

Potential assessment methods: simple, complex, and everything in between

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Main considerations

- Objectives
 - Maximize yield (target species)
 - Prioritize species for management
 - Evaluate rebuilding
- Available information and data
- Applicable methods





Data

- Biological
 - Growth (growth increment or age-length)
 - Length-weight
 - Mortality
 - Maturity/fecundity
 - Movement
- Fishery/survey
 - Catch
 - Effort
 - Index of abundance (survey/CPUE)
 - Composition (age/size/stage)
 - Tagging
 - Spatial



- Biological

- Growth (growth increment or age-length)
- Length-weight
- Mortality
- Maturity/fecundity
- Movement



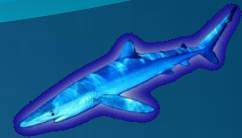
- Fishery/survey

- Catch
- Effort
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- Spatial



Assessment methods





Indicators

- Data
 - Catch
 - Effort
 - CPUE
 - Mean length
- Model based
- How to use
 - Don't optimize yield
 - Direction (i.e recovery)
 - Reference points
 - Mean length > Lmat
 - Limits
 - Percentiles of historical data

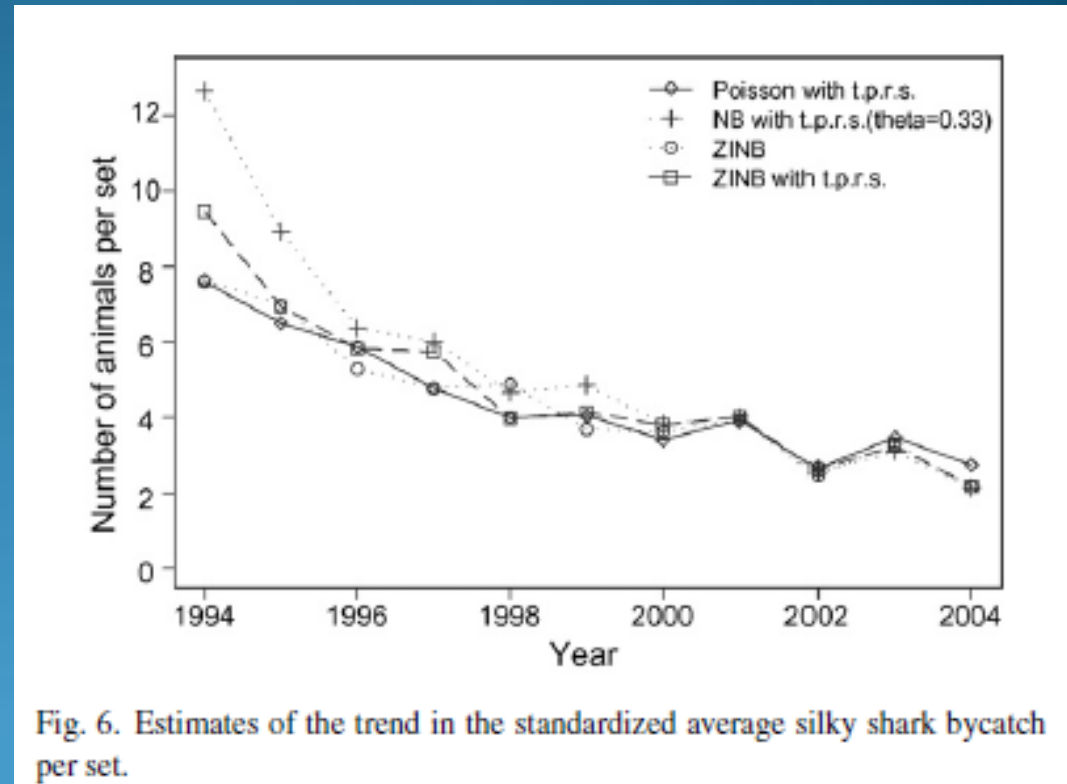


Fig. 6. Estimates of the trend in the standardized average silky shark bycatch per set.

