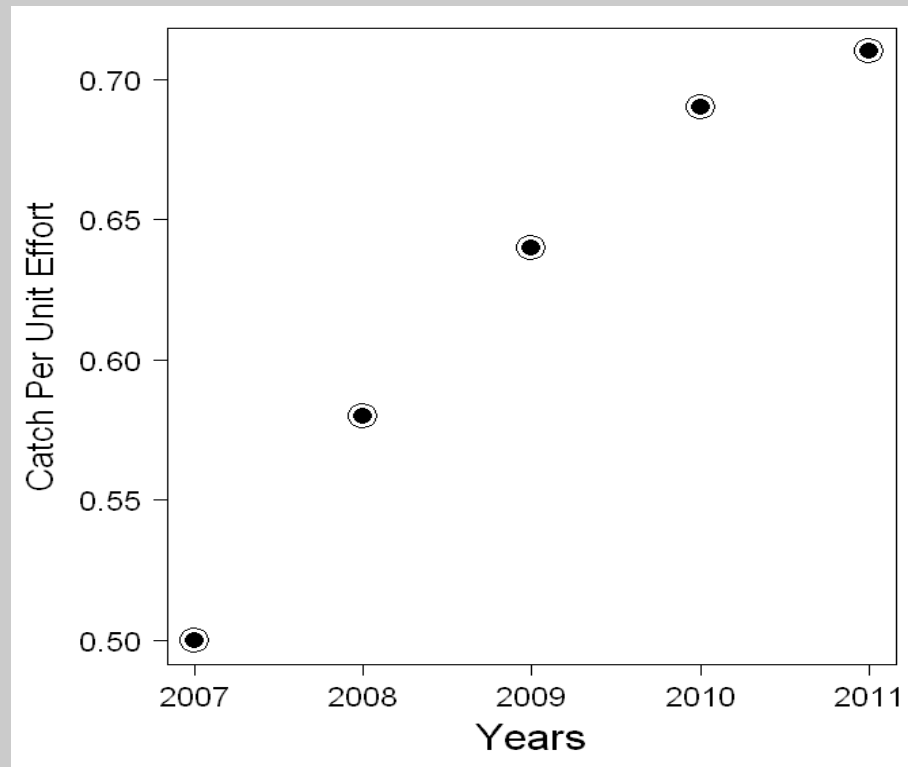
Level 2

Evaluate trend in CPUE (prime) in fished area over previous 5 years

rising

stable

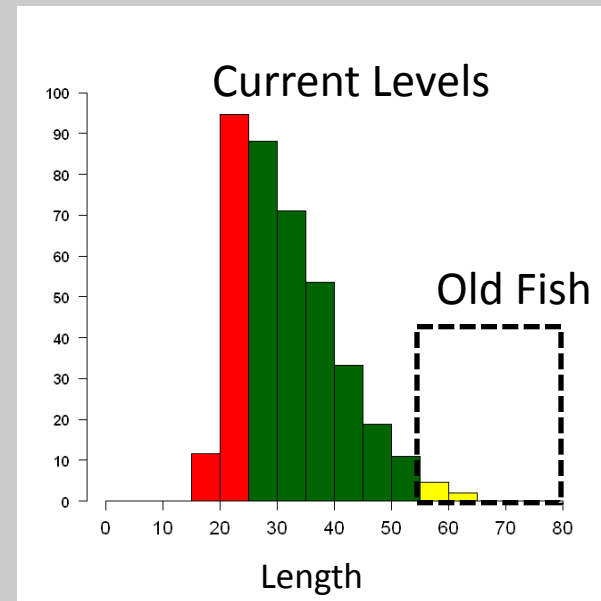
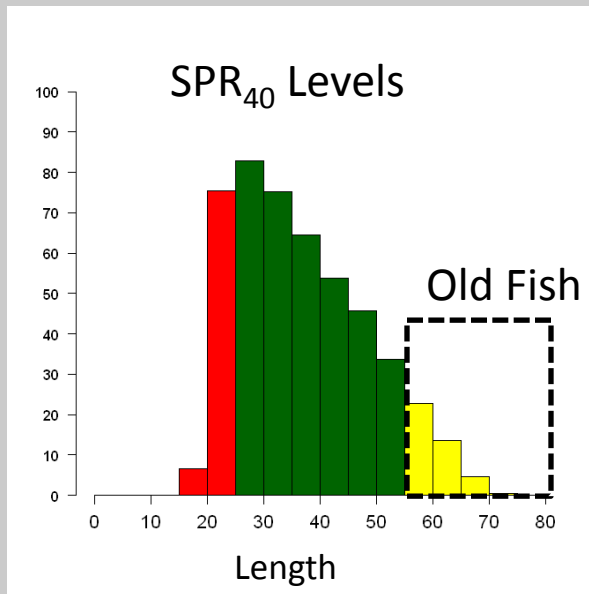
falling



