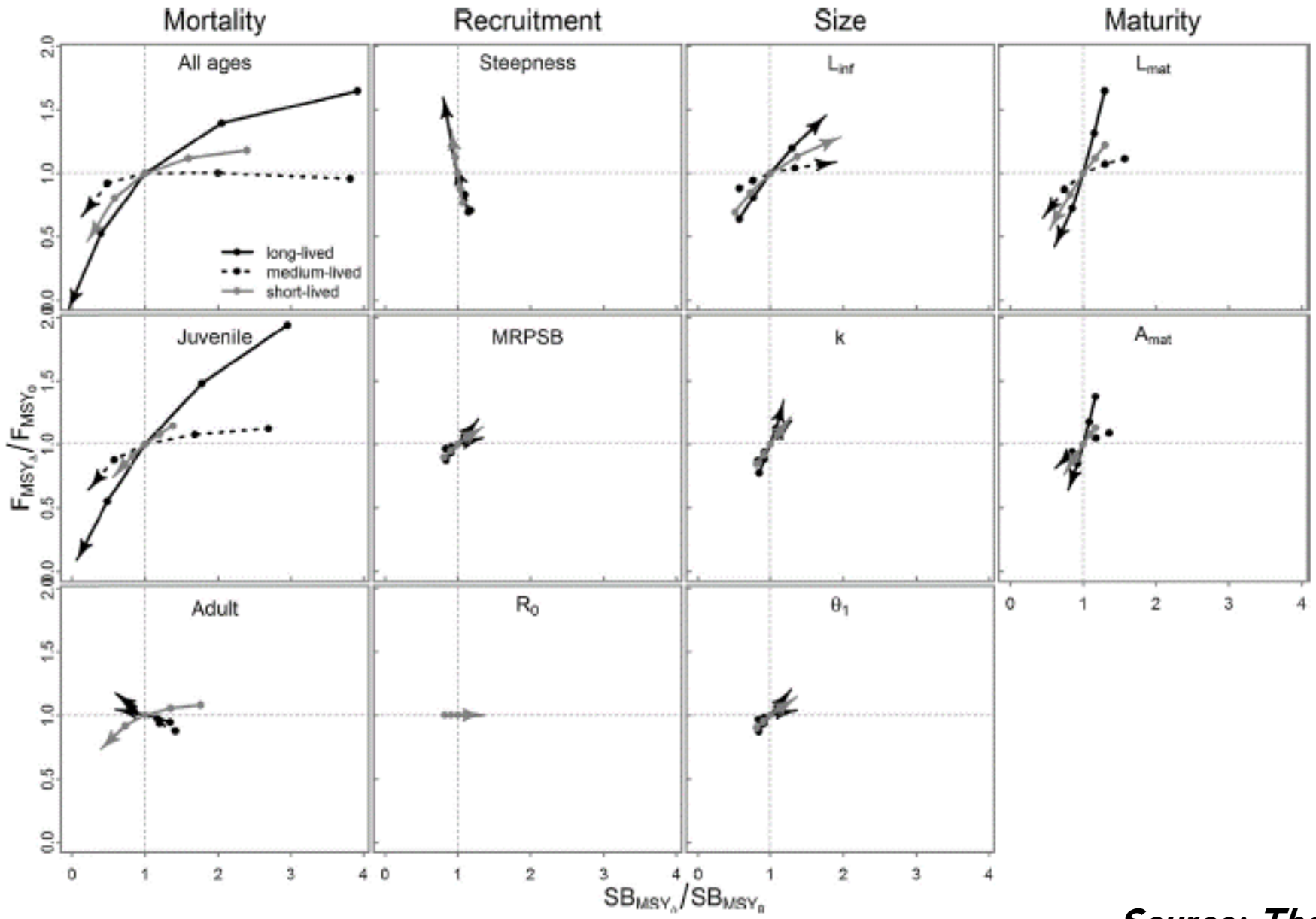
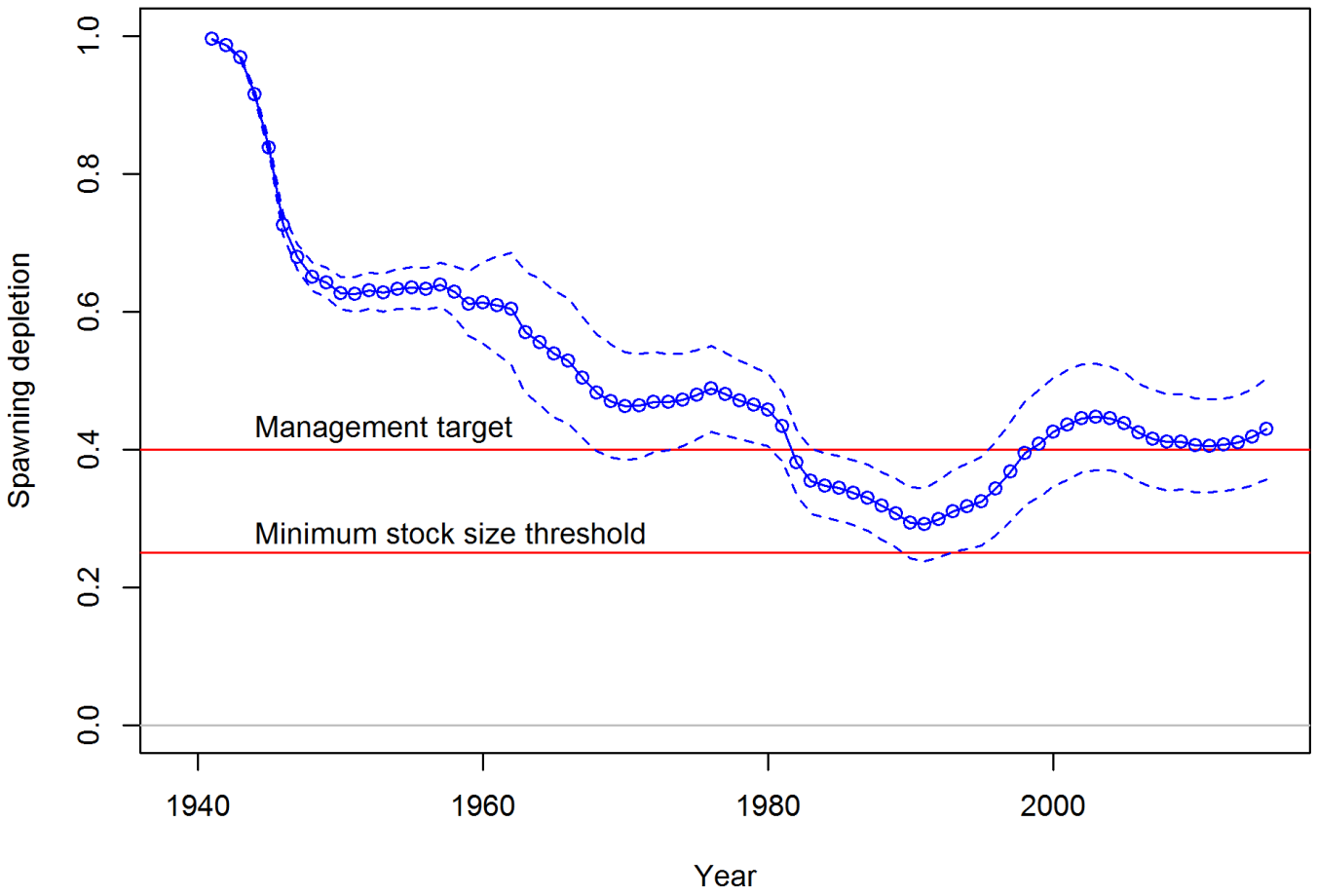
Data-limited fundamentals: Characterizing uncertainty

