STOCK ASSESSMENT 101

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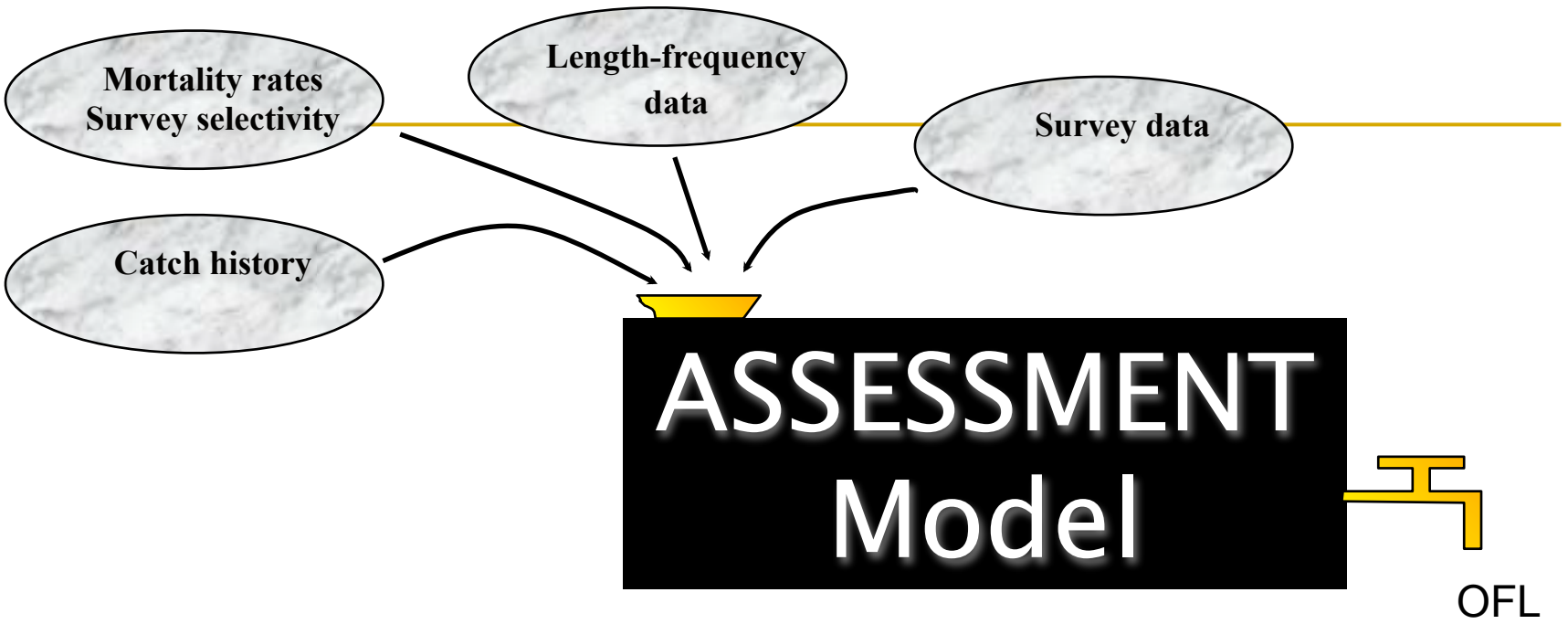
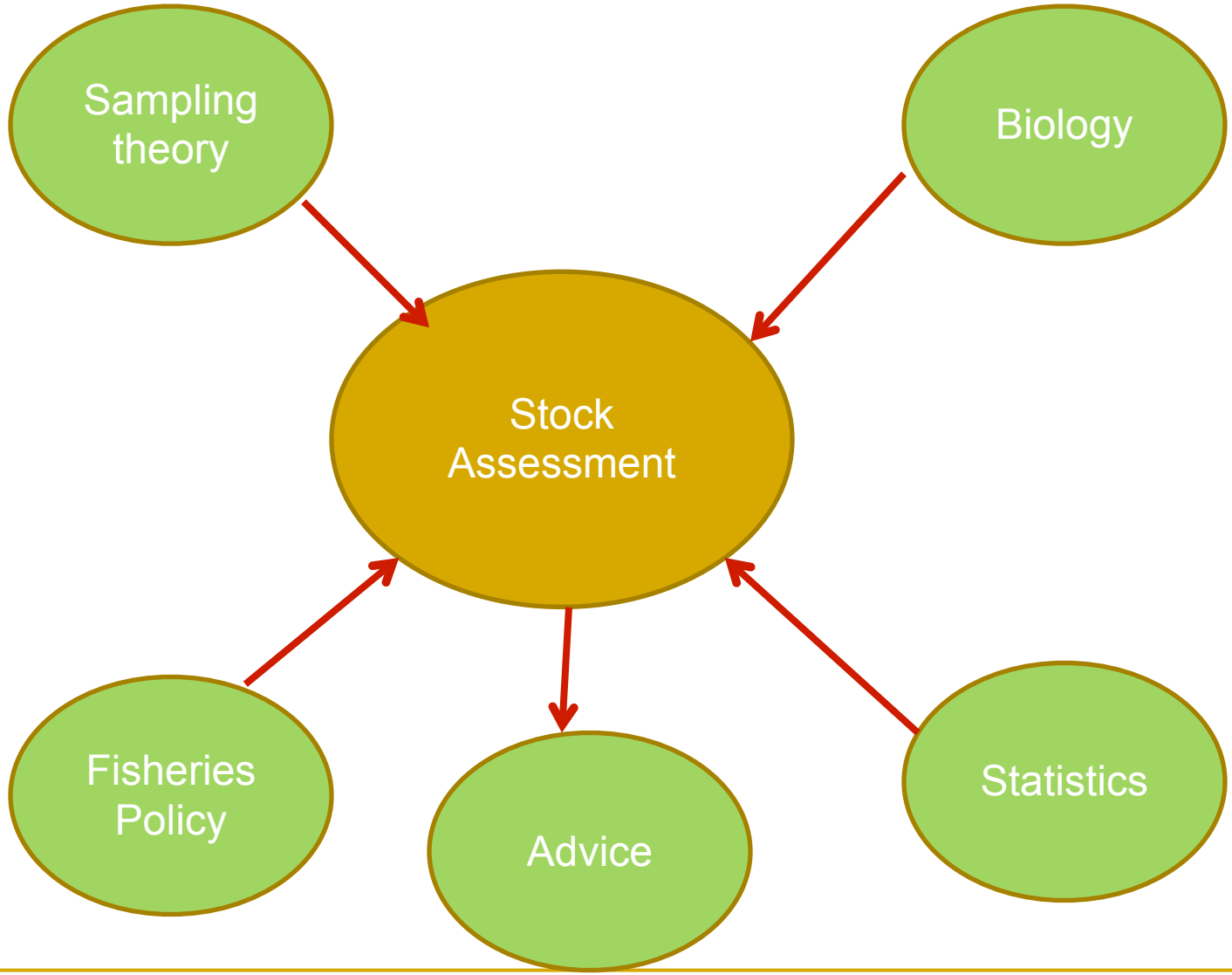


