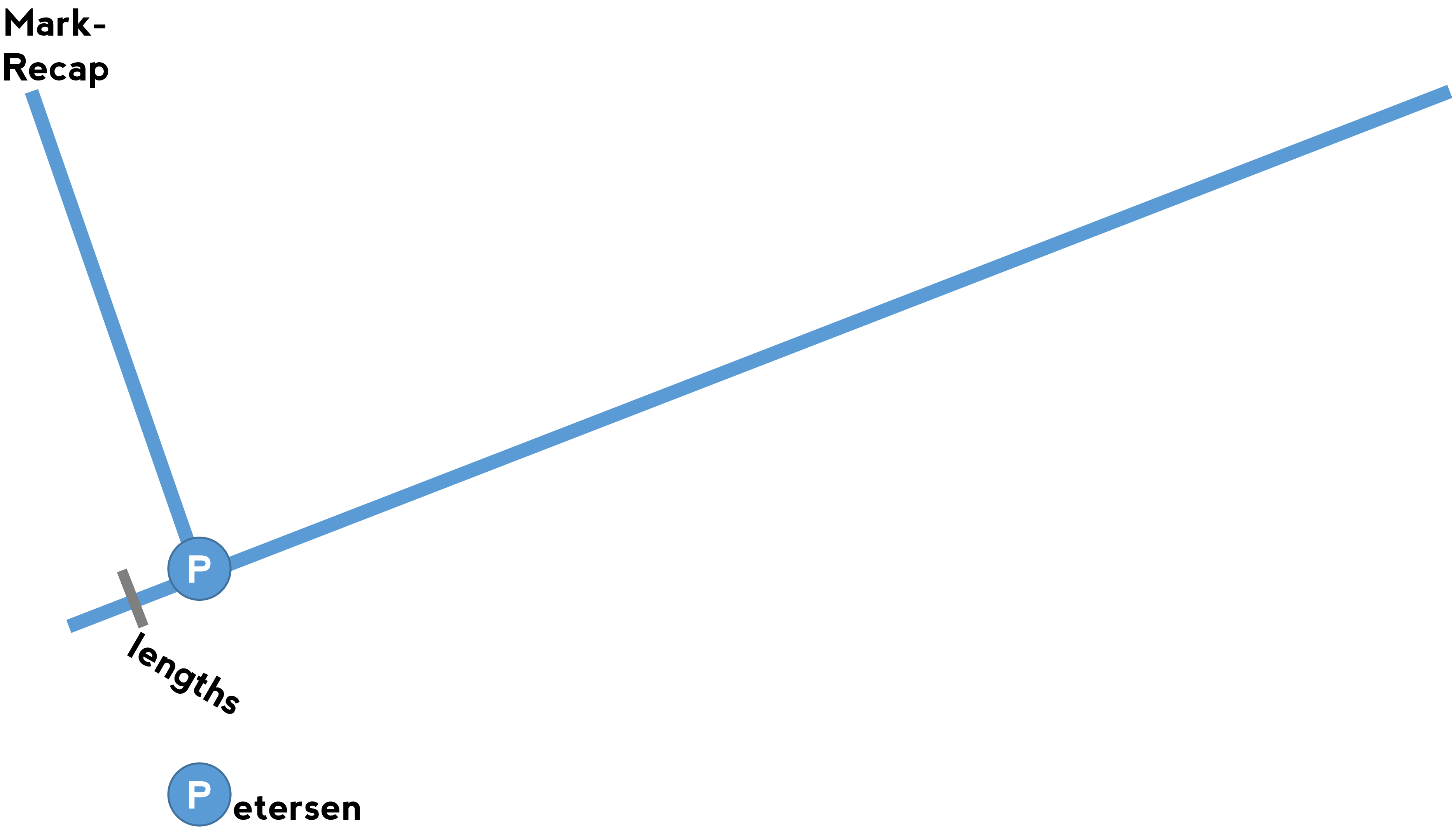
Assessing stocks in a data-limited world: methods and approaches