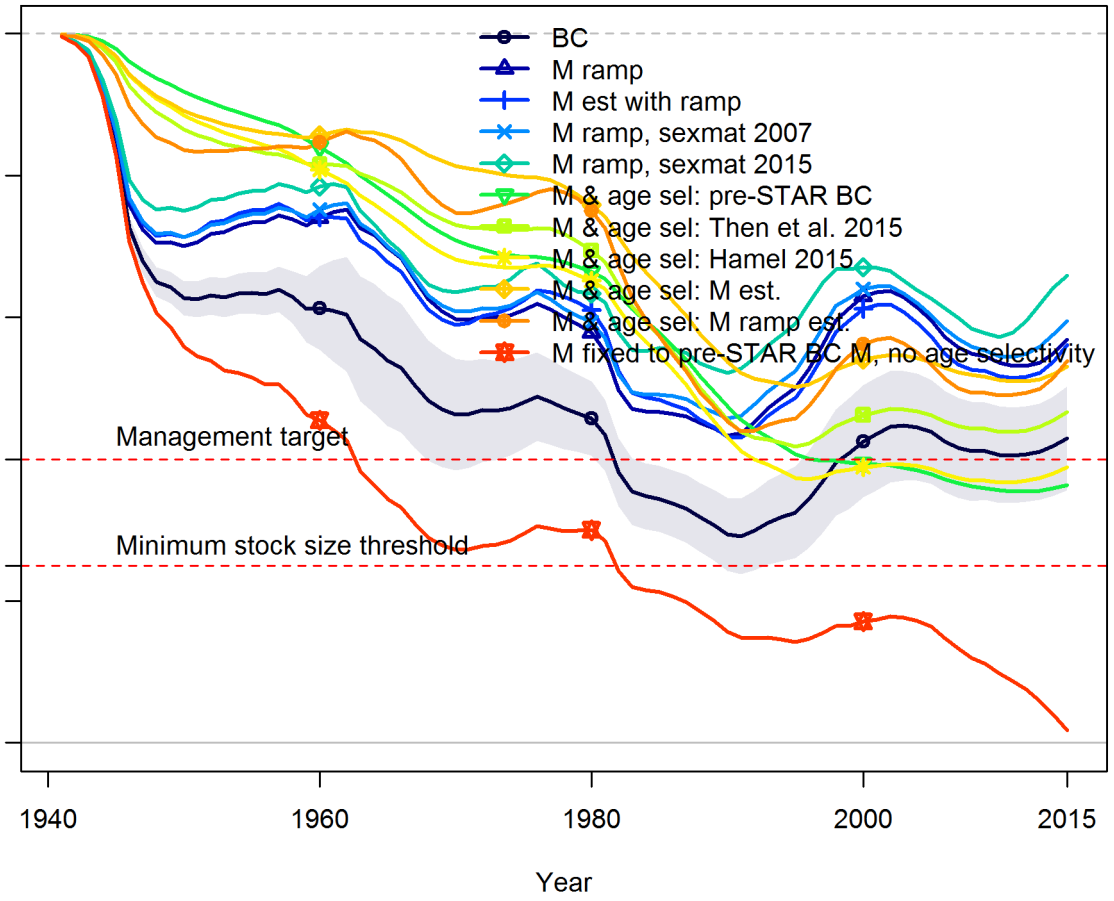
Understanding & characterizing uncertainty