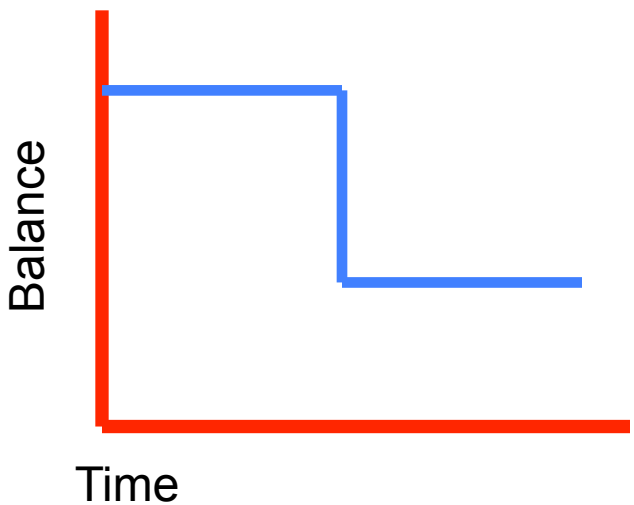

Sampling theory
Biology
Stock Assessment
Fisheries Policy
Advice
Statistics

The Absolute Basics (No math)

Consider you have a bank account and you take $50 out on Monday. You want to know your balance so you phone the bank and ask but they say all they can tell you is that you have 210 Z$ before the withdrawal and 105 Z$ after the withdrawal?

Can you work out your balance?

Yes. Your balance halved when you took out $50 so you must have had $100 to start with [hint this assumes that the US$-Z$ exchange rate didn't change during the day and you got no interest or bank charges]



The Absolute Basics (Some math)

It is always easy to find your balance with this information. However, we like to use math. Let *z* be our initial balance in Z$, *y* be what is taken out and *x* be the final balance in Z$. We can find our balance using the equation:

Initial balance = *z* x *y* / [*z*-*x*]. Try it out!!

This is very simple, but is how the simplest of stock assessments actually work.

Hint for the next steps: Life would have been MUCH easier if we knew the exchange rate between Z$ and US$ – this is the infamous “Q” we will talk about later

How This Relates to Fisheries-I

There is a close link between bank balances and fish stocks:

- Bank balance = spawning stock biomass (SSB)
- Removals = catches
- Interest = growth and recruitment
- Bank charges = natural mortality

How This Relates to Fisheries–II

$$$$$

Balance (next year) = Balance (this year) + interest – withdrawals – bank charges

SSB (next year) = SSB (this year) + growth + recruitment – catch - mortality

Why Fisheries Assessment is More Difficult than Banking

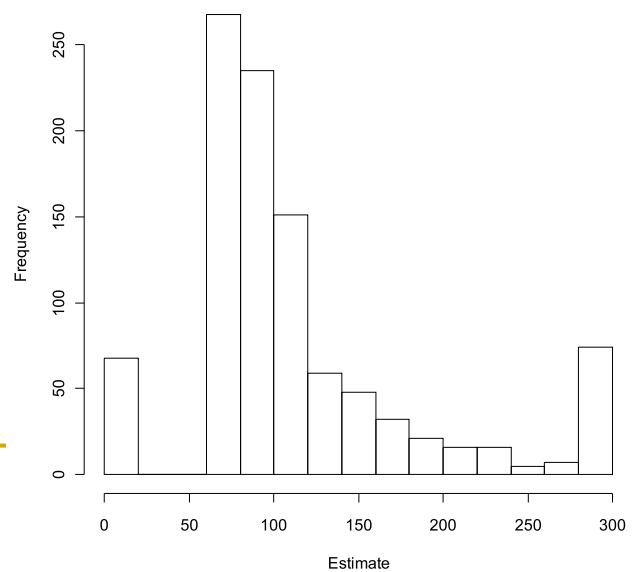
Fishery surveys are subject to sampling error!

Imagine phoning your bank and being told: (a) we will tell your balance in Z$ and not US$, and (b) your balance will be reported ± 50%.

What does this mean:

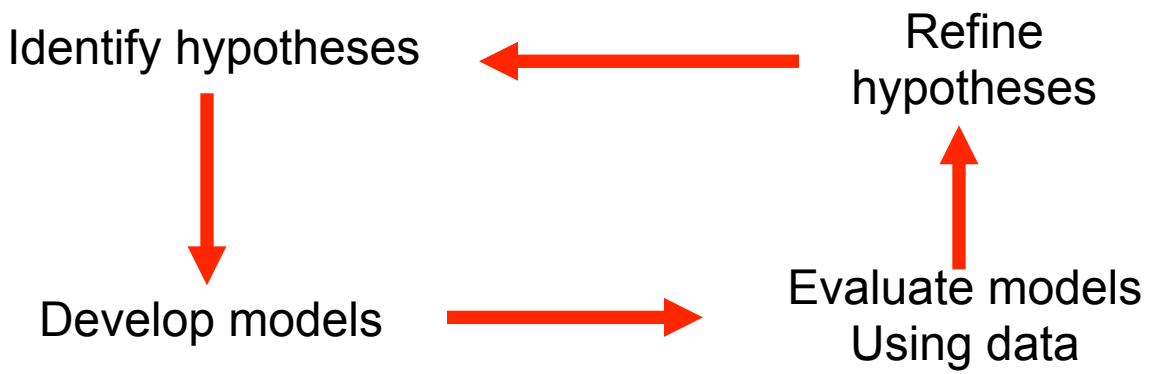
If your balance was really 210Z$, the bank could give you values of 174, 269, 279

Lets repeat the previous calculation with error (the true answer was 100) but this time we allow for ± 50% error when reporting balances :



The Stock Assessment Cycle

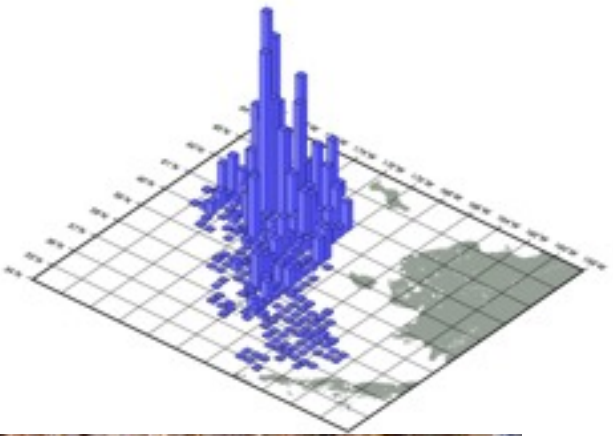
Stock assessment (and science in general) is never finished. We continue to refine our understanding over time.