Marine Reserve-Based Decision Tree

Level 3

Compare CPUE and proportion of old fish in catch to SPR40 levels

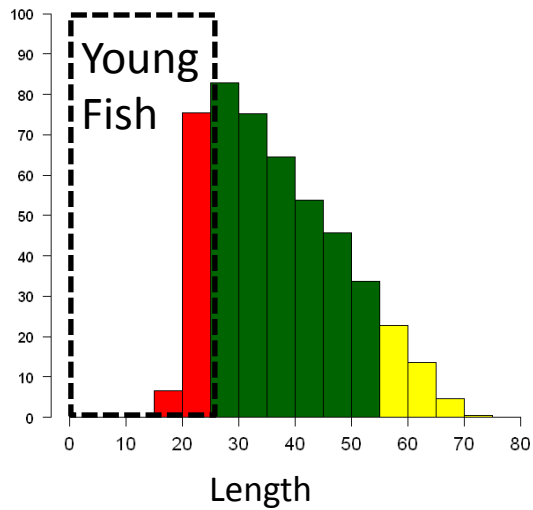


Marine Reserve-Based Decision Tree

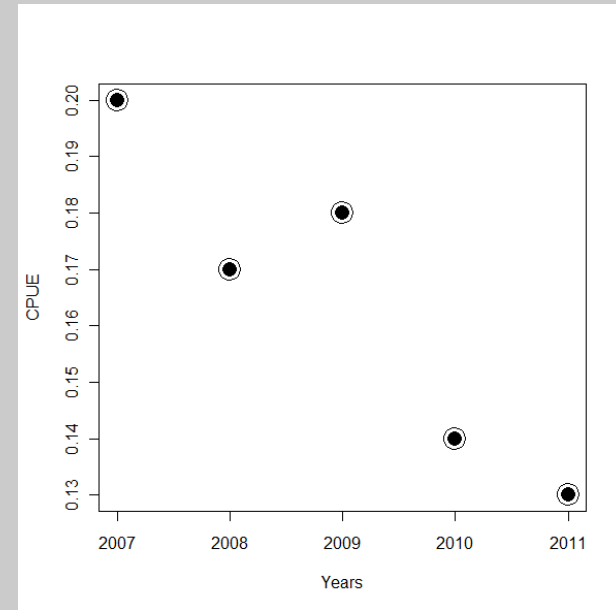
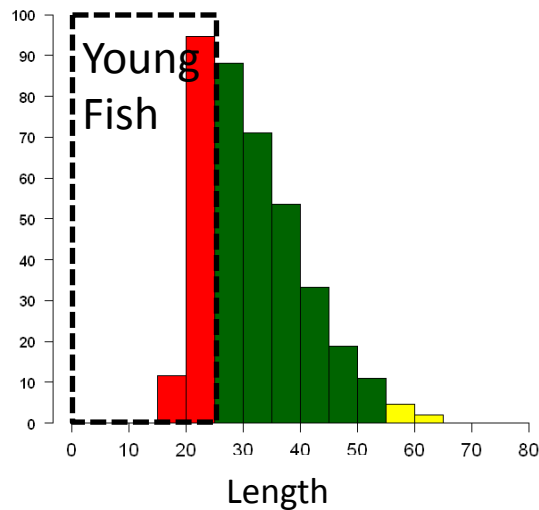
Level 4