Source: Thorson et al. 2015

Understanding & characterizing uncertainty





Source: 2015 Black rockfish assessment

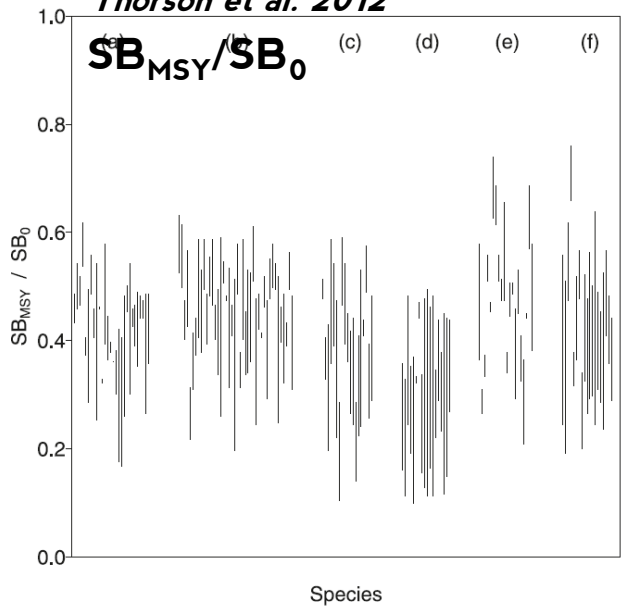
Understanding & characterizing uncertainty

- Uncertainty analysis attempts to quantify what we don't know
- Uncertainty analysis is not bad, but a necessary part of stock assessment

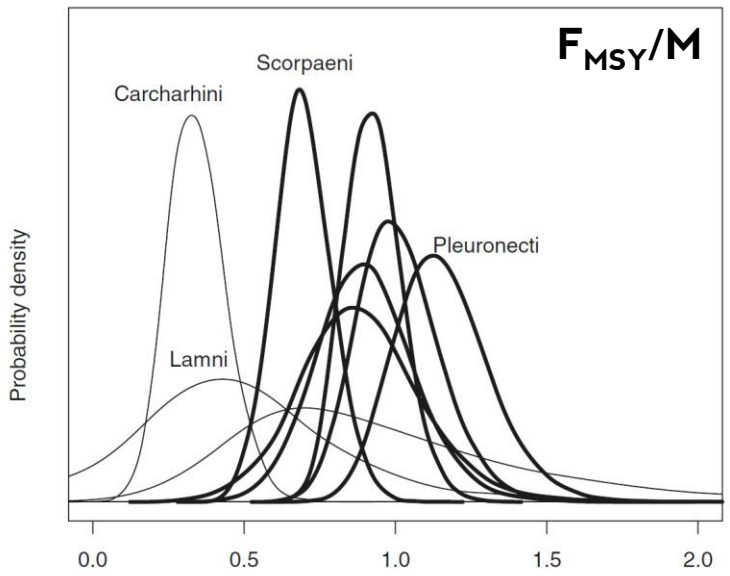
For data-limited methods, consider uncertainty in inputs and across methods