The ICES data-limited stock assessment workshop

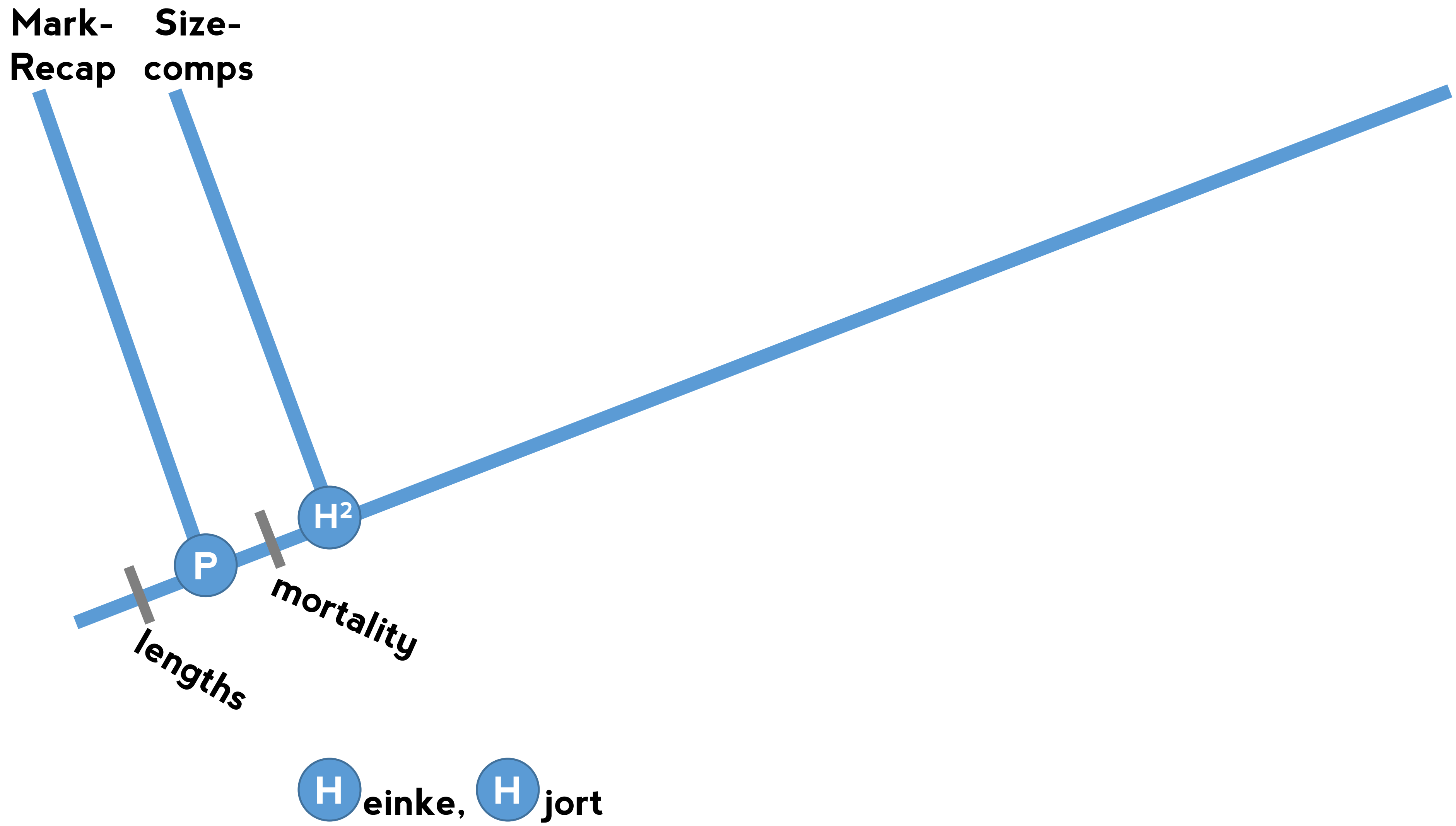
Reykjavik, Iceland

12-16 September, 2016