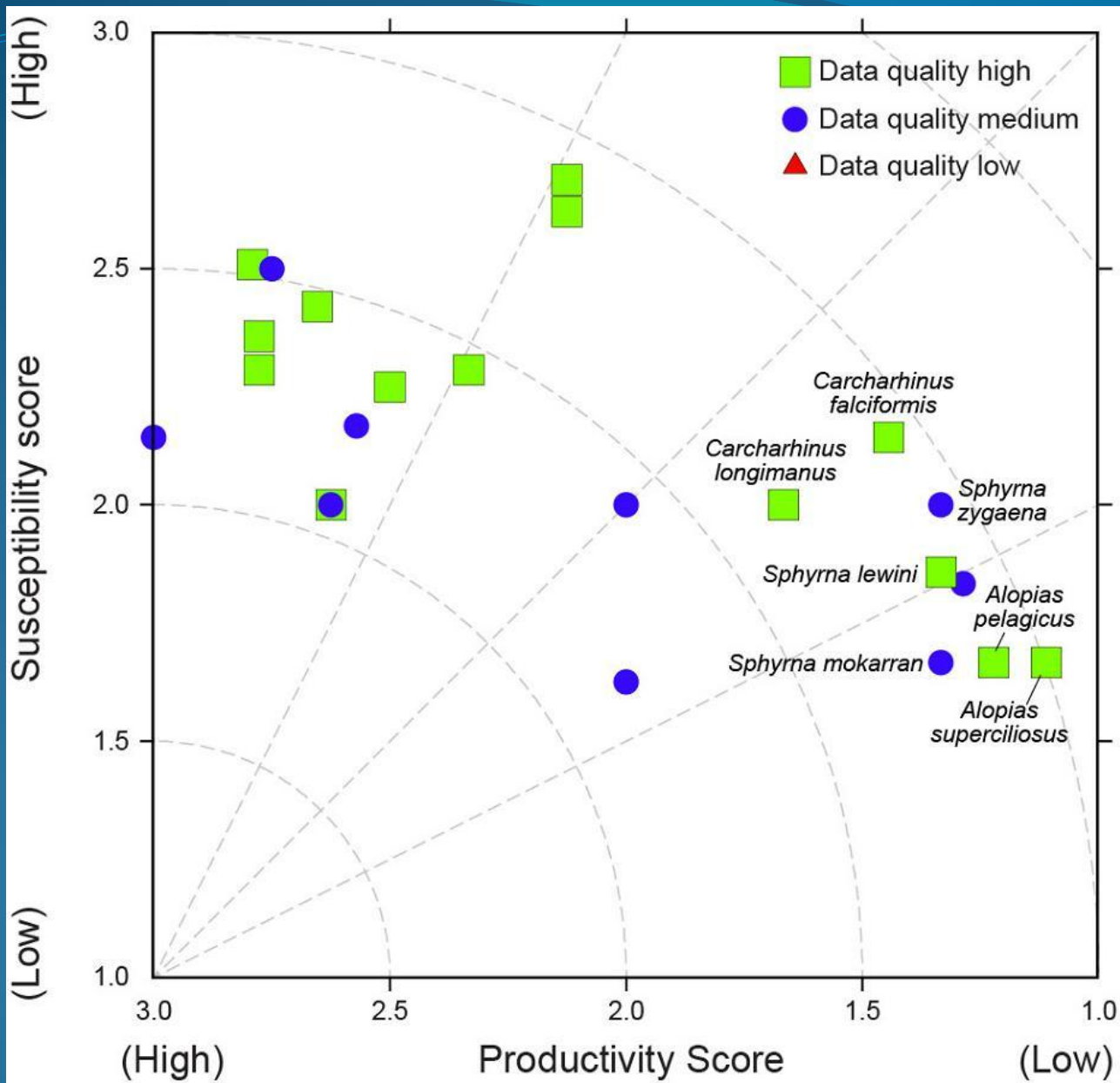
Minami et al. (2007) Fisheries Research 84: 210–221



Productivity Susceptibility analysis

- Includes both biological and fishery information
- Qualitative ranking system
- Triage system
- Productivity
 - Growth rate
 - Longevity/natural mortality
 - Fecundity/breeding strategy/age at maturity
 - r
- Susceptibility
 - Overlap with fishery
 - Aggregation behavior
 - Desirability
 - Survival after discarding





From Olson and Duffy presentation later this week



Demographic analysis



$$\begin{pmatrix} n_0 \\ n_1 \\ n_2 \\ \vdots \\ n_x \end{pmatrix}_{t+1} = \begin{pmatrix} f_0 & f_1 & f_2 & \dots & f_x \\ s_0 & 0 & 0 & 0 & 0 \\ 0 & s_1 & 0 & 0 & 0 \\ 0 & 0 & \dots & 0 & 0 \\ 0 & 0 & 0 & s_{x-1} & 0 \end{pmatrix} \begin{pmatrix} 1-h_0 & 0 & 0 & 0 & 0 \\ 0 & 1-h_1 & 0 & 0 & 0 \\ 0 & 0 & 1-h_2 & 0 & 0 \\ 0 & 0 & 0 & \ddots & 0 \\ 0 & 0 & 0 & 0 & 1-h_x \end{pmatrix} \begin{pmatrix} n_0 \\ n_1 \\ n_2 \\ \vdots \\ n_x \end{pmatrix}_t$$