Improving inputs: parameters

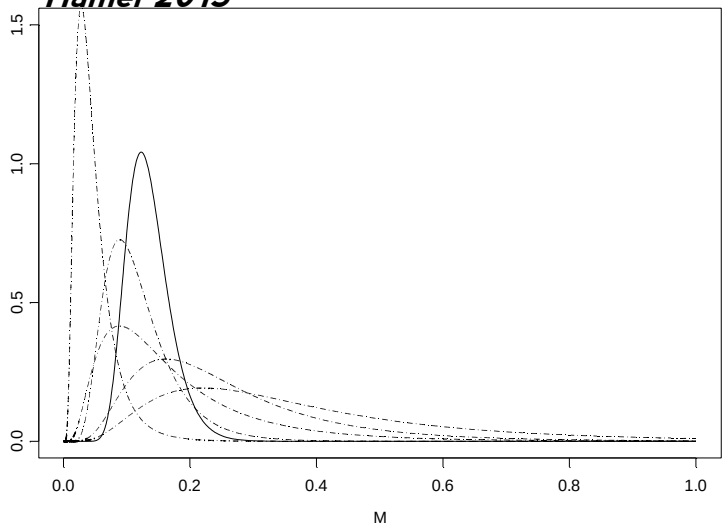
Thorson et al. 2012



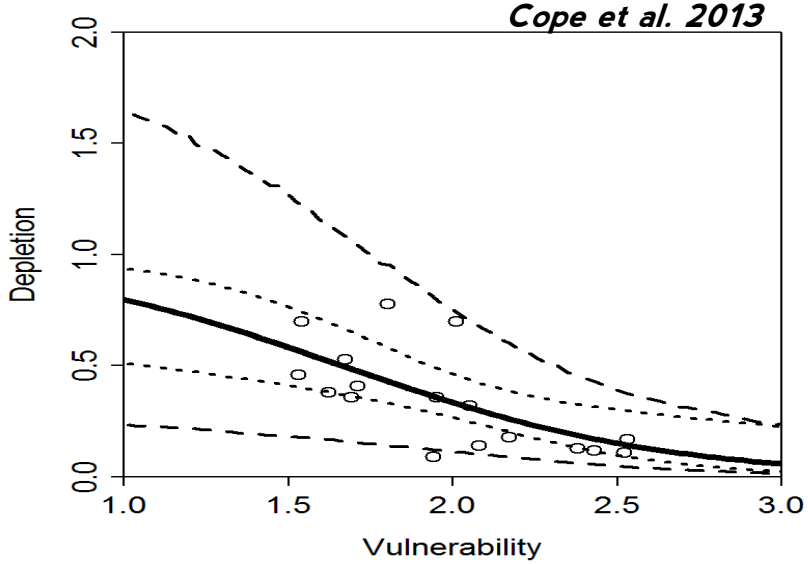
Zhou et al. 2012



Hamel 2015