Stock assessment is somewhat unusual because decisions need to be made (annually for crab), which means that decisions may be made using the “best available science”™.

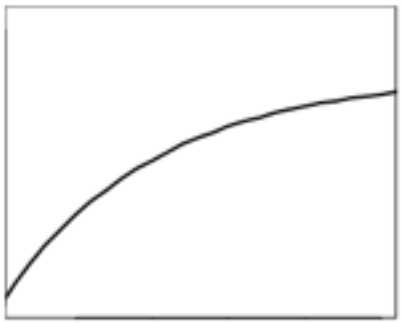
Data we use for crab (abalone, rock lobsters)

Survey length frequency



Catches (direct, discard, bycatch)

Models and data

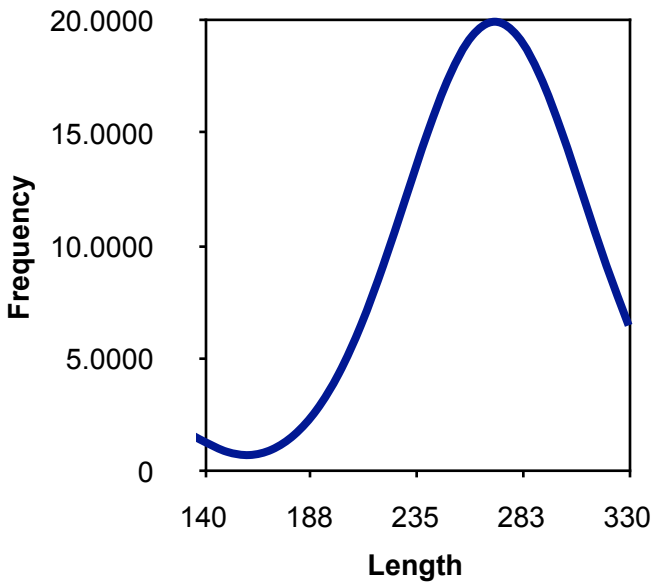


Which of these curves are ”most likely” to have generated the data?

These two seem pretty similar – is one better?

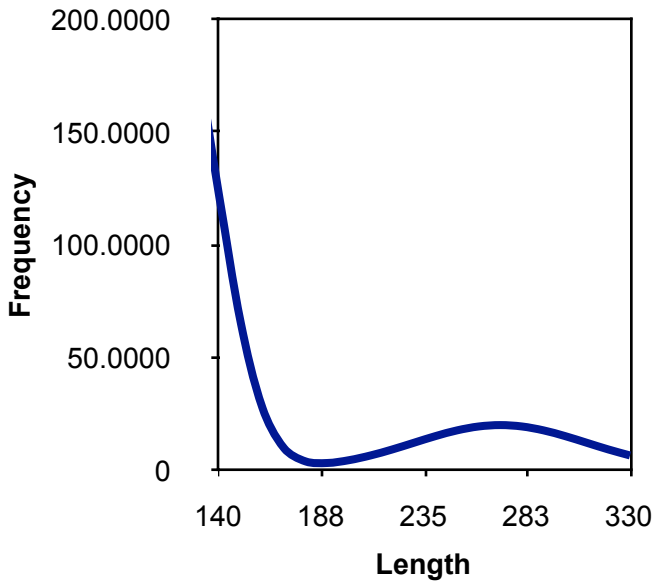
Why we use Length-frequency data

1990



What happened?

1991



Hypothesis 1: We had some really good recruitment (big bump is now small)
Hypothesis 2: Recruitment wasn't good but mortality was high!

We can use our survey data to distinguish between these two hypotheses.

“Q” and Vulnerability-I

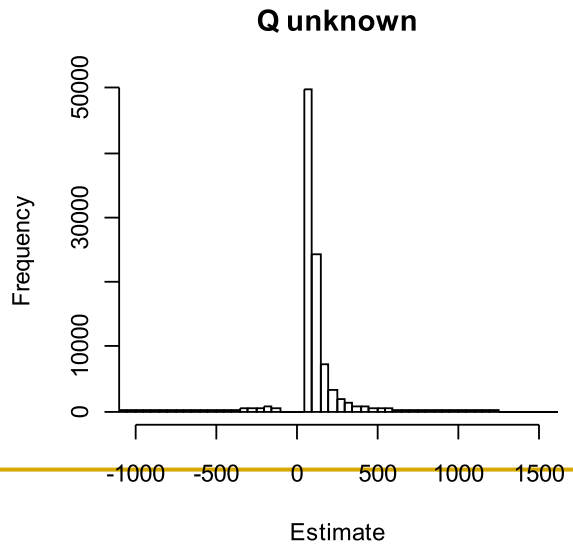
All crab are not equally susceptible to capture by the survey. The number of crab in the sea in some length-class and the number you estimate from a survey differ because of:

1. Availability (are the crab outside of where the survey is taking place)
2. Gear selectivity (are crab of all sizes equally vulnerable to capture if they were in front of the survey net).
3. “Q” (what is the probability that crab of the “most vulnerable” size are caught).
4. Sampling error (bad luck).