Evaluate CPUE of young fish

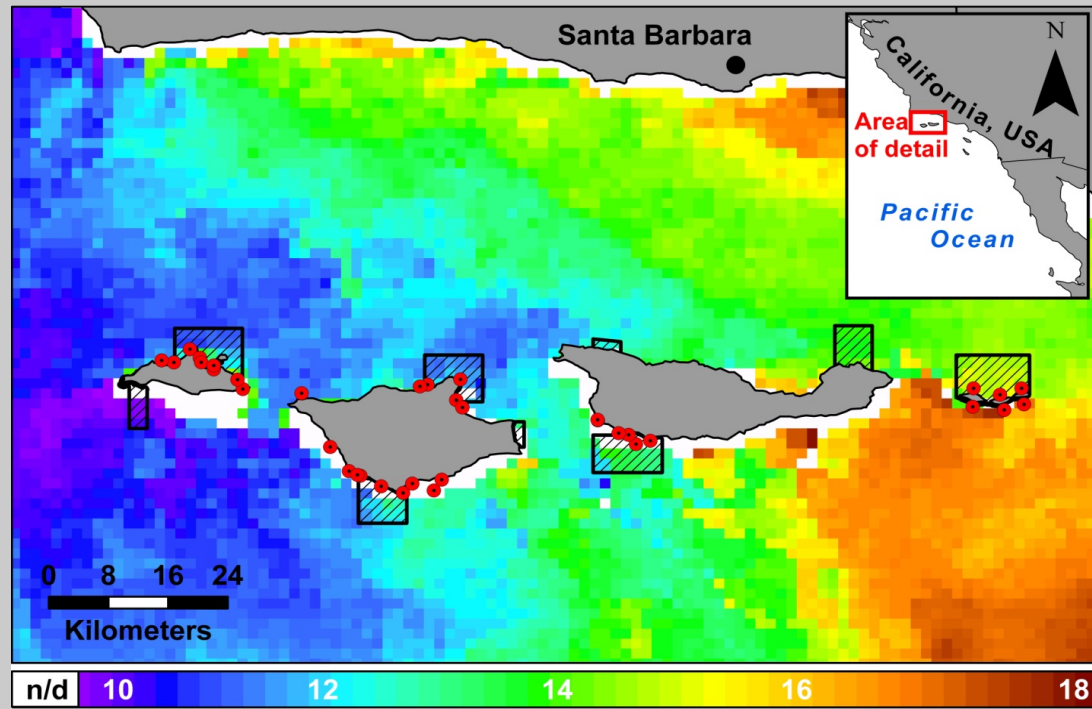
SPR₄₀ Levels



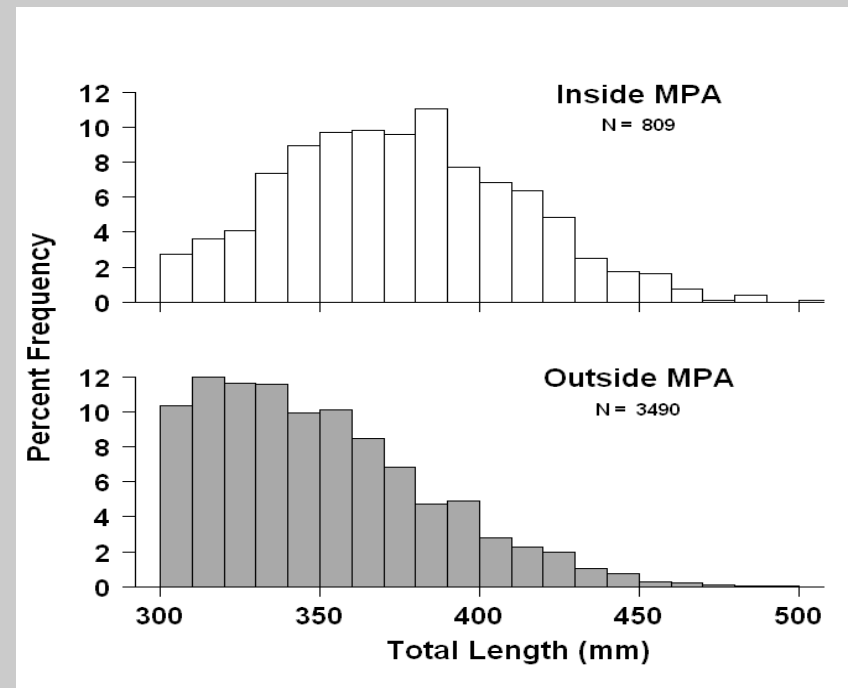
Current Levels