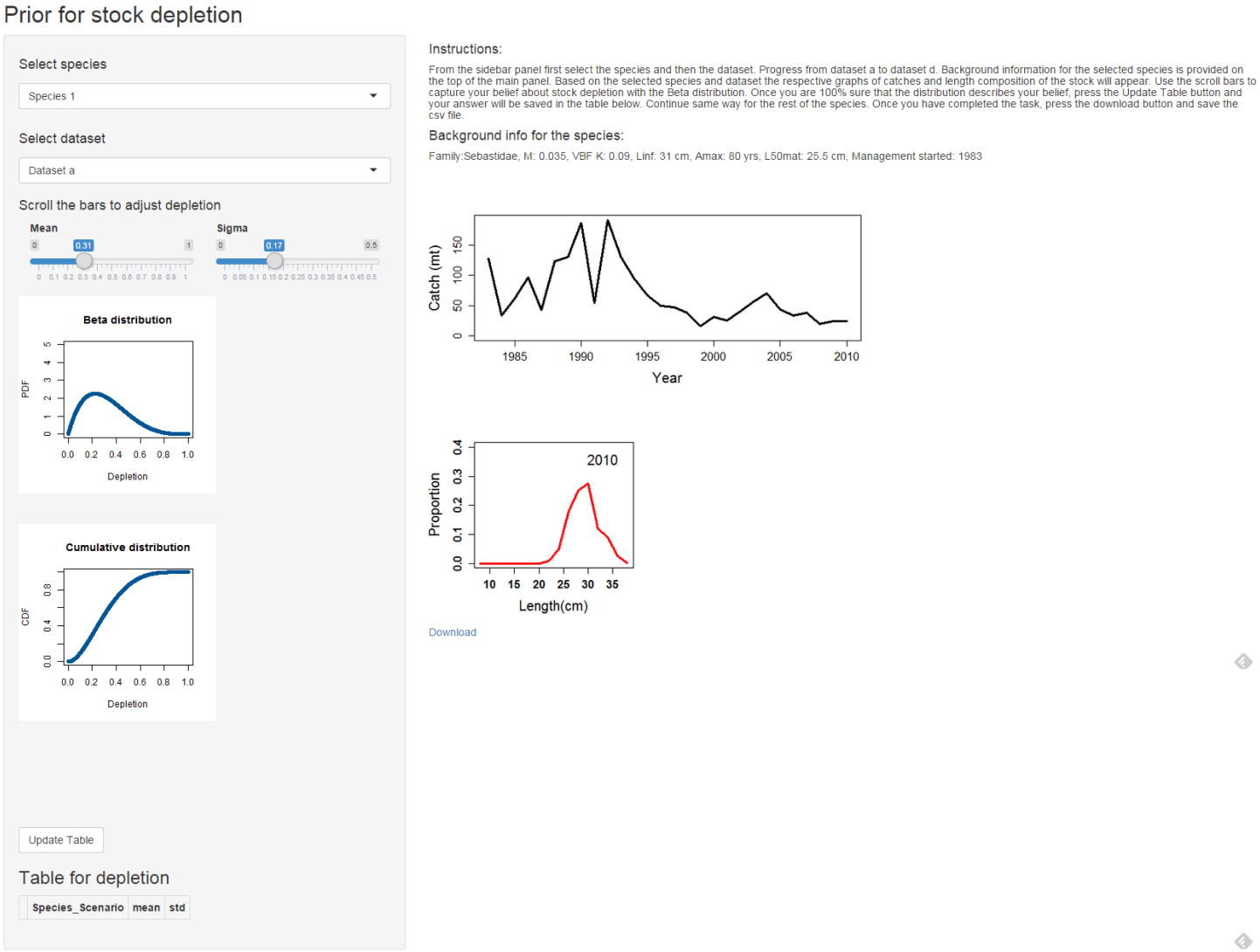


Cope et al. 2013



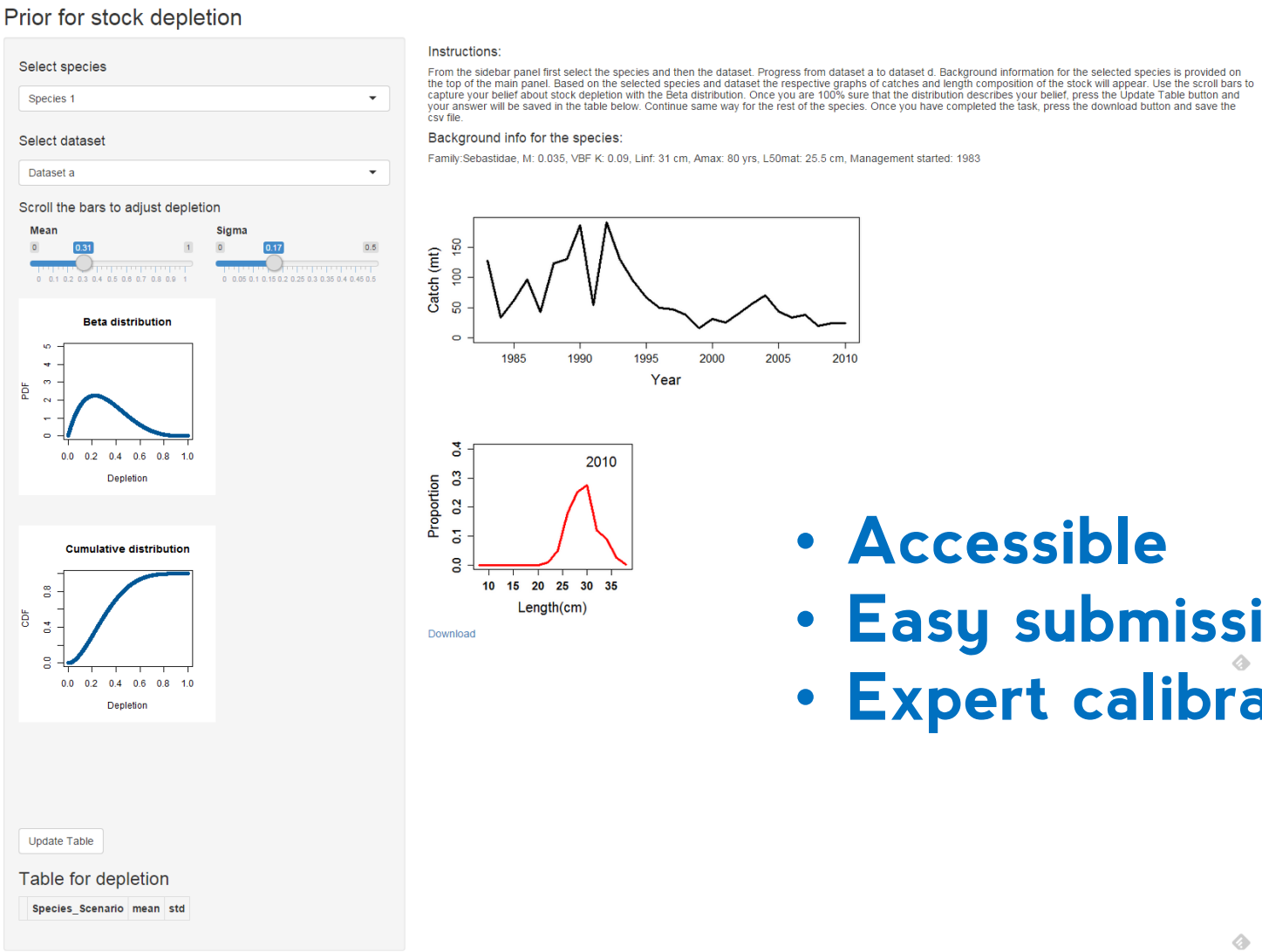
What else can we improve? What should we focus on?