“Q” and Vulnerability-II

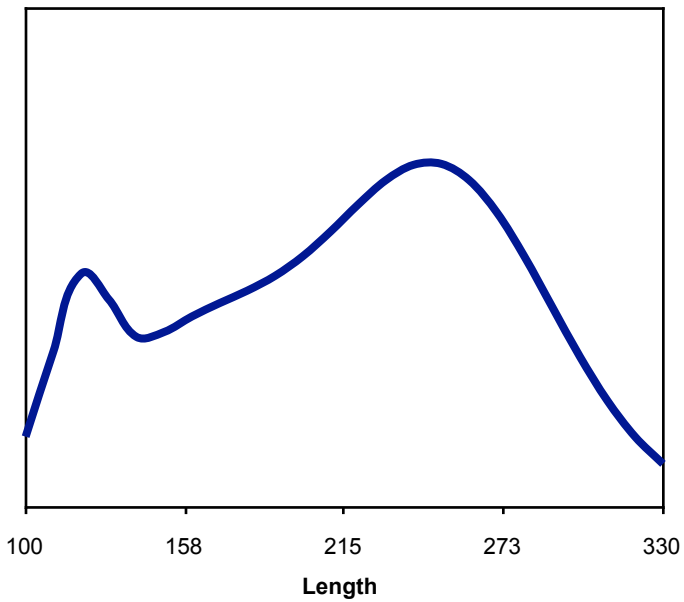
Knowing “Q” can substantially improve estimates (because we can relate survey estimates directly to what is in the population) – of course getting it wrong can lead to all sorts of problems too!

Returning to the bank balance example. Lets say we know the exchange rate between Z$ and US$



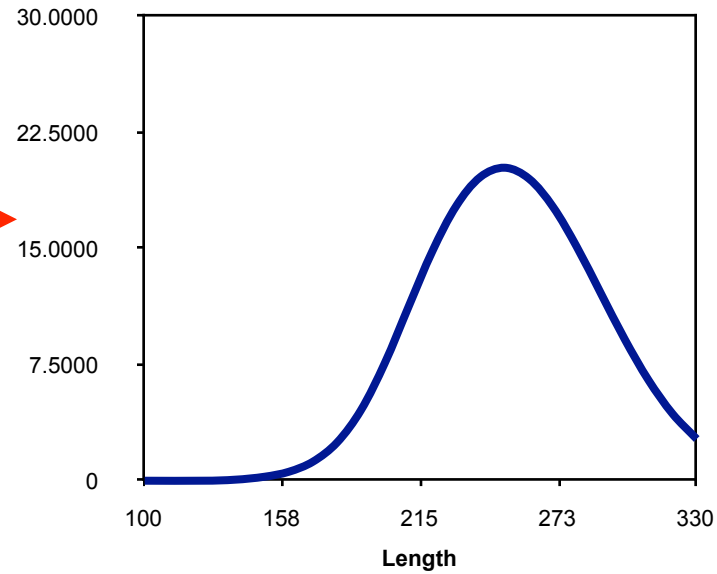
More about vulnernability

Population
Size-structure



Vulnerability

Survey
Size-structure



Question: How to “find” the animals which are not selected by the gear

Answer: Wait a while. If the small animals are there they will appear in the catch (and survey) length-frequencies in while.

Using data in crab stock assessments

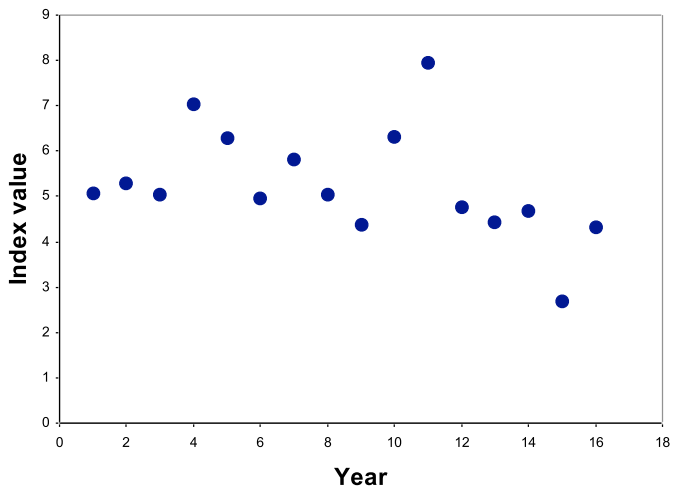
- Common data
  - Survey indices (the trend in population)
  - Length data (which cohorts are strong weak)

- Other data
  - Information of spatial distribution
  - Environmental data

Putting it all together-I

Stock assessment has been described as detective work. We have a several hypotheses and many clues. The art is to understand how all the pieces link together. Like detective work, the more pieces of information you have the easier it should be. However, the more pieces of information you have the greater the potential for contradictory evidence because fisheries are not experiments.

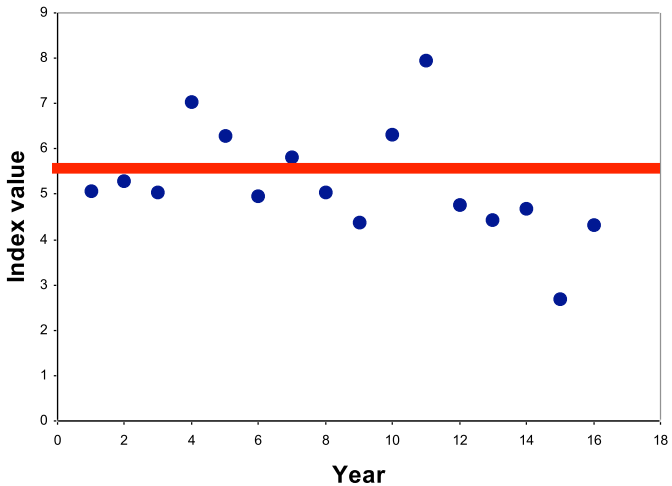
Let us look two hypotheses: (a) the stock is stable, and (b) the stock has declined 50% over the period we collect the data. Here are the data:



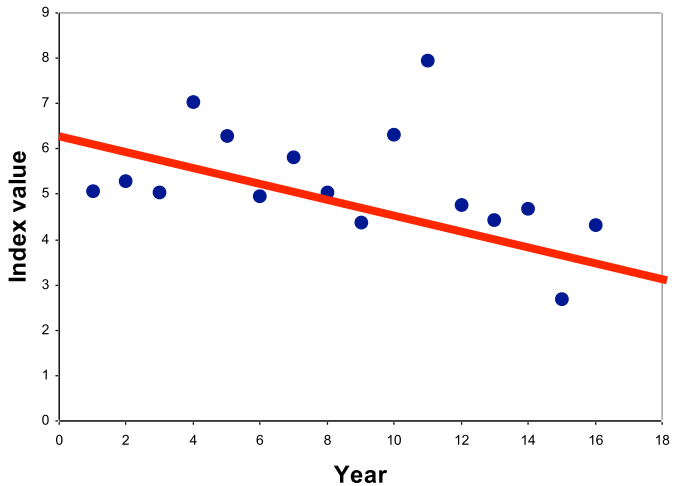
Putting it all together–II

Lets look at what data tell us about our two hypotheses:

Stable



Declining

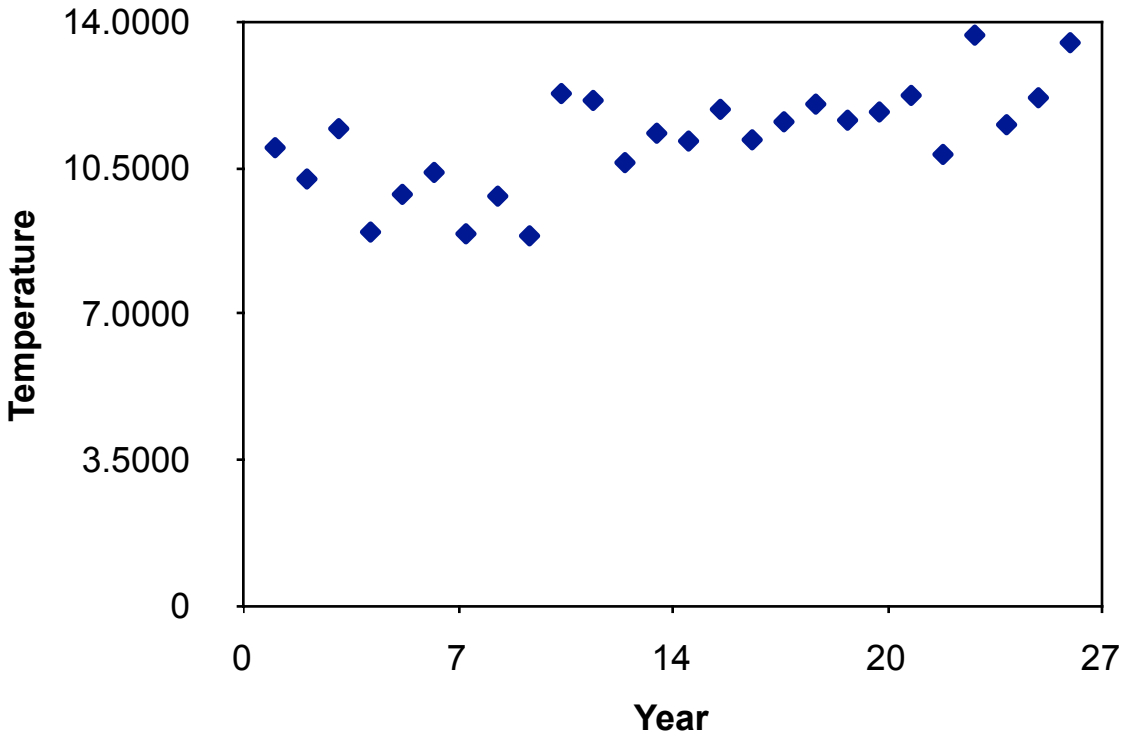


The hypotheses can be compared using statistics, and the evidence in the data prefer the stable hypotheses (this doesn't mean that the declining hypothesis is completely wrong – the declining hypothesis has a 30% change of being right).

Stock Assessments are not static

We continually update analyses as new data become available

Predicted Temperature in Year 30;



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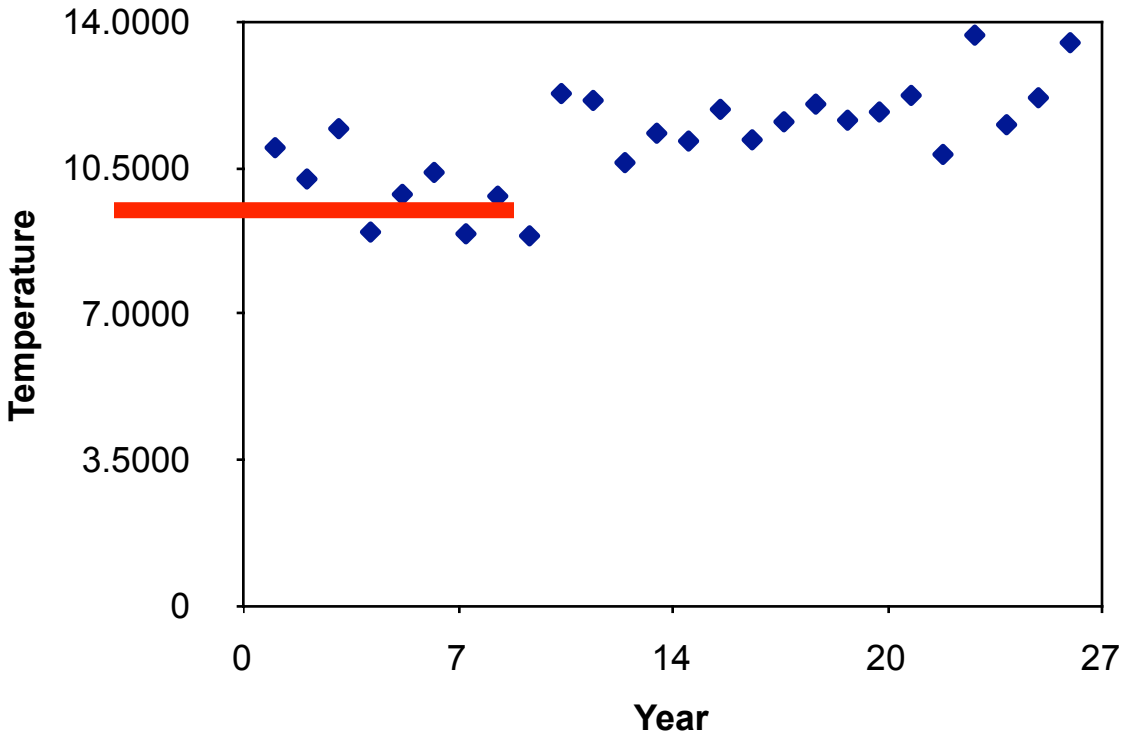
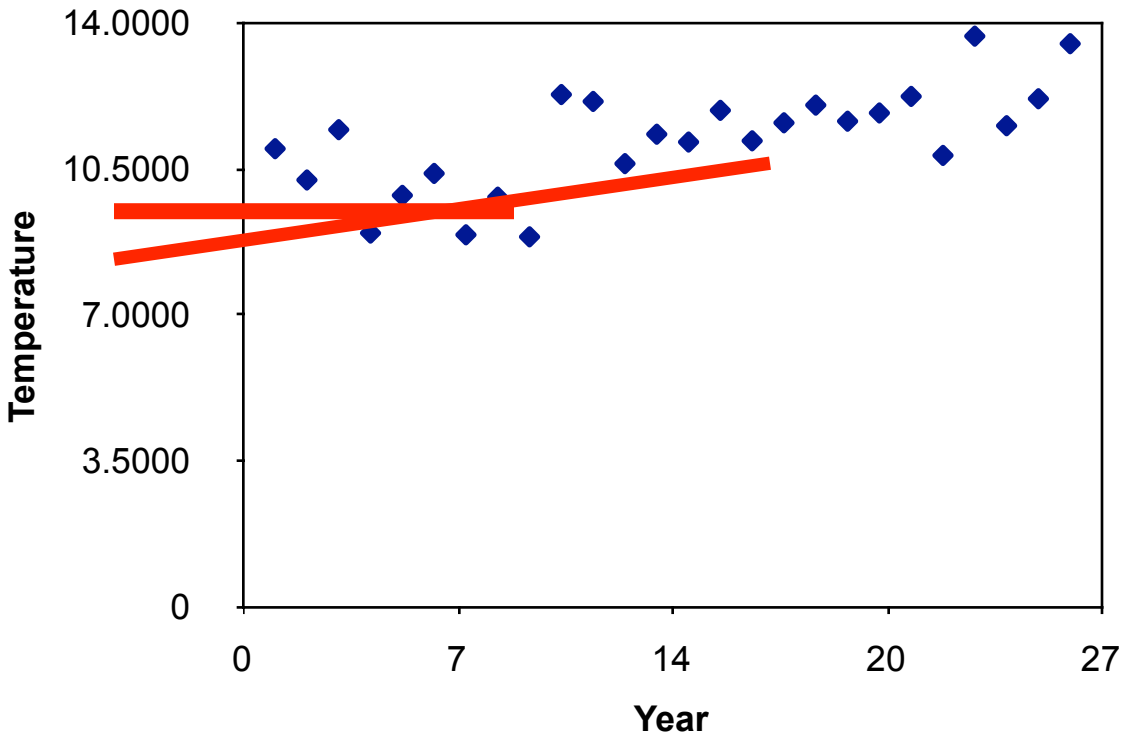