Population Growth rate



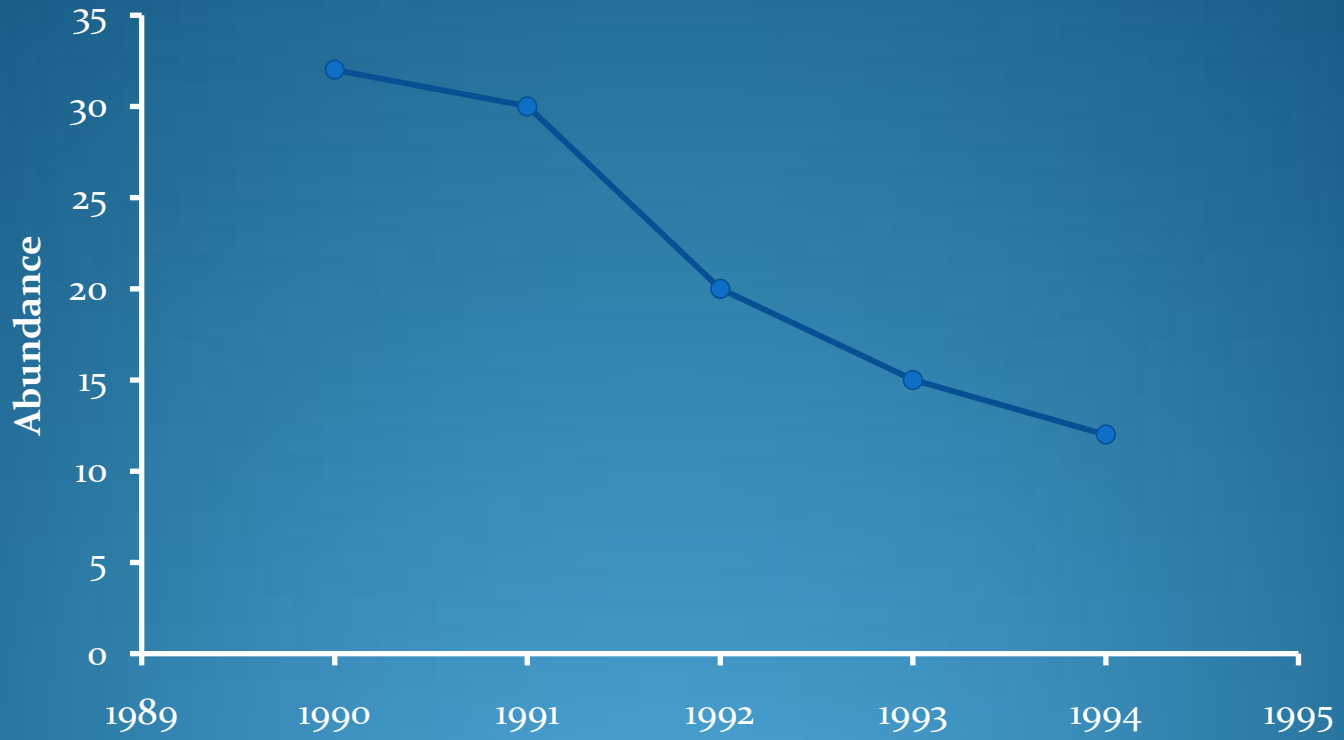
Catch free analysis

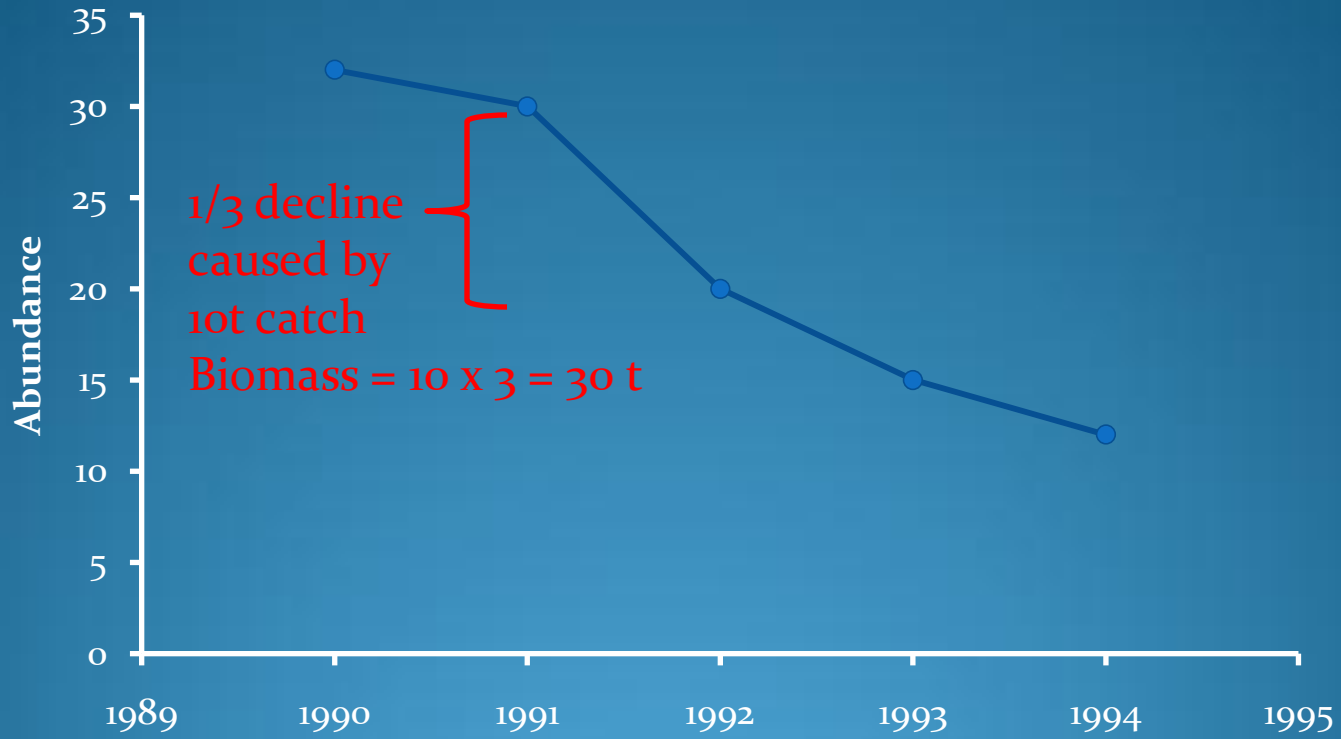
- Data
 - Index of abundance
 - Total biomass
 - Recruitment
 - Age specific
- Essentially smoothes abundance index based on theory/assumptions
 - Population dynamics theory
 - Fishing mortality separability: year and age
 - Random effects
- Relative only
- Estimates fishing mortality