Expert elicitation: stock status



Source: Chrysafi et al. in review

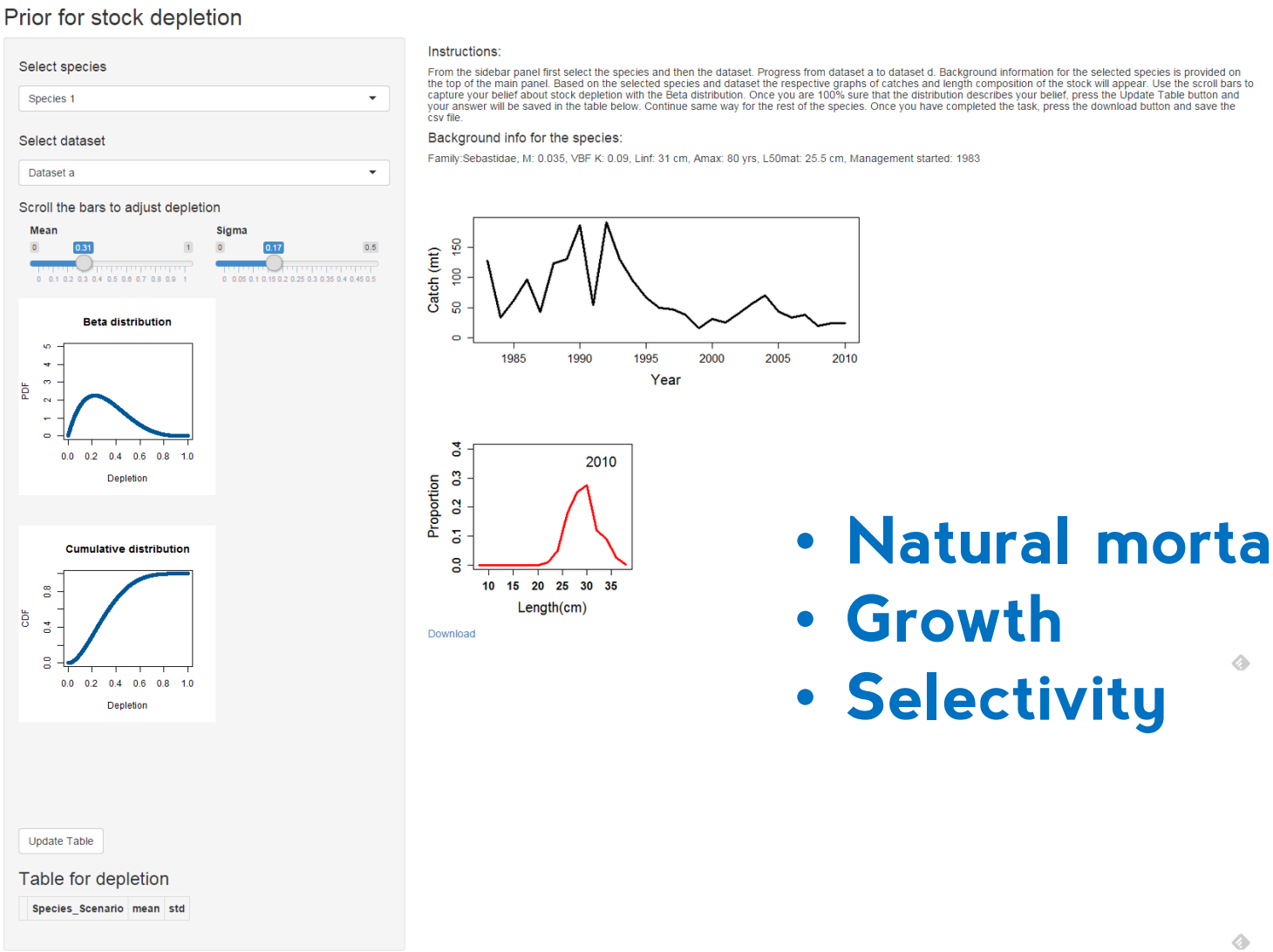
Expert elicitation: stock status



- Accessible
- Easy submission
- Expert calibration

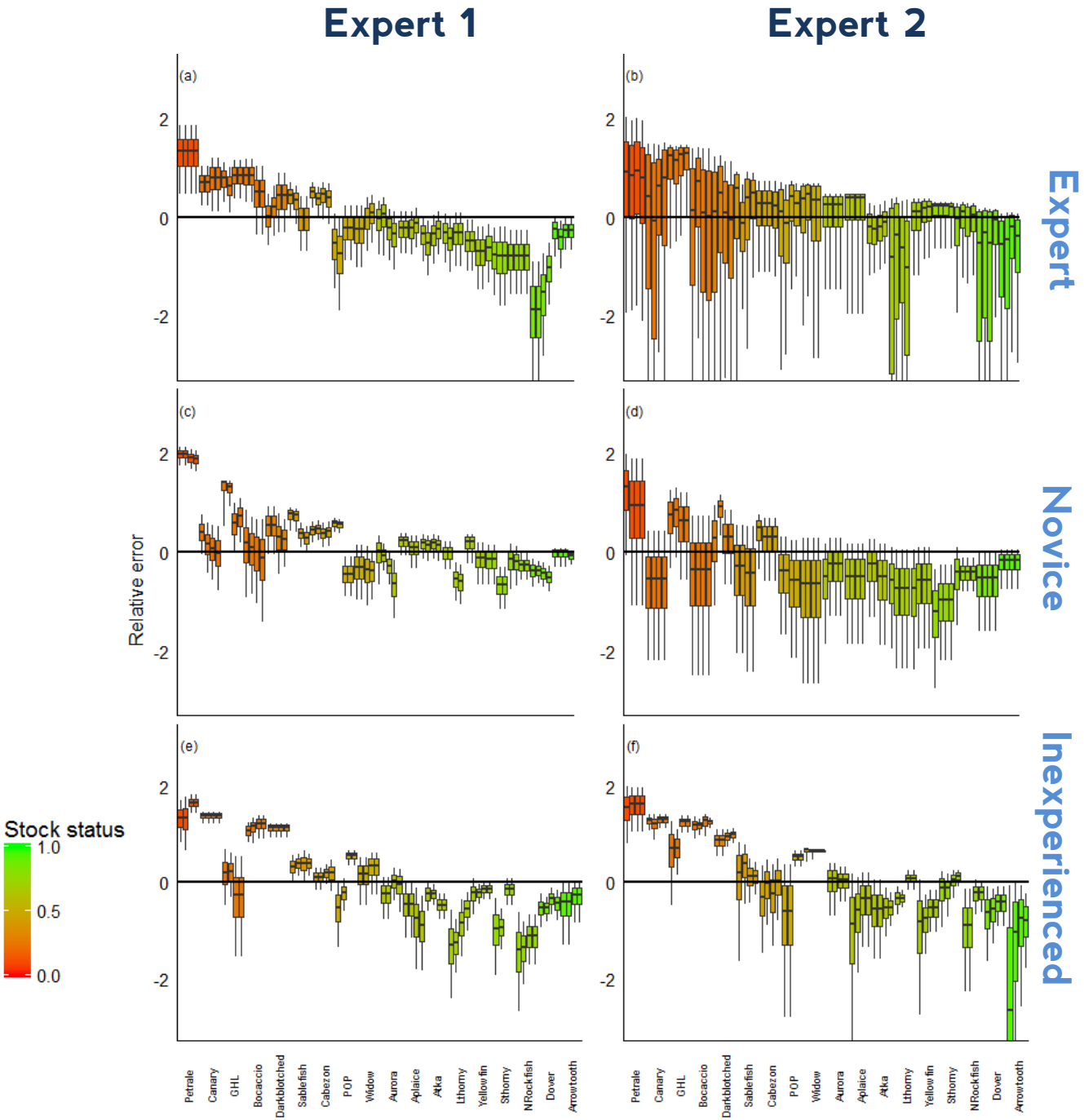
Source: Chrysafi et al. in review

Expert elicitation: stock status



- Natural mortality
- Growth
- Selectivity

Source: Chrysafi et al. in review



For stock status:

- Low status overestimated; high status underestimated
- Similar pattern in bias among expert level
- More expert, more uncertainty recorded

Source: Chrysafi et al. in review

Demo:
Natural mortality tool

Summary: Uncertainty

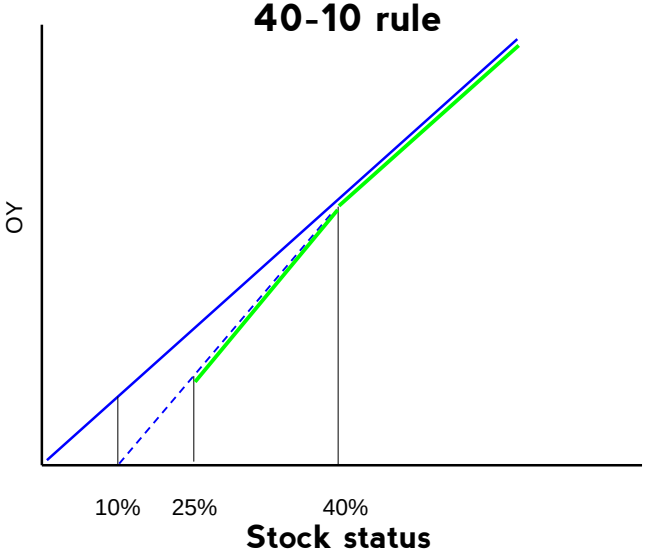
- A necessary and critical element of assessing stocks and informing management
  - Uncertain input values
  - Method sensitivity
- In data-limited approaches, summarize over two dimensions
  - Parameter uncertainty
  - Methods uncertainty
- Look to improve input values through prioritized research