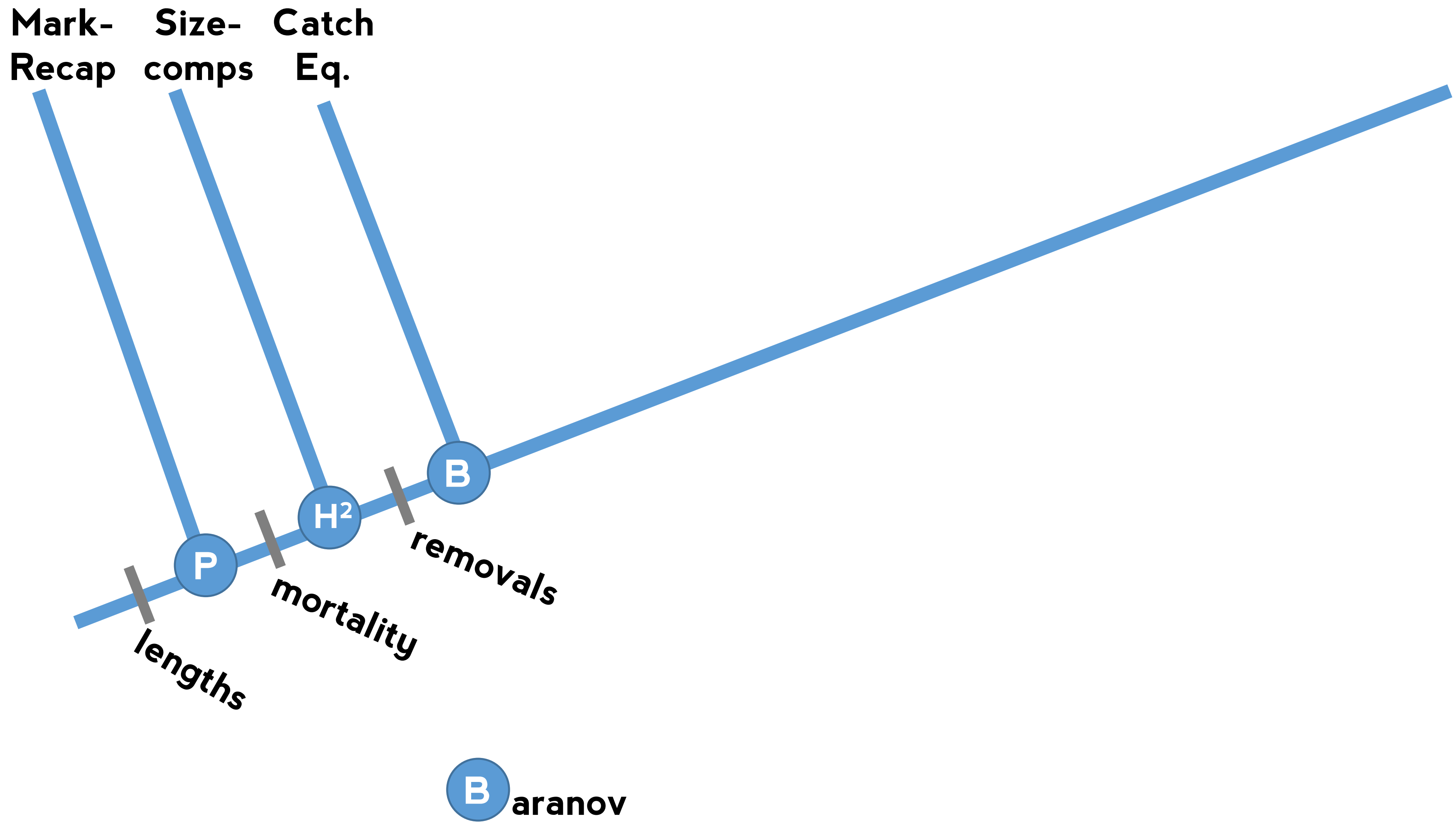
Evolution of fisheries models



Evolution of fisheries models



Evolution of fisheries models