Collaborative Monitoring of Channel Islands Marine Reserves

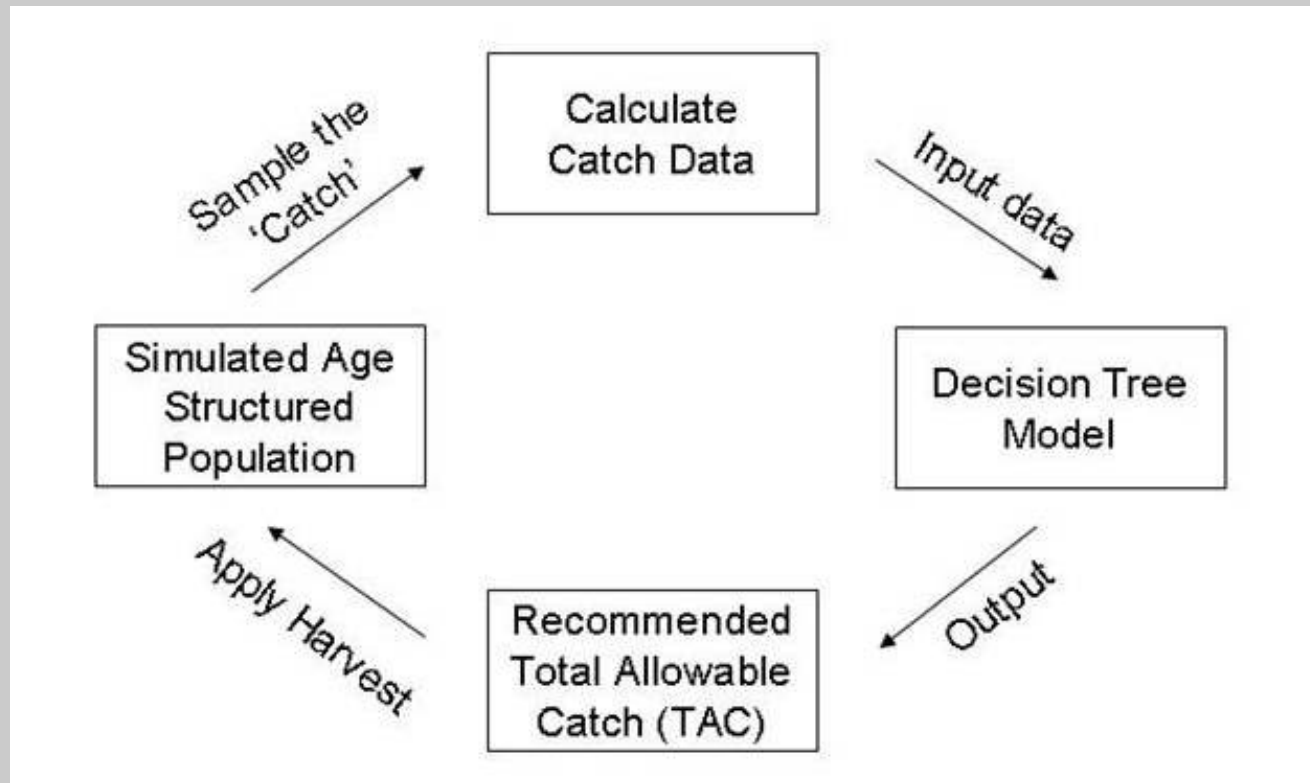


grass rockfish



Management Strategy Evaluation (MSE)