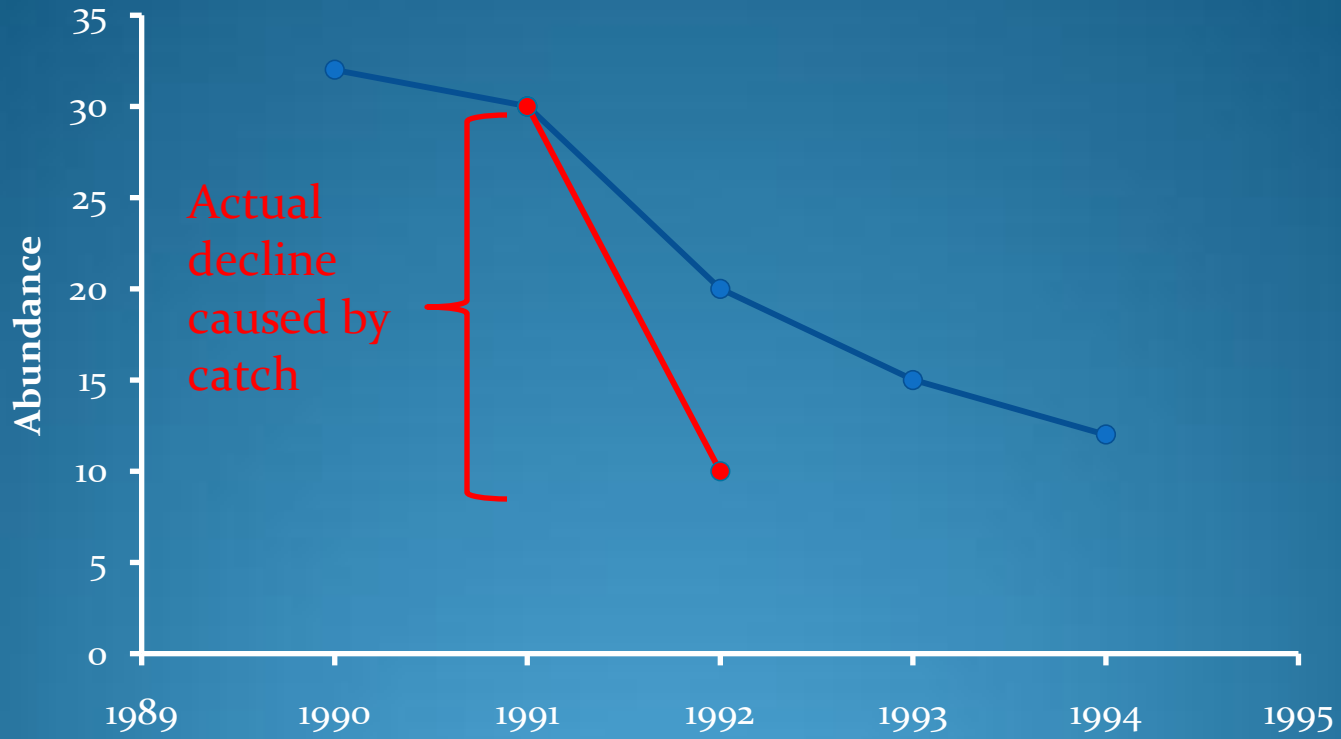


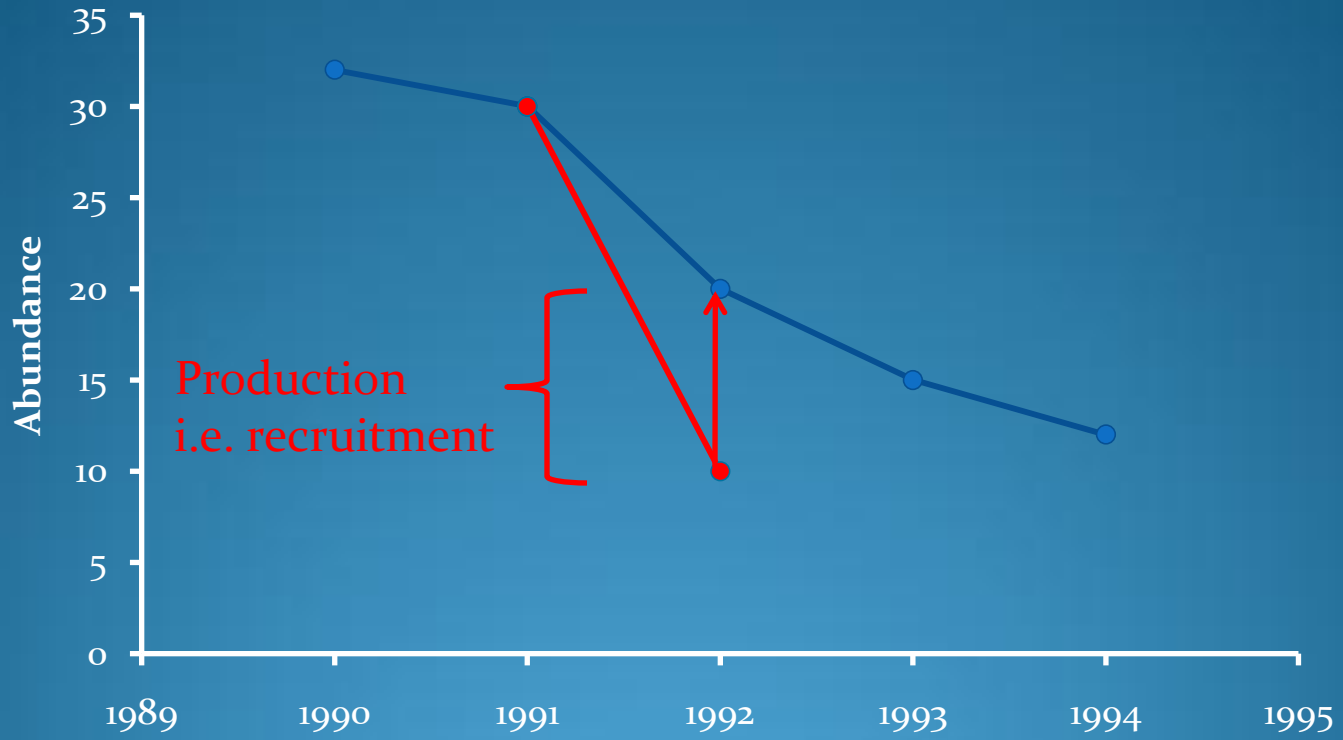
Simple population dynamics

- Data
 - Catch
 - Index of abundance
- Concept
 - Use change in relative abundance index caused by known catch used to scale absolute abundance









