Overview of statistical catch at age modeling

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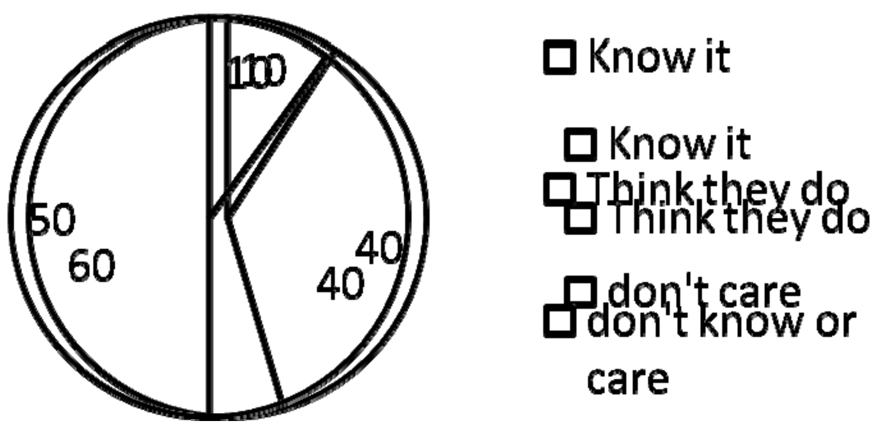
The challenge for this talk

- What does this have to do with age-1 mortality anyway?
- Who cares about SCAA?