Predicted Temperature in Year 30;

Years 1-10: 9.36

Stock Assessments are not static

We continually update analyses as new data become available



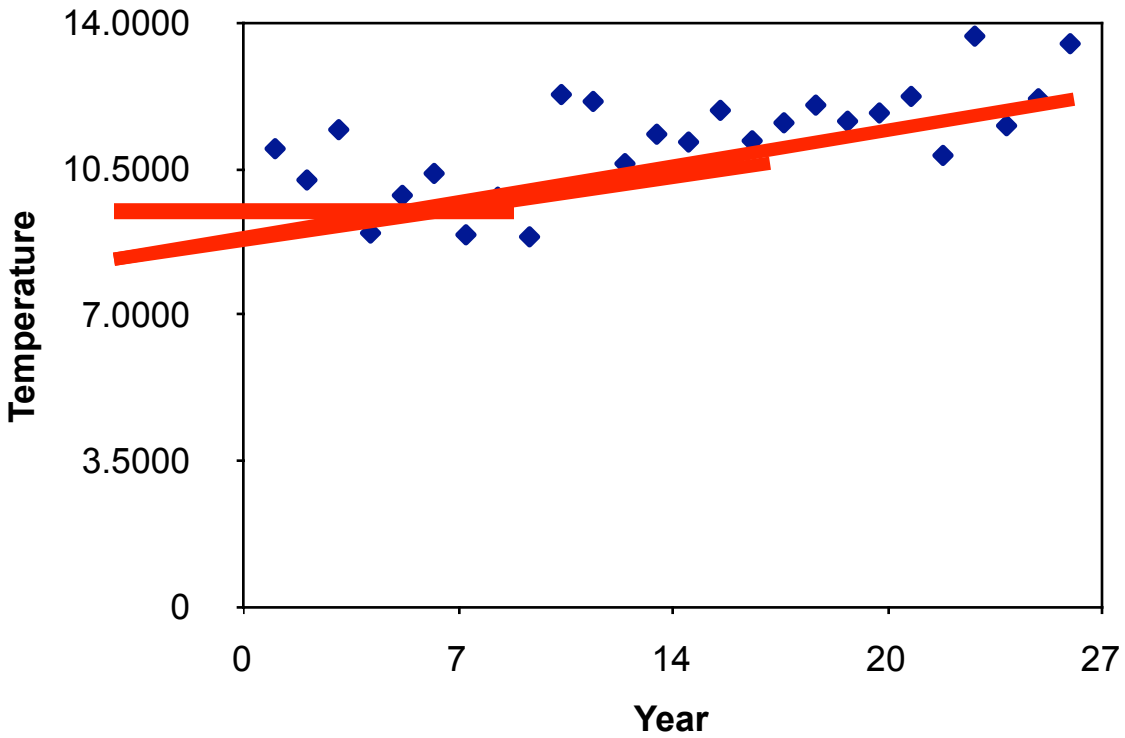
Predicted Temperature in Year 30;