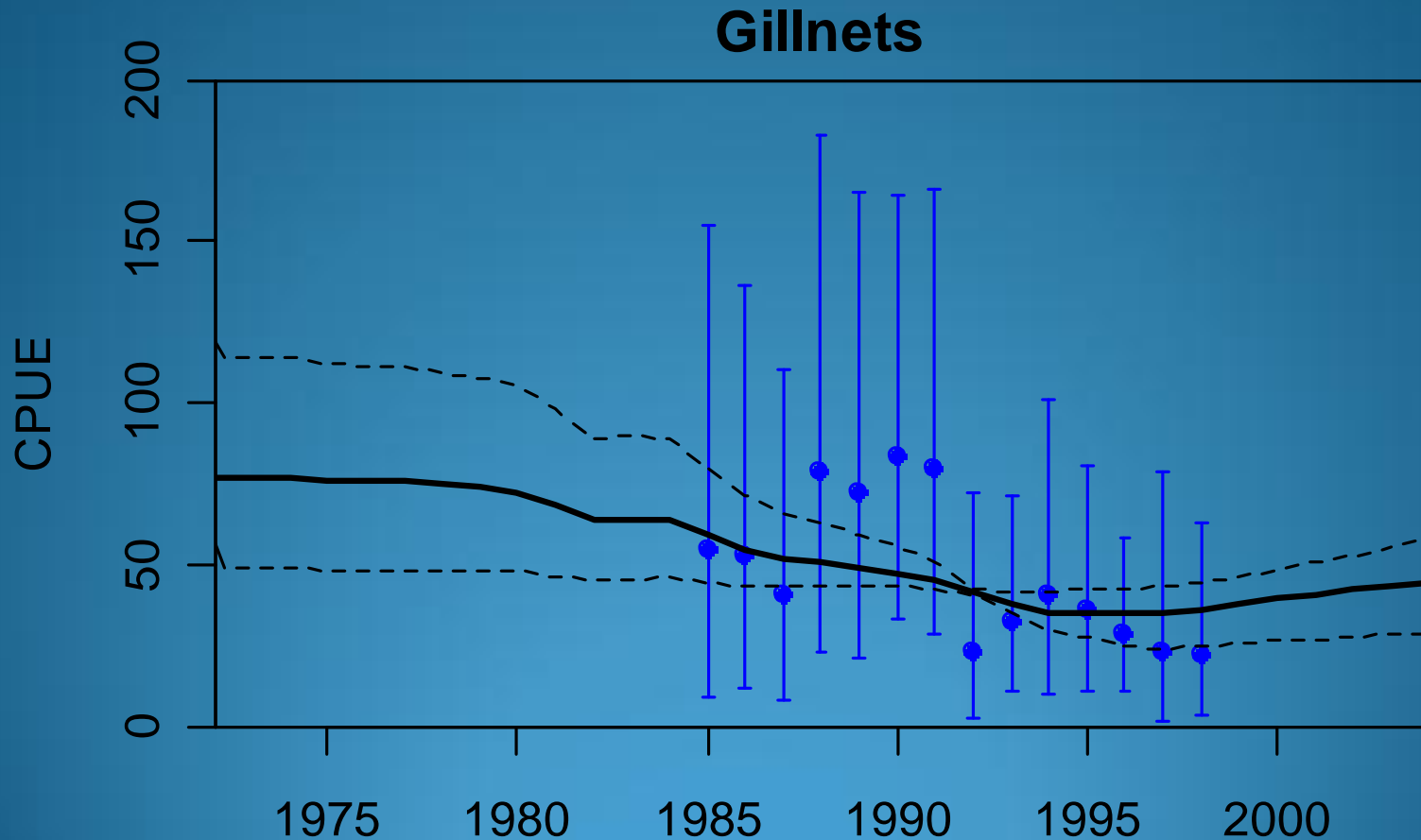


Simple population dynamics

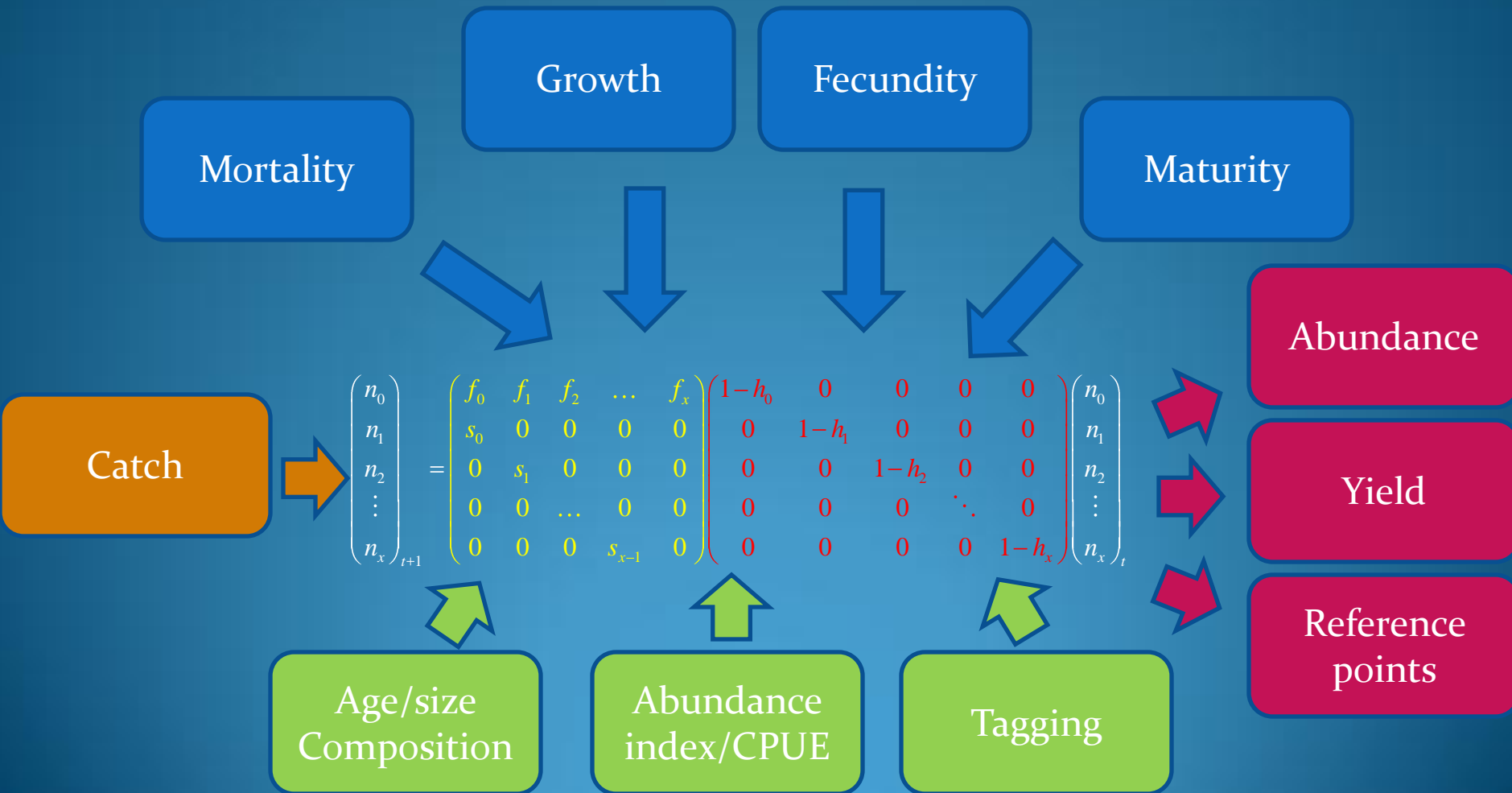
- Surplus production
 - Production function
 - Weakly demographic based
- Delay difference
 - Semi demographic based
- Age-structured production
 - Fully demographic based