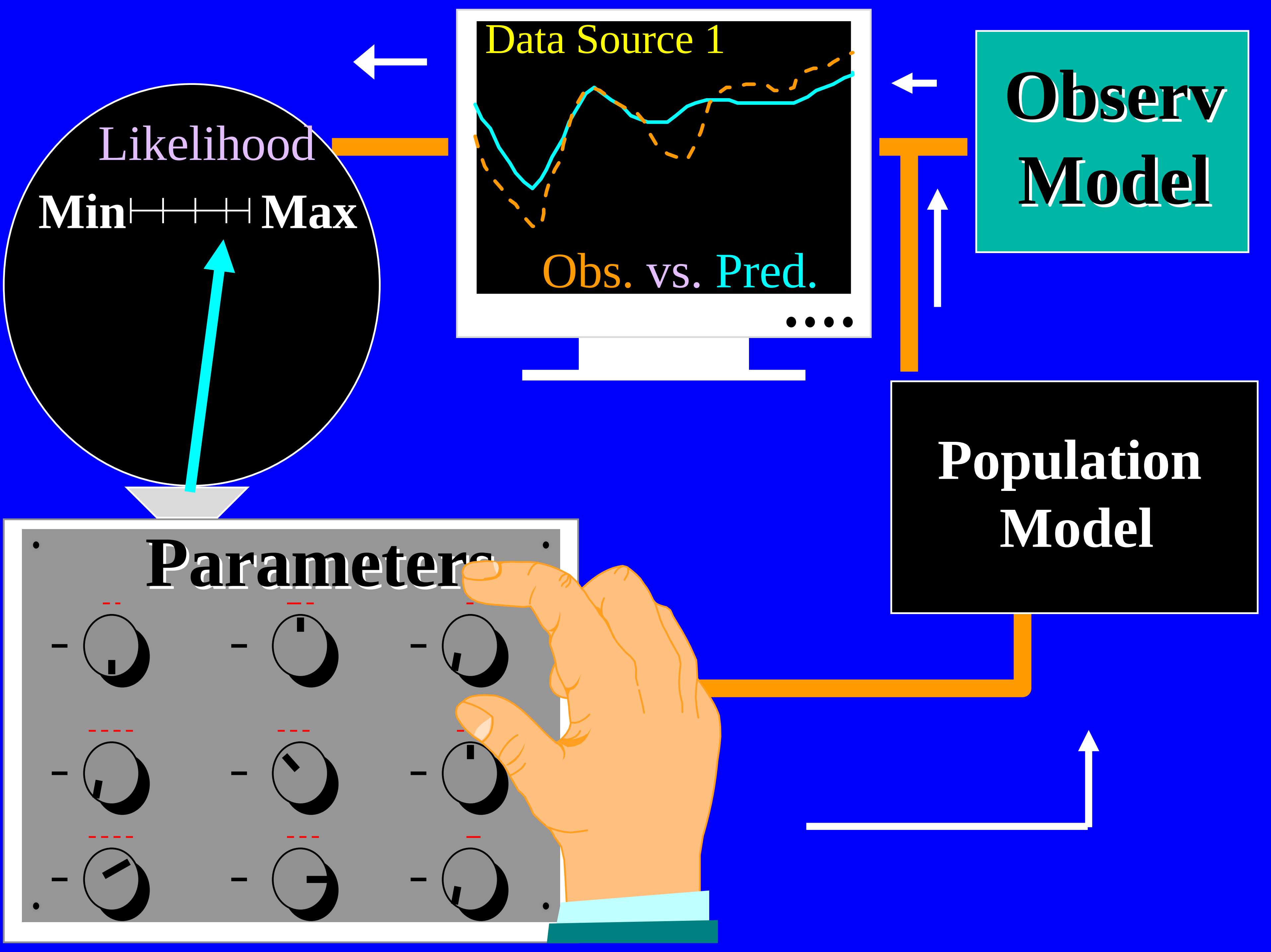


Reasons to care…

- Assumptions about early life survival in SCAA assessment models could be having a big influence on results.
  - Results are being used widely not just for setting harvest limits.
- Properly formulated and with the right data SCAA can be used to assess or estimate how early life survival is changing.

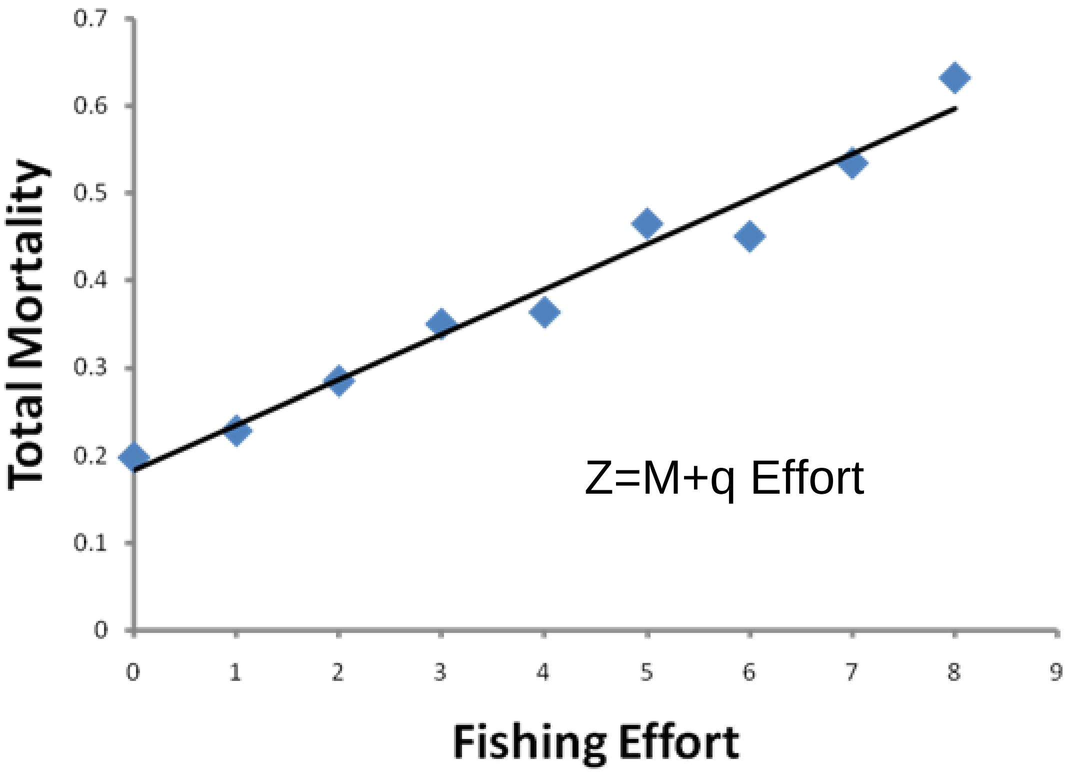
OK so what is SCAA?

- It is sort of like a fancy nonlinear regression
  - Parameters are iteratively adjusted in an automated fashion until the fit to data (and prior assumptions – more on that later) is a good as possible
  - Good fit to data is not enough to show the model is right or even useful. It could be overparameterized.
  - The next graphic slide that Shawn Sitar came up with in 1996 is still good and almost right…



Data Source 1
Obs. vs. Pred.
Likelihood
Min
Max
Observ
Model
Population
Model
Parameters