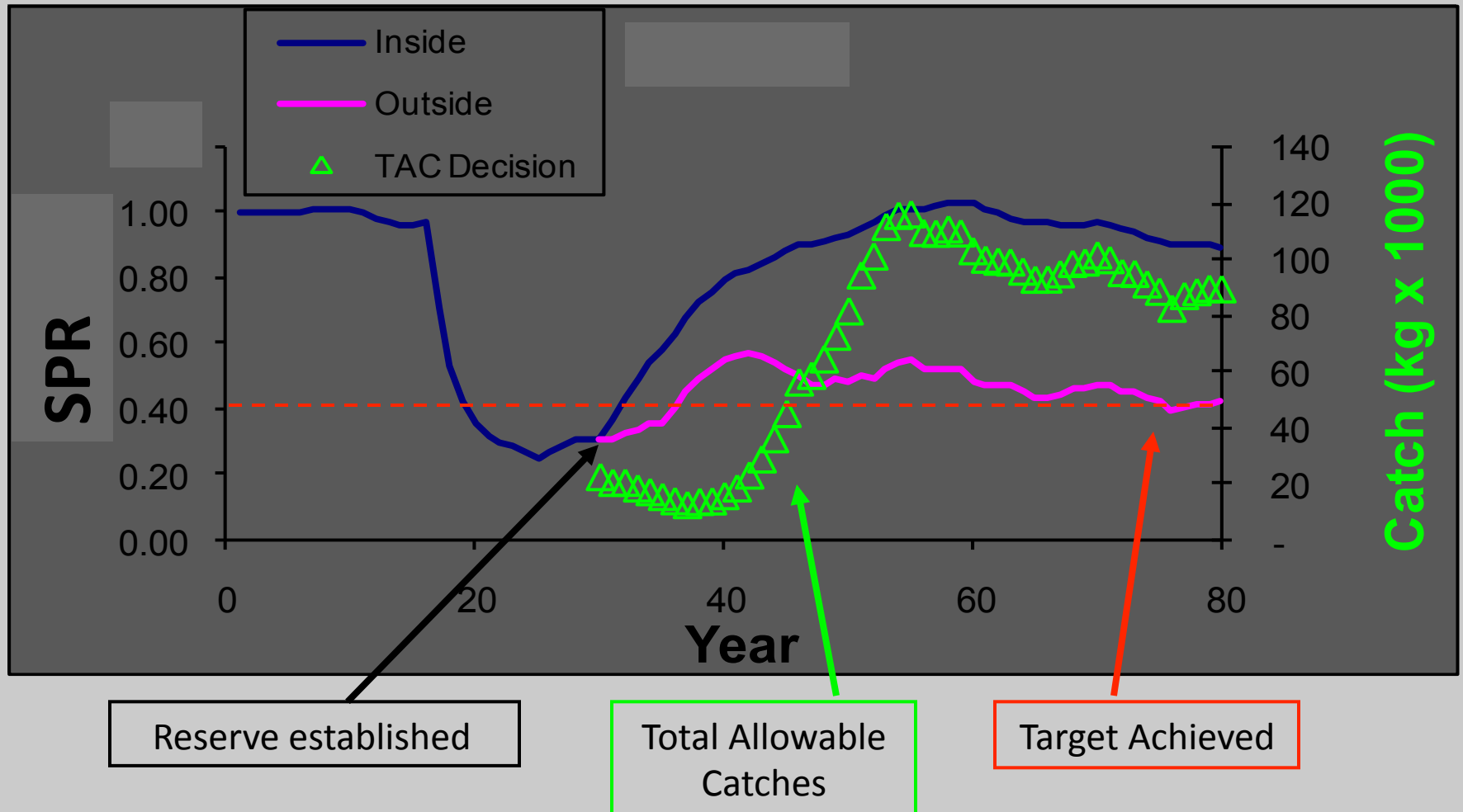
Simulation testing of alternative management approaches