Years 1-10: 9.36

Years 1-17: 12.78

Stock Assessments are not static

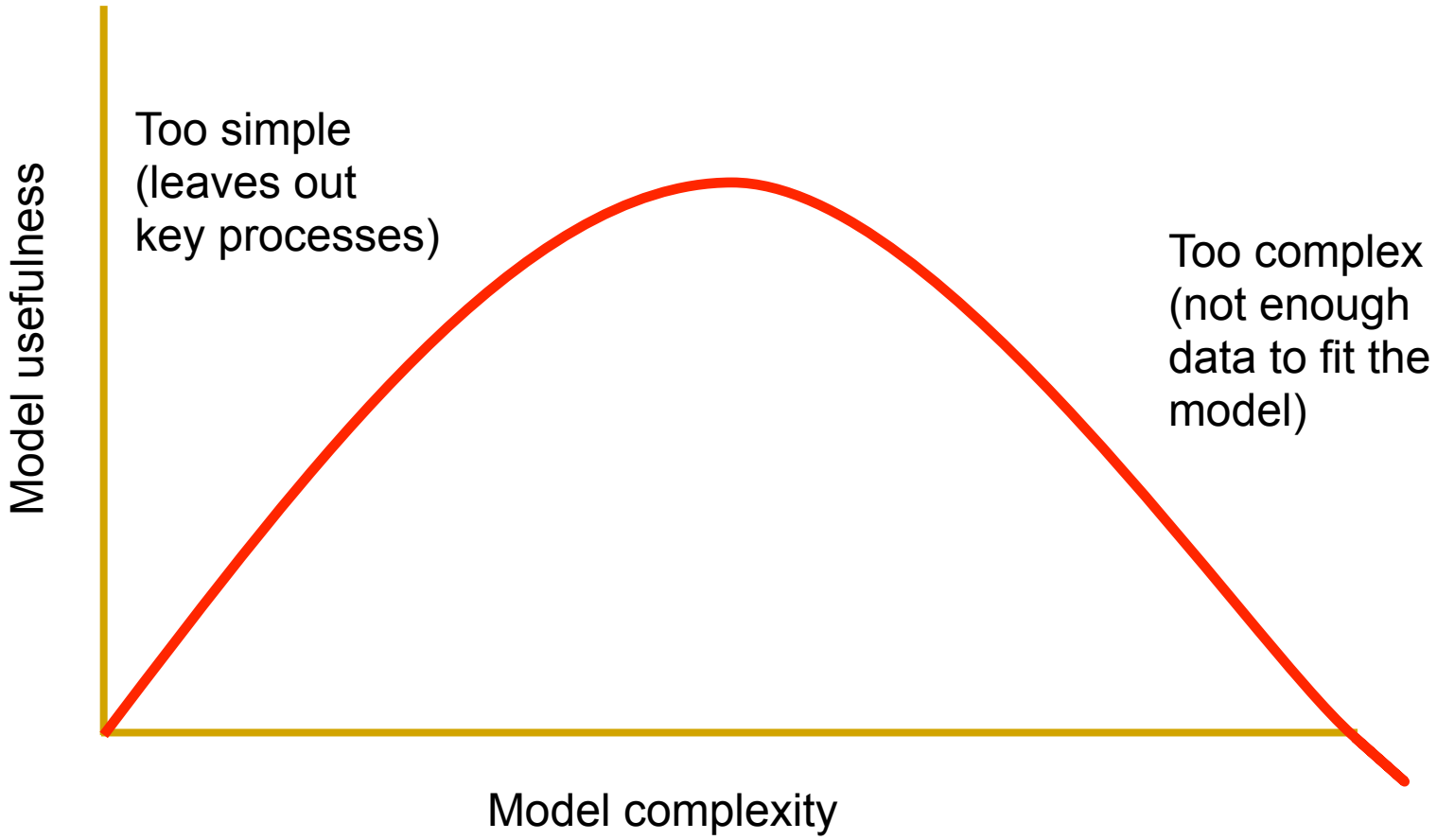
We continually update analyses as new data become available



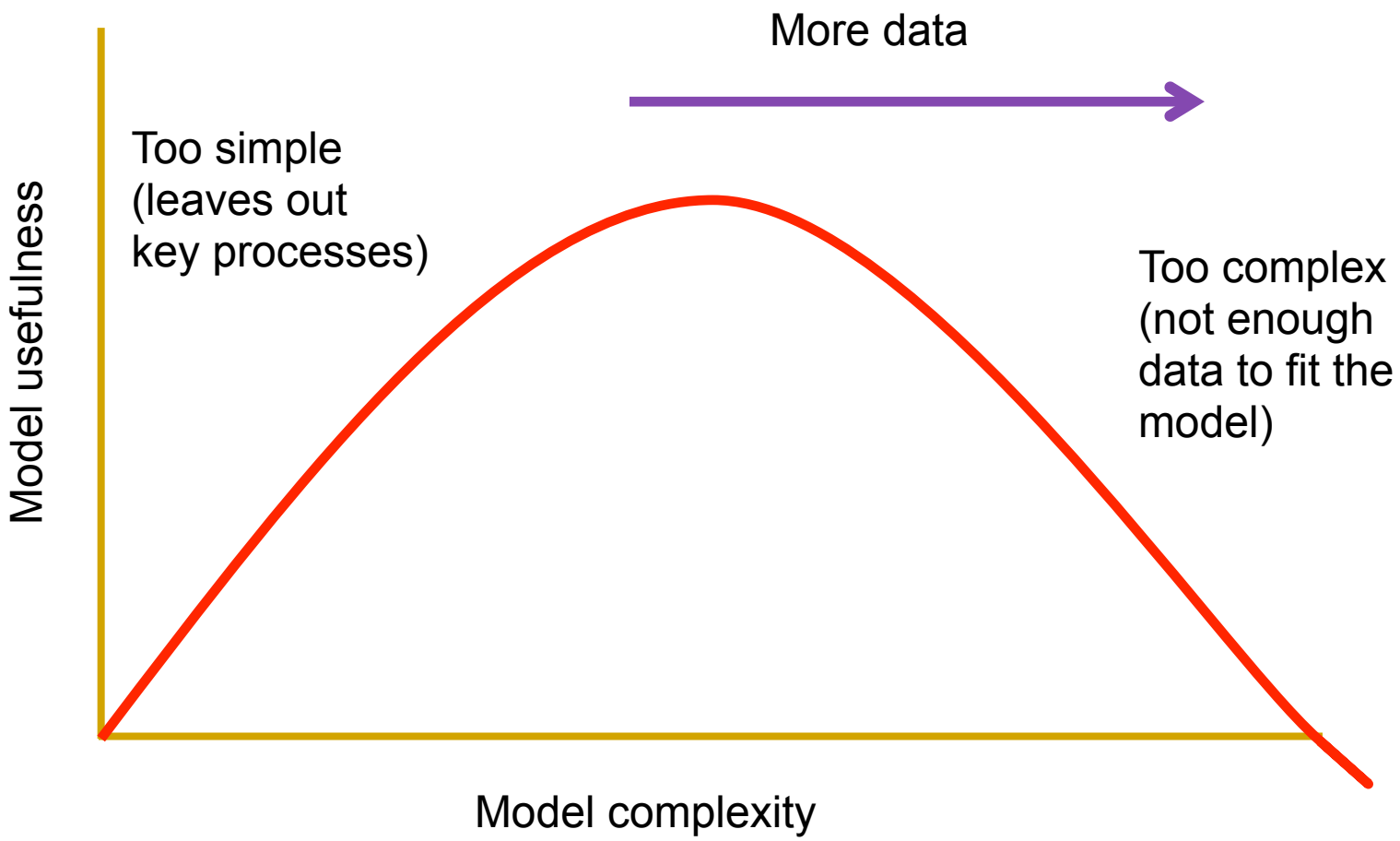
Predicted Temperature in Year 30;