An approach from more than 50 years ago…



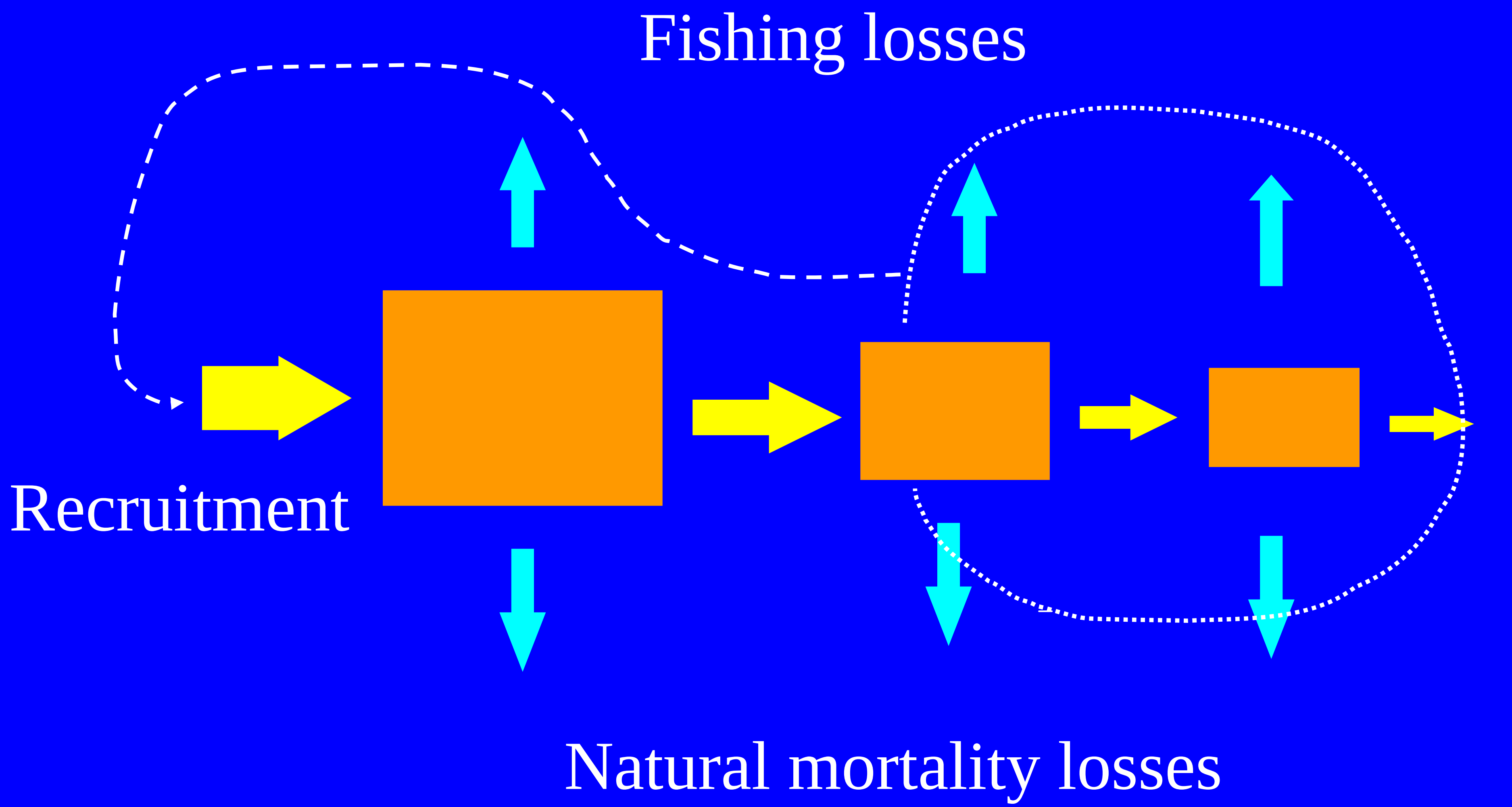
What the SCAA model is fit to

Observation submodel

- Data needs to include catch-at-age
- Some index of abundance (e.g., fishery cpe or survey index – typically structured by age or sometimes size)

- Other non-data components (e.g., deviations between estimated fishing intensity and direct proportionality to effort)

Part of population submodel


Fishing losses
Recruitment
Natural mortality losses

Population numbers-at-age

$N_{90,3}$	$N_{90,4}$	$N_{90,5}$	$N_{90,6}$	$N_{90,7}$
$N_{91,3}$	$N_{91,4}$	$N_{91,5}$	$N_{91,6}$	$N_{91,7}$
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Instantaneous mortality

Total (Z) =

Commercial (F_C)

\+ Sport (F_R)

\+ Sea lamprey (M_L)