Marine Reserve-Based Decision Tree

Example Model Run

Spawning Potential Ratio -> A measure of egg production relative to unfished conditions



Marine Reserve-Based Decision Tree

Simulation Results - After 30 Years

Scenario	% Catch Change	< 0.10 SPR	< 0.20 SPR	< 0.10 Biomass	< 0.20 Biomass	Avg. SPR
1	+ 91	1.42	22.84	0.00	1.79	0.36
2	+ 147	1.82	28.35	0.00	2.42	0.34
3	+ 100	1.70	25.40	0.00	2.29	0.38
4	0	0.43	10.19	0.00	0.93	0.49
5	+ 39	0.99	17.09	0.00	1.25	0.43
6	+ 69	1.85	24.04	0.00	2.42	0.35
7	+ 32	1.67	22.81	0.00	2.25	0.38
8	0	0.47	11.17	0.00	0.98	0.46

- 8 scenarios with various combinations of uncertainty:
 - variable recruitment
 - observation error
 - non linear relationship between CPUE and abundance
 - unequal harvest pressure on older age classes



Next Steps

- **Define biological, social and economic fishery objectives**
- **Identify current reserve monitoring programs and expand where appropriate – need length and CPUE estimates**
- **Identify existing biological data and perform additional lab analyses to parameterize SPR models**
- **Perform Management Strategy Evaluation (MSE)**
- **Set the optimal plan into action**