Data-limited fundamental: Reference points and risk

Reference points

- Embodies management objectives
  - Biomass (e.g.,B_{MSY})
  - Fishing rate (e.g., F_{MSY})
- Target reference points (TRP)- where you want to be
- Limit reference points (LRP)- where you don't want to go
- Proxy RPs (e.g., F=M)

Harvest control rule → Input (effort) or output (catch) management options



LRP's	STOCK "TRAFFIC" LIGHT
$Z \geq Z^*$?	
$B \leq 0.2B_0$?	
$F \geq xM$?	
$R_t \ll \bar{R}$?	
$F > \begin{cases} 2/3F_{MSY} \text{ ?} \\ F_{0.1} \text{ ?} \end{cases}$	

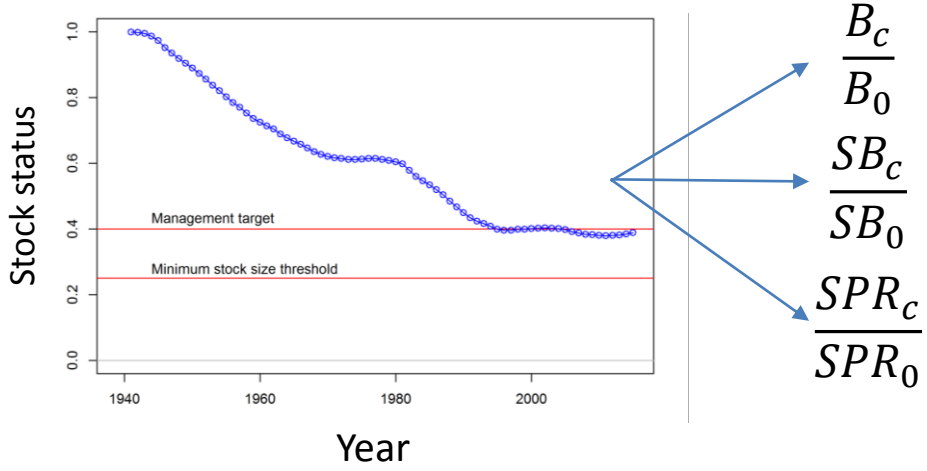
Source: Caddy 1998

Spawning Potential Ratio (SPR) Goodyear 1993; MacCall 2012

The ratio of current to unfished spawning output per recruit

$$SPR = \frac{N_0 e^{\sum_t -(M_t + Sel_t F)} \sum_t m_t f_t}{N_0 e^{\sum_t -(M_t)} \sum_t m_t f_t}$$

where N_0 = Numbers at age 0
t = integer age
m = maturity at age
f = fecundity at age