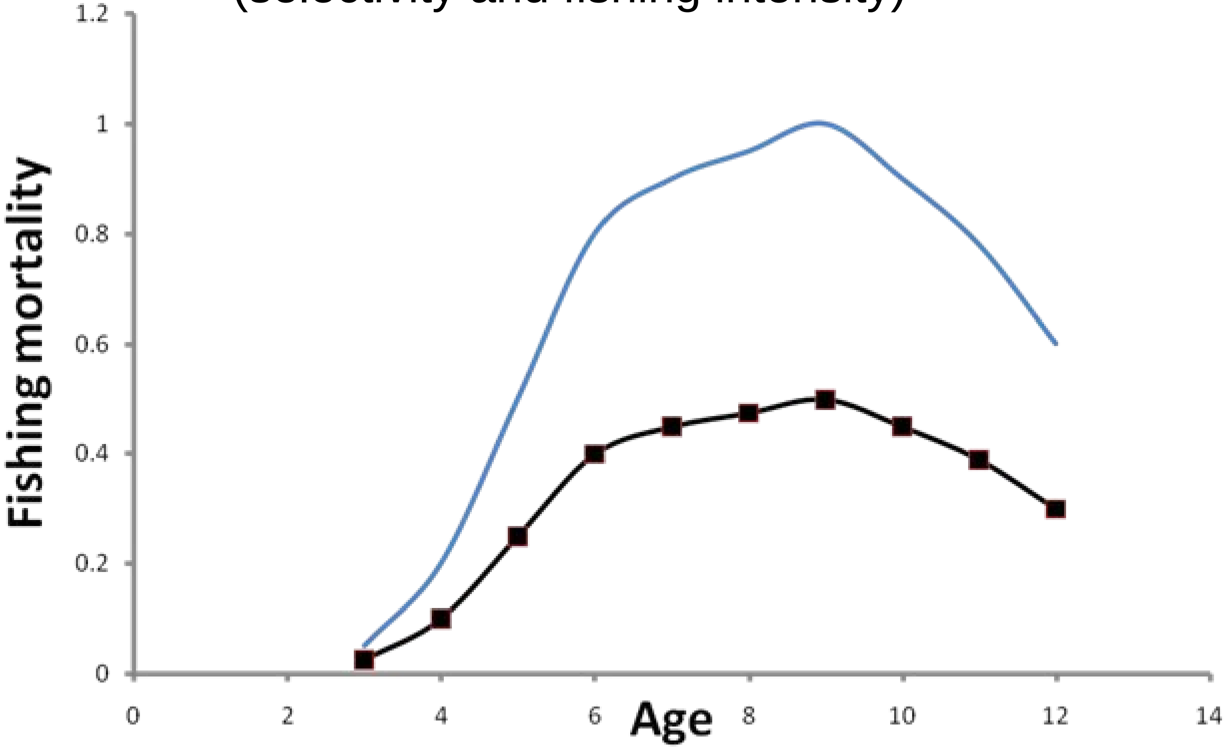
\+ Background natural (M)