Estimating unknown parameters

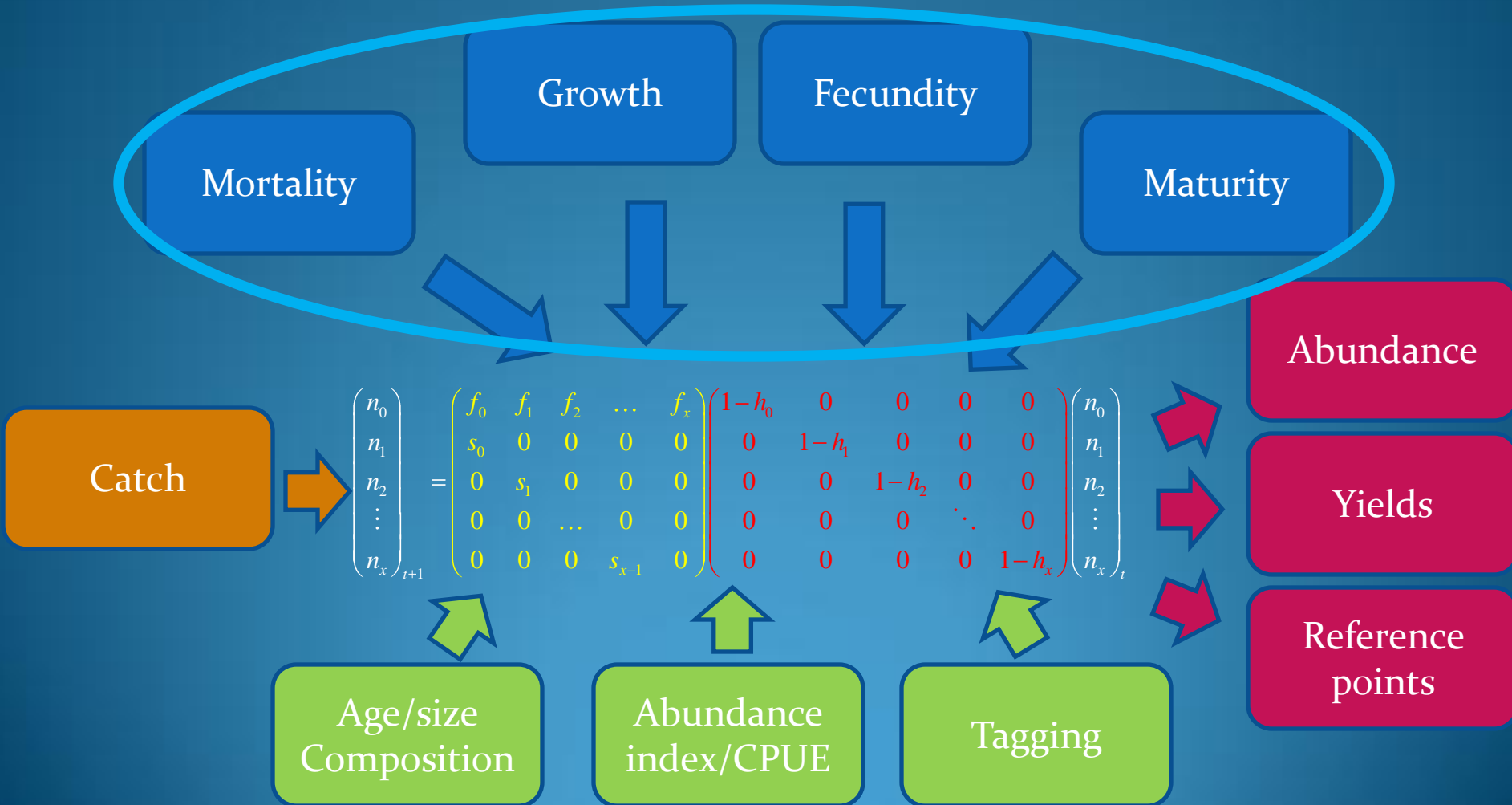


Integrated models

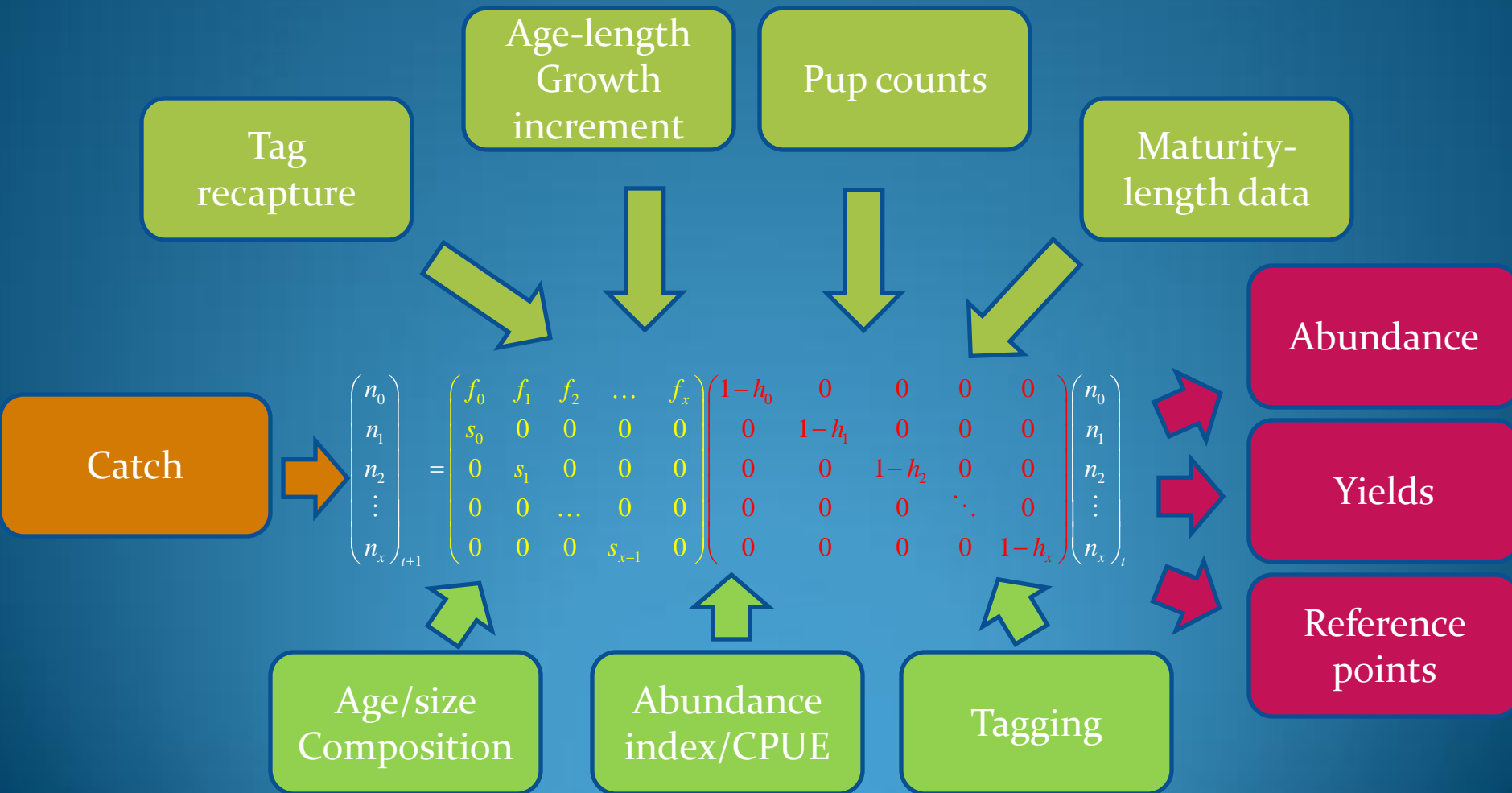


Bayesian Integrated models

Priors



Fully Integrated models



Biological information
(growth, mortality, recruitment)

Fishery data (catch,
effort, composition)



Productivity
Susceptibility

Indicators
(catch, effort, CPUE,
mean length)

Demographic
(Growth, mortality,
recruitment)

Yield per recruit
(Growth, mortality,
Recruitment, selectivity)

Production models
(catch, CPUE)

Catch free
(Growth, mortality,
Recruitment, CPUE)

Age structured production
Models (growth, mortality,
recruitment, catch, CPUE)

Integrated model (growth,
mortality, recruitment, catch,
CPUE, composition, tagging)

Simple, data poor,
qualitative

Complex, data rich,
quantitative



Biological information
(growth, mortality, recruitment)

Fishery data (catch,
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Productivity
Susceptibility

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(catch, effort, CPUE,
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Simple, data poor,
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Integrated model (growth,
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Issues for shark assessments

- Missing biological information
- Missing data
- Stock-recruitment relationship