$$\frac{B_c}{B_0}$$

where B = biomass

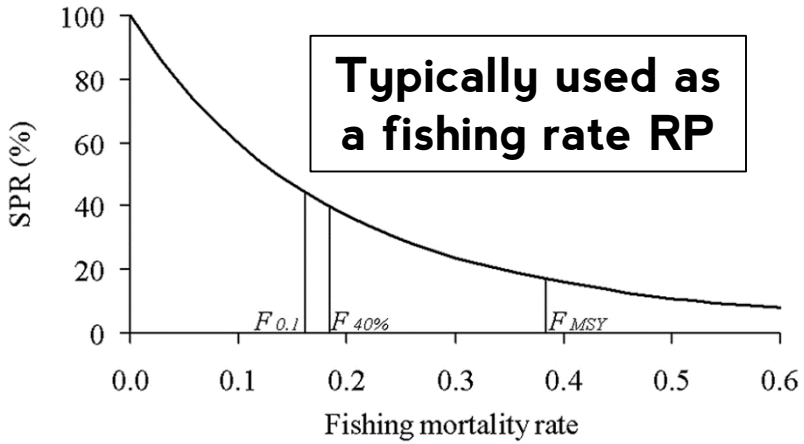
$$\frac{SB_c}{SB_0}$$

where SB = spawning biomass

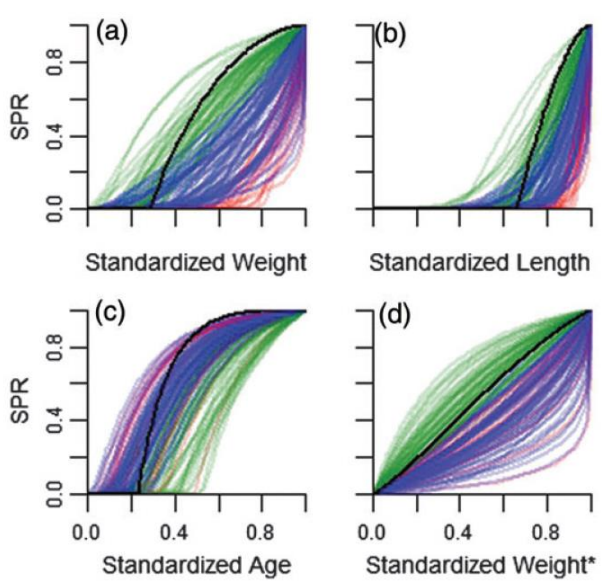
$$\frac{SPR_c}{SPR_0}$$

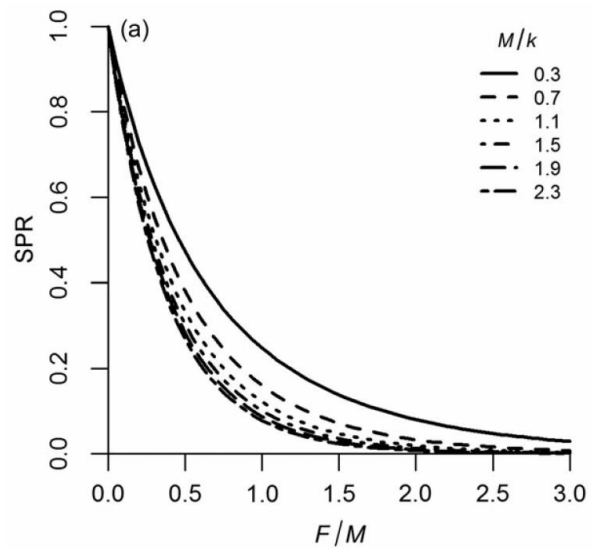
where SPR is in #s or biomass

SPR is tied to life history relationships



Source: Puga et al. 2013

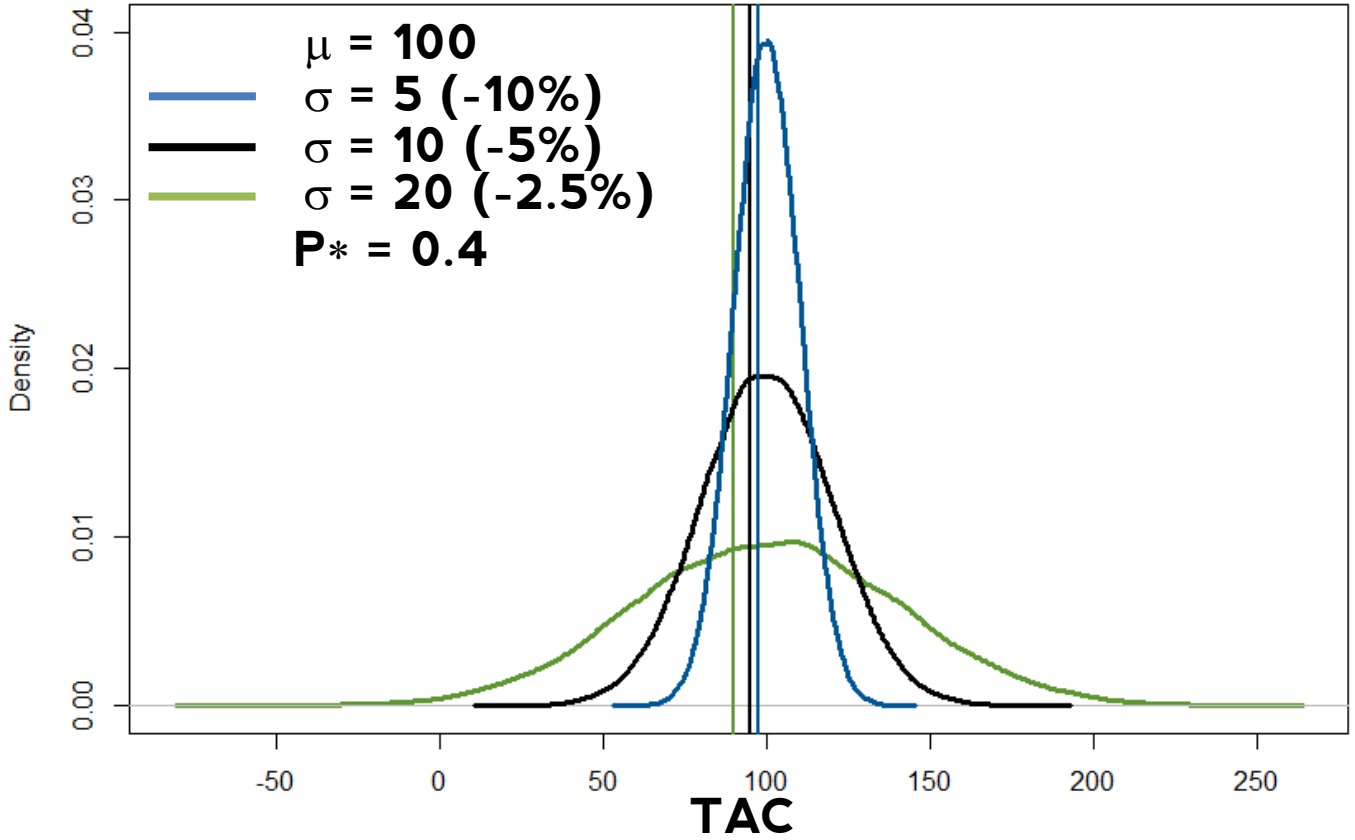




Sources: Hordyk et al. 2014; Prince et al. 2014

Quantifying risk for applied management

- **Risk tolerance- willingness to be wrong**
  - Depends on life history
  - Depends on data availability & quality
- **Data-limited approaches should be risk averse**
  - Method output/recommendation
  - Risk tolerance ⇒ Management option



Example: "P* approach"

- **Precautionary catch limit**
- **Uncertainty in catch (σ)**
- **P*: Risk quantile**

Sources: Prager et al. 2003; Ralston et al. 2011