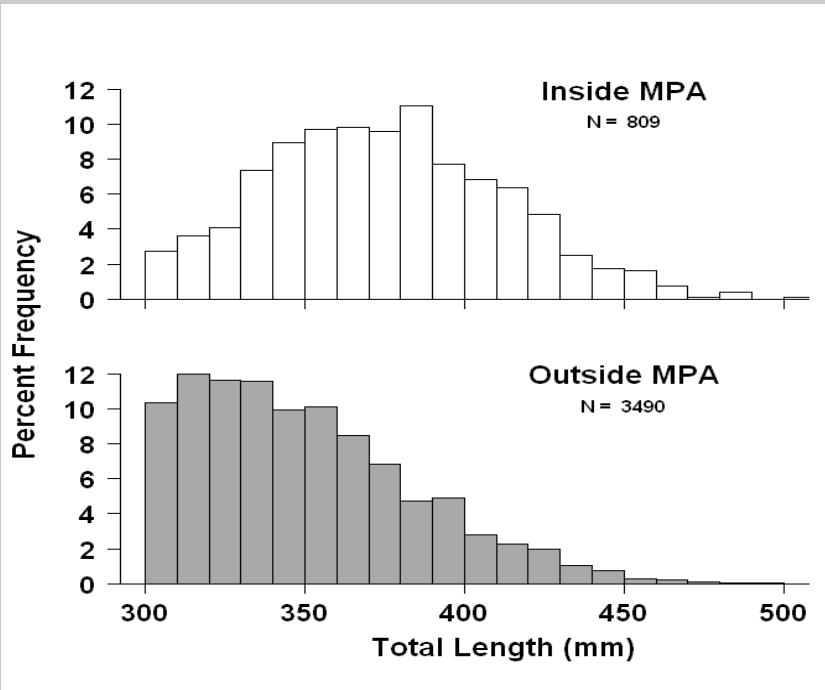
END

Use of marine reserves and equilibrium models in management

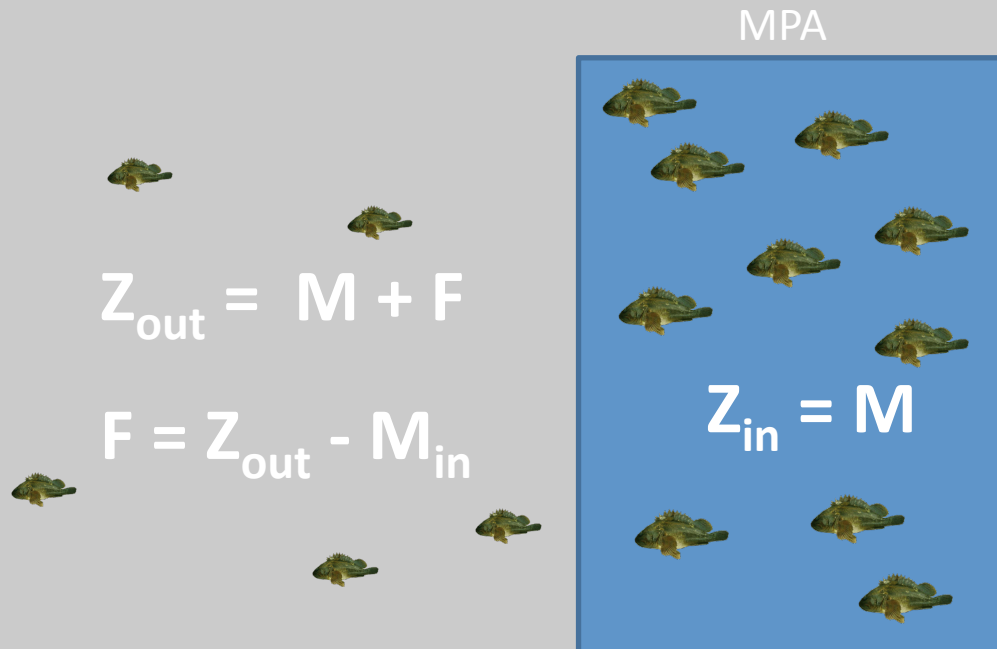
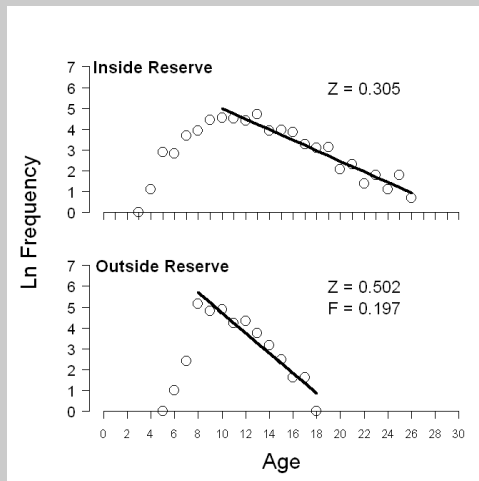
Can we estimate F and probability of overfishing using 1-2 years of reserve monitoring data and basic demographic data?

- **Fisheries independent monitoring and biological data**
 - Length Frequency of fish populations inside and outside marine reserves
 - Age – length data
 - Reproductive maturity, fecundity, selectivity

Estimating natural and fishing mortality (F)