Population submodel - each fishing mortality component

Modeled as product of age (selectivity) and year (fishing intensity) factor

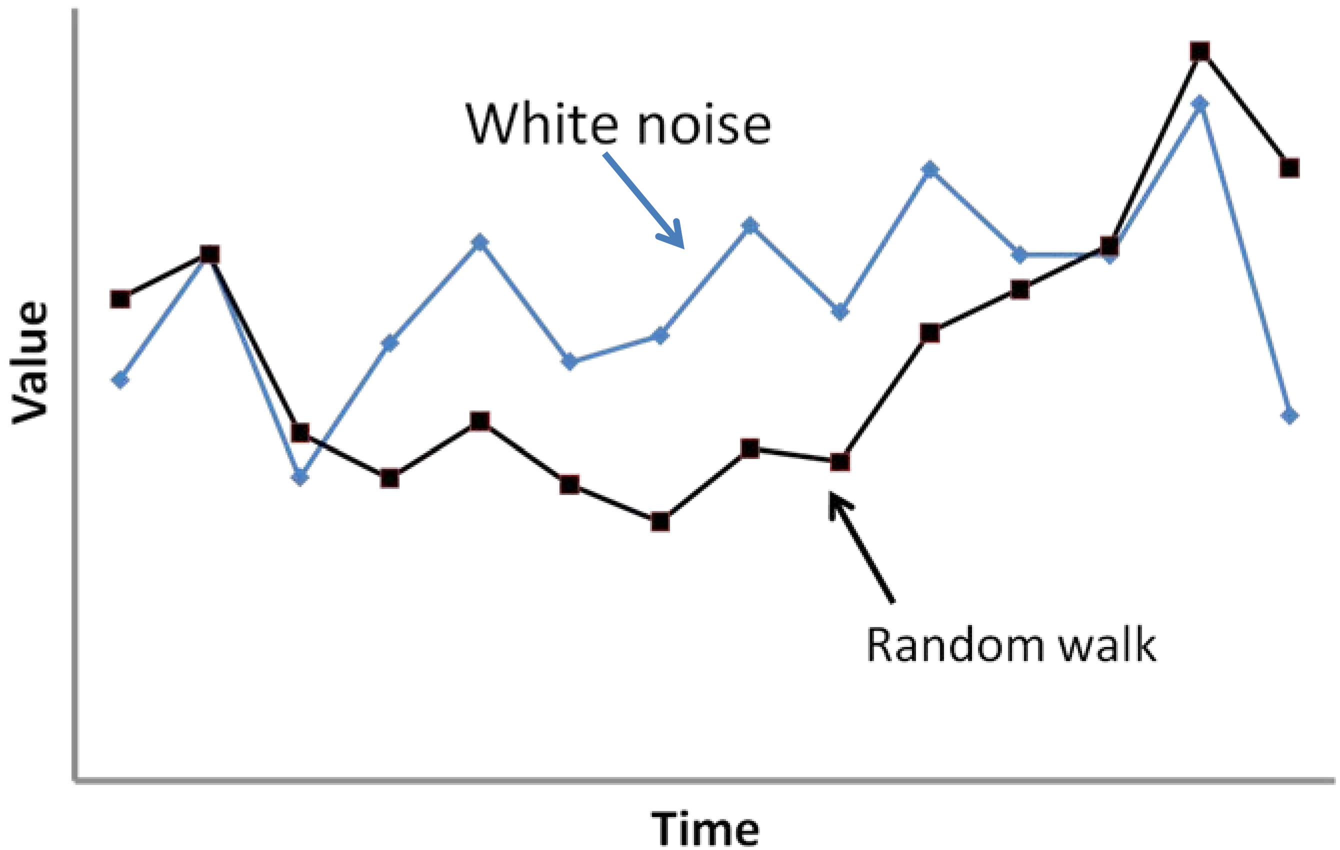
Fishing mortality (F_{ay}) = selectivity(s_a) × fishing intensity(f_y)

Graphical representation of separability
(selectivity and fishing intensity)



So here are some ways fishing intensity has been modeled

- $f_y = qE_y$
- $f_y = qE_y error_y$
  - $\log(error_y)$ white noise
- $f_y = q_y E_y \quad q_y = q\,error_y$
  - $\log(error_y)$ white noise
  - $\log(error_y)$ random walk


White noise
Random walk
Value
Time

- So model fit include components about prior assumptions.
- As discussed for fishing intensity, can be viewed as penalties for to big a variation from the mean in catchability (white noise assumption) or too big a change from year to year (random walk)

Population numbers-at-age

$N_{90,3}$	$N_{90,4}$	$N_{90,5}$	$N_{90,6}$	$N_{90,7}$
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. . .	. . .	. . .		

Some ways recruitment has been modeled

- R_y just estimated as parameter each year (no prior assumptions)
- R_y=f(stock size)*$error_y$ (stock recruitment prior). One could view all the information used in the SCAA as providing some information on number of eggs which provides (very weak) prior info on subsequent recruitment
- R_y=$stocking_y$ adj_y
  - log(adj) as white noise or random walk (Ji He modification so adj stays below 1!)
  - If adj is just estimated each year this is same as just estimating R for each year

What about pre-recruit surveys?

- By pre-recruit I mean mainly before major fishing mortality
- If it can be assumed that survival from ages sampled to later ages fished is constant the survey is informative on recruitment to the fishery.
- If survival is changing but something can be assumed about it such as it is changing slowly over time it’s still informative.
- If survival is assumed to potentially be varying in an arbitrary pattern then the pre-recruit survey is not informative on stock status but incorporating into SCAA is a way to assess changes in pre-recruit mortality.
- None of this is much different than issue of using stocking data (a kind of “survey”).

Basic messages/conclusions

- We face a tradeoff
  - The more we can assume about survival after stocking or prerecruit survey the more informative these data are on stock status
  - Assuming too much will mess things up
  - At some point the data do not help the SCAA but instead the SCAA helps to understand survival from these earlier life stage until subsequent recruitment
  - There is some middle ground where survival changes gradually so data help SCAA and SCAA can be used to assess changes