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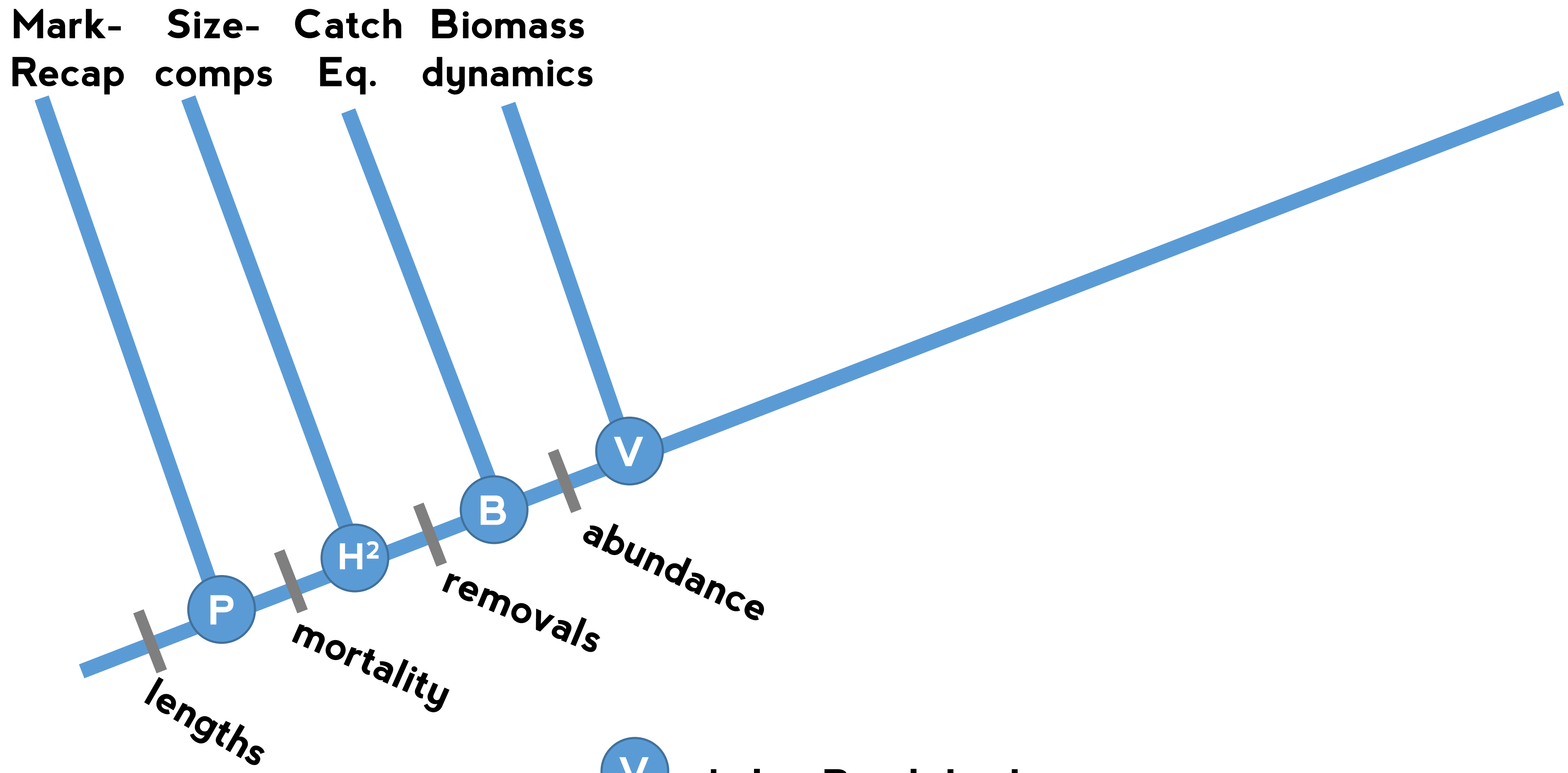
Evolution of fisheries models



V erhulst, Pearl, Lotka,
Volterra, Russell, Buckman,
Hjort, DeLury, Leslie,
Schaefer, Pella, Tomlinson

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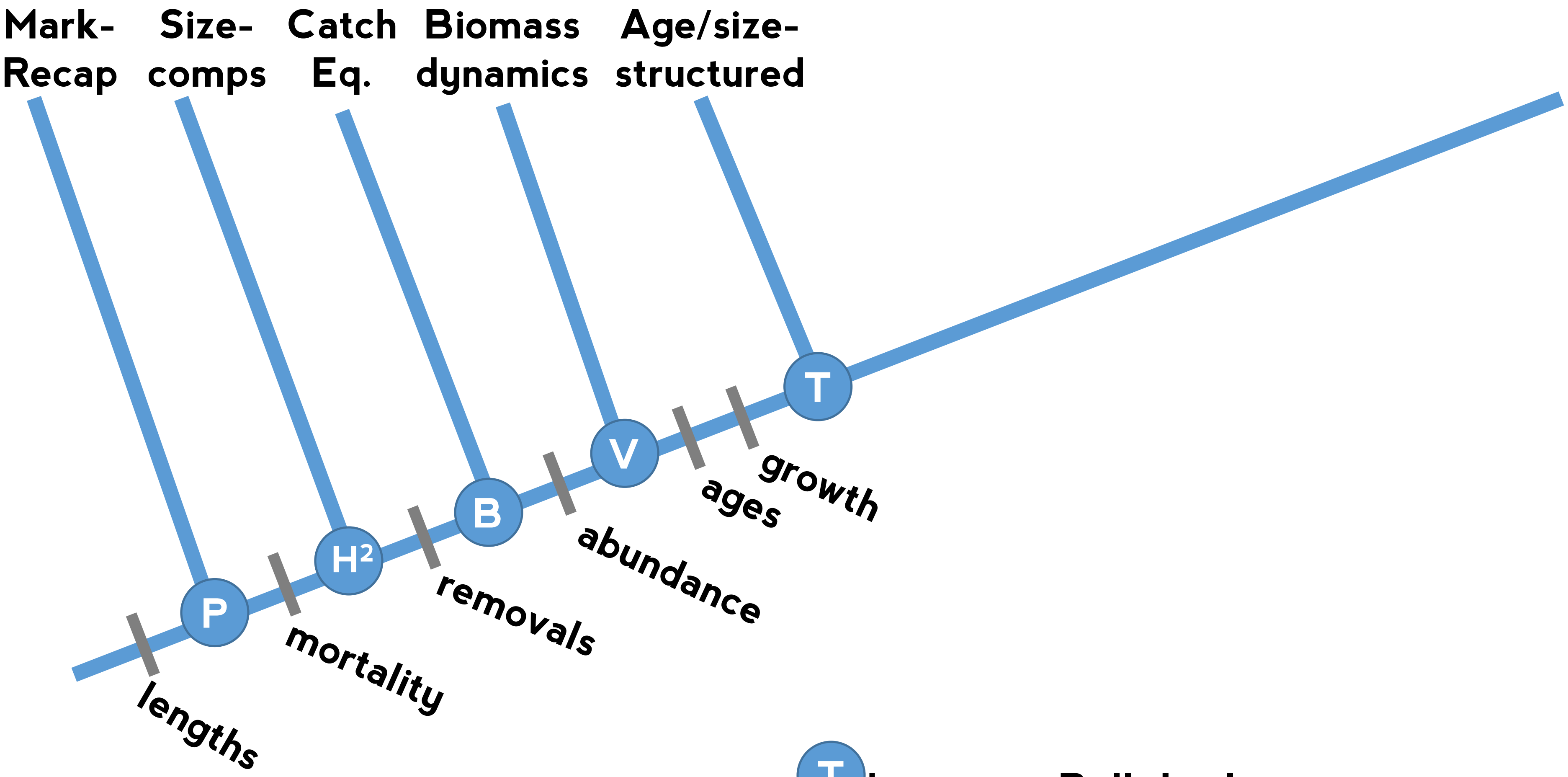
Evolution of fisheries models



T hompson, Bell, Lotka, Hjort, Leslie, Gulland, Pope

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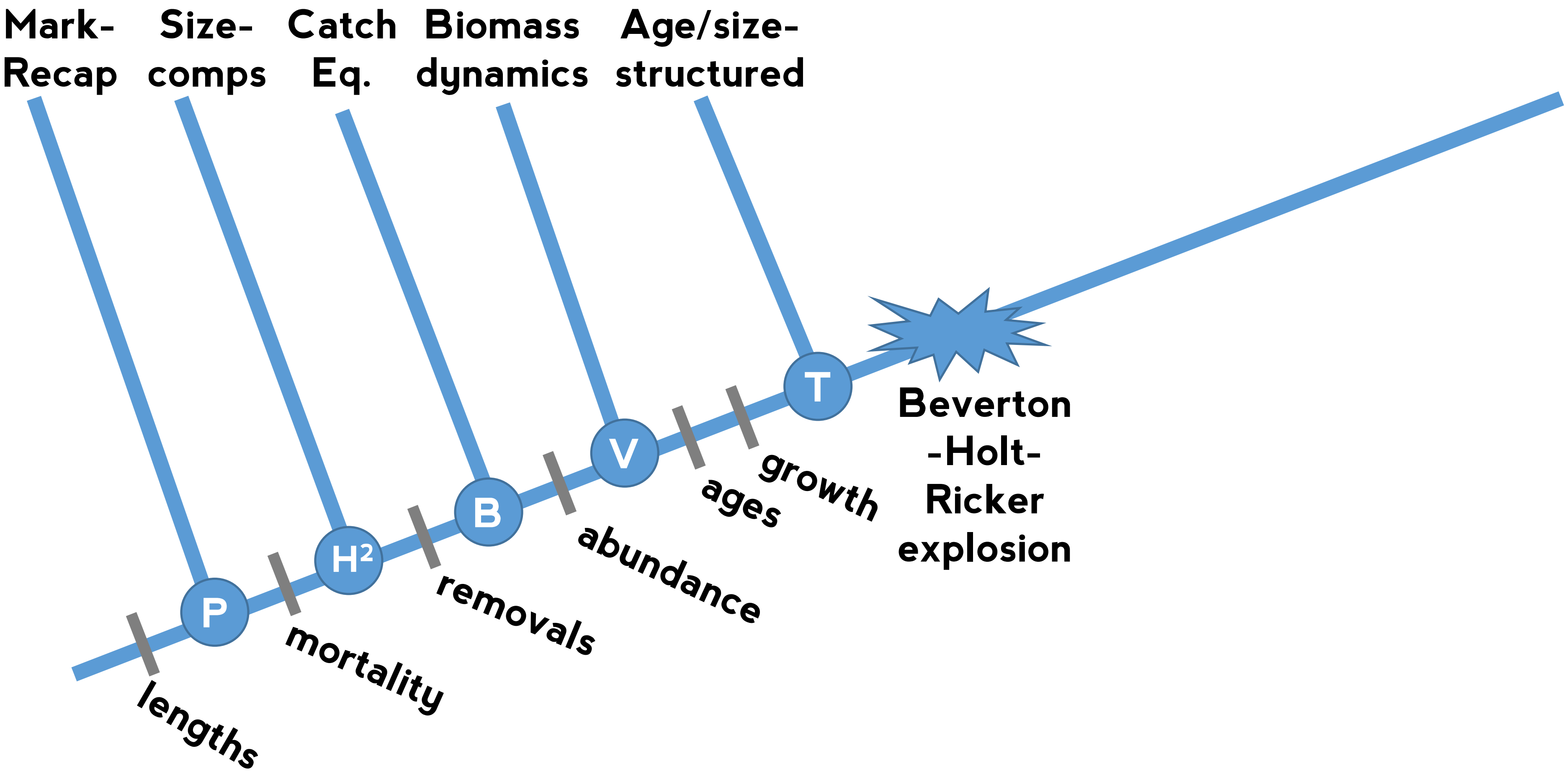
Evolution of fisheries models



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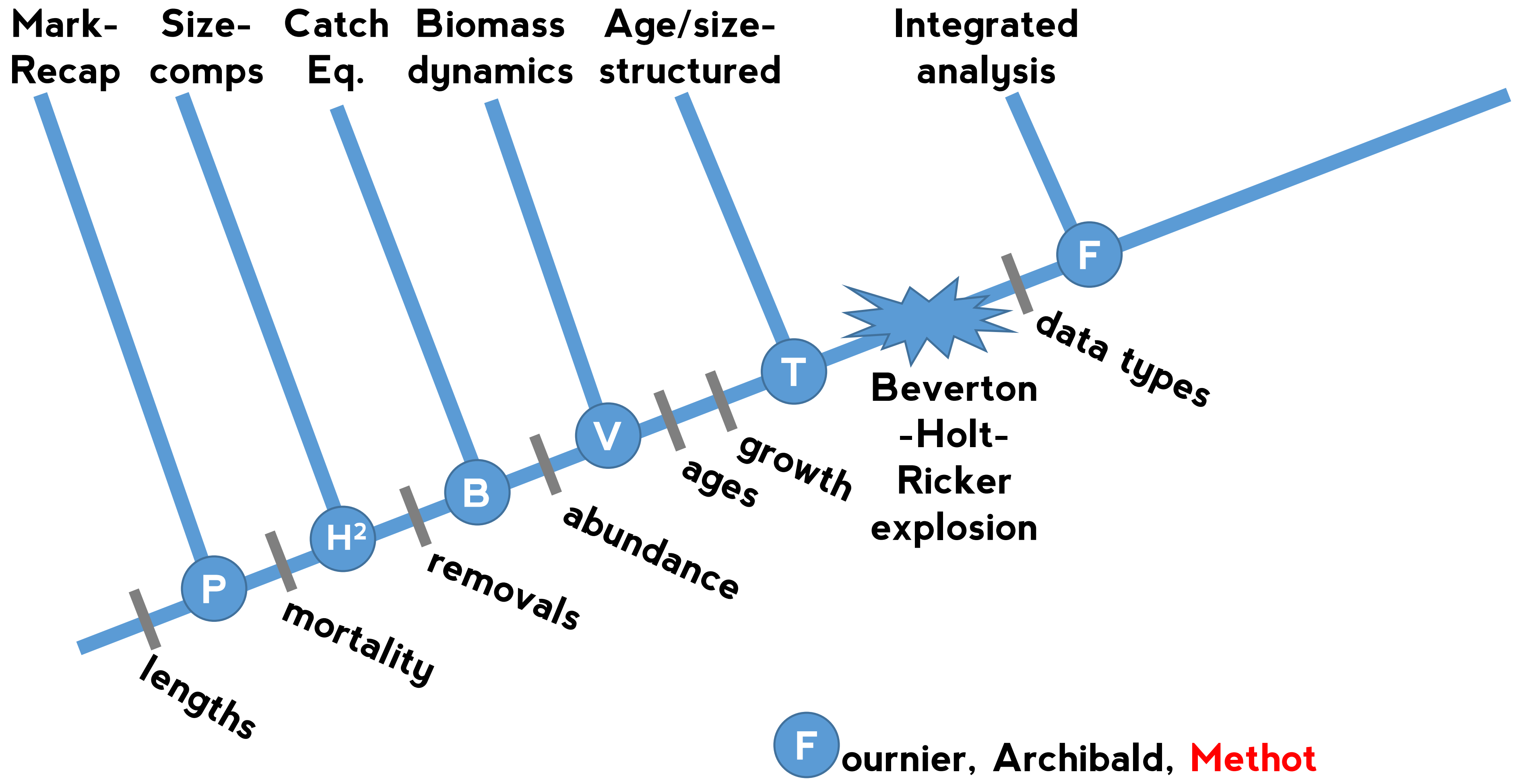
Evolution of fisheries models



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