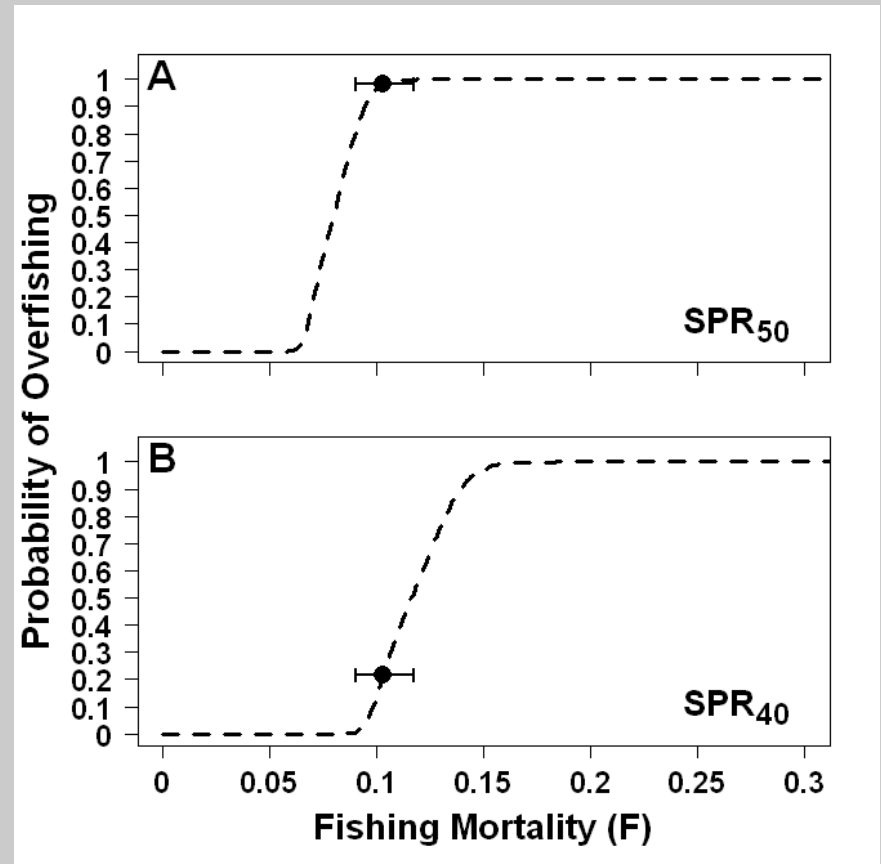
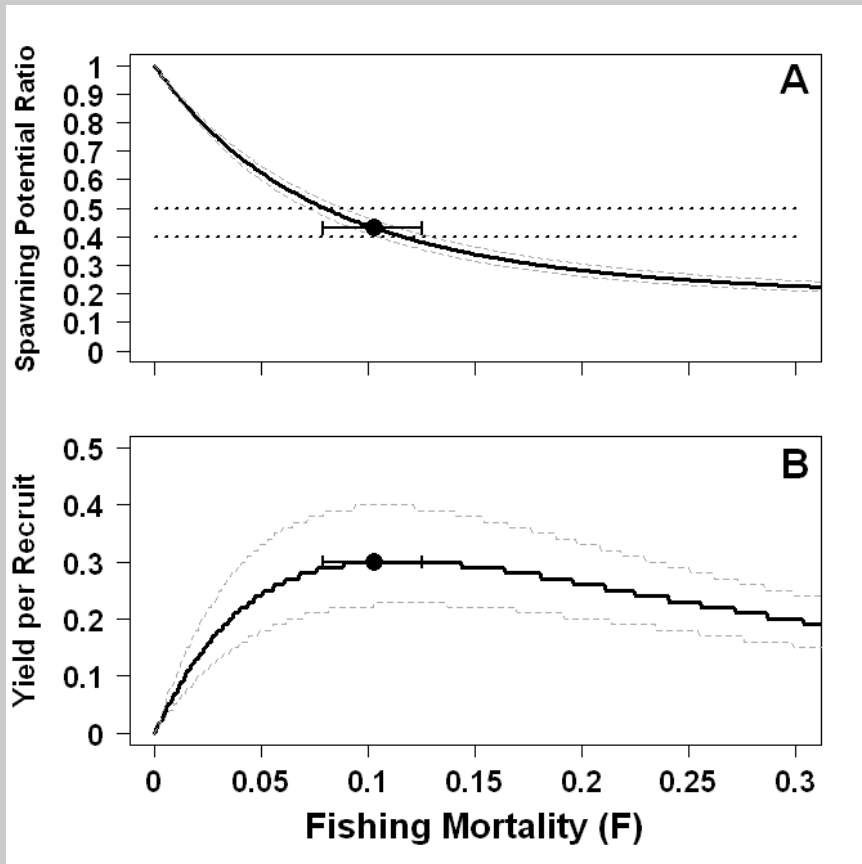


$$Z_t = k \frac{L_\infty - \bar{L}}{\bar{L} - L_c}$$



Model Outputs

- Performance Indicators : SPR, Fishing Mortality Rate, Probability of Overfishing



- Compare performance indicators to predetermined reference points and adjust F accordingly