- Spatial structure



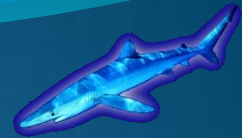
Missing biological information

- Priors
 - Share information from other species
- Empirical or theoretical relationships among life history parameters



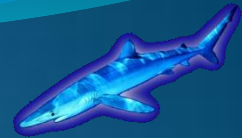
Missing data

- Statistical models deal with most missing data
 - Abundance index/CPUE
 - Composition
- Catch
 - Use effort to estimate catch within model
 - Integrate catch-free methods into integrated analysis



Stock-recruitment relationship

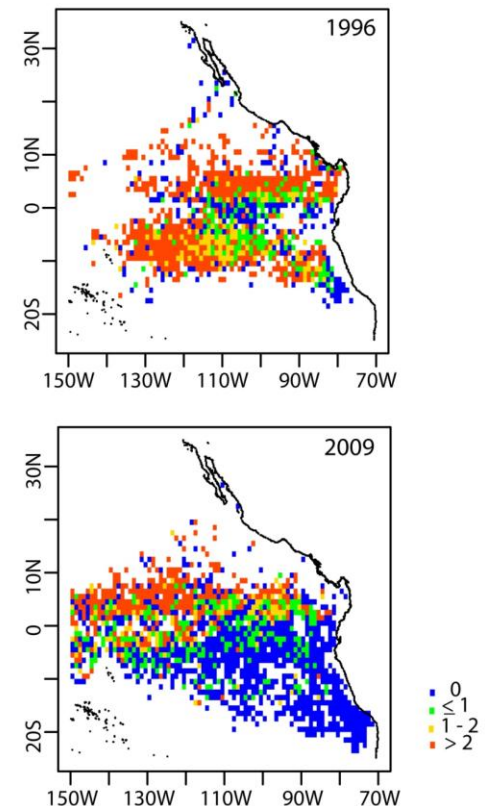
- Different from standard fisheries stock-recruitment relationships
- Limited number of pups
- Density dependence
 - Litter size
 - Pup survival
 - Pregnancy rates



Spatial structure

- Create separate fisheries by area with different selectivity and catchability
- Model separate populations
- Model interacting populations
- Fine scale spatial models

Average silky shark bycatch per set
(number sharks per floating-object set)





Summary

- Integrated analysis
 - Uses all the theory, knowledge, biological information, and fishery data
 - Encapsulates the other models and can be made as simple or complex as desired
 - Provides a flexible framework that is consistent in its treatment of information and assumptions
 - Provides outputs that are directly relevant to management