- Years 1-10: 9.36
- Years 1-17: 12.78
- Years 1-26: 13.03

Model complexity



Model complexity

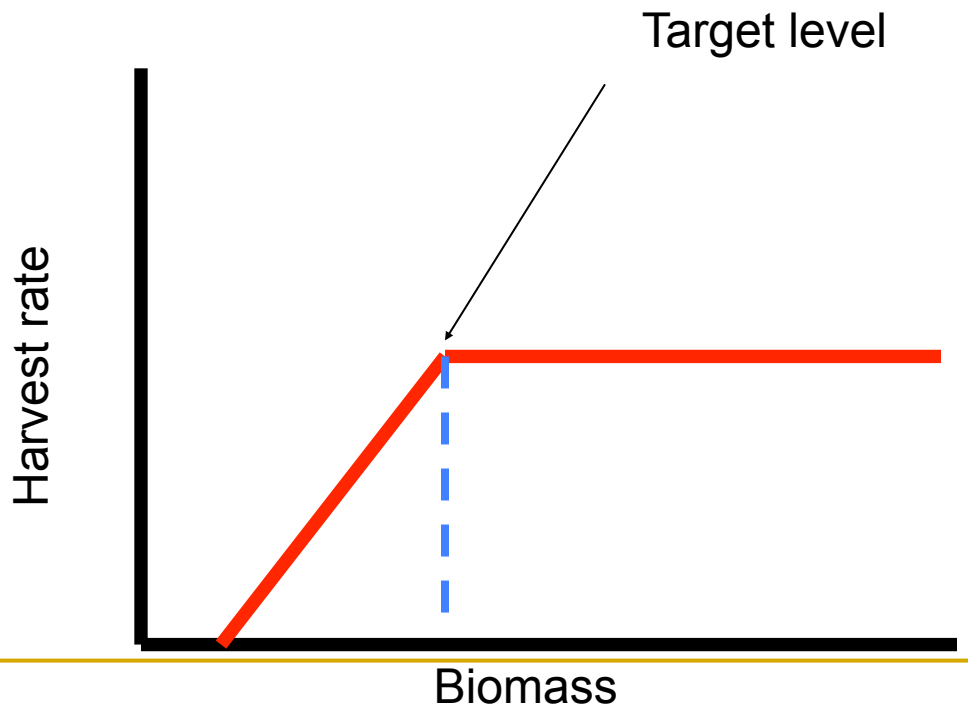


Control Rules and OFLs-I

The overfishing level (OFL) is the catch you cannot exceed (legally).

OFL = Harvest rate * Biomass

The OFL is lower for lower levels of biomass and much lower if the biomass is below the target level

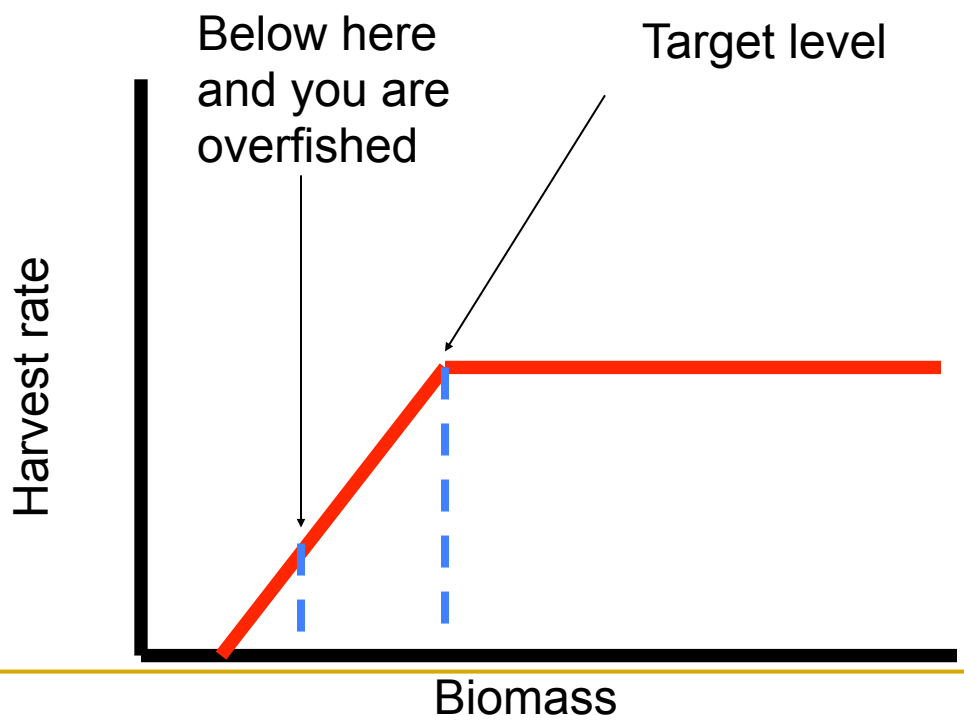


Control Rules and OFLs-II

OFL = Harvest rate * Biomass

We get the estimate of biomass from the assessment model and the harvest rate from a control rule.

The control rule and associated constraints arise from the Magnusson Act.



Questions?

$$\bar{N}^{s,A}_{t,m+1,a} = \sum_{A'} X^{s,A,A'}_{m,a} \left(\bar{N}^{s,A'}_{t,m,a} e^{-M_a \Delta t} (1 - K_b \Delta t) + \frac{\mu_a \Delta t}{n_A} U^{s,A'}_{a} N^{NZ}_{a} - C^{s,A'}_{t,m,a} \right)$$

$$N^{obs}_{y,l} = N^{True}_{y,l} \, e^{b - \sigma_b^2/2} e^{\varepsilon_y - \sigma_\varepsilon^2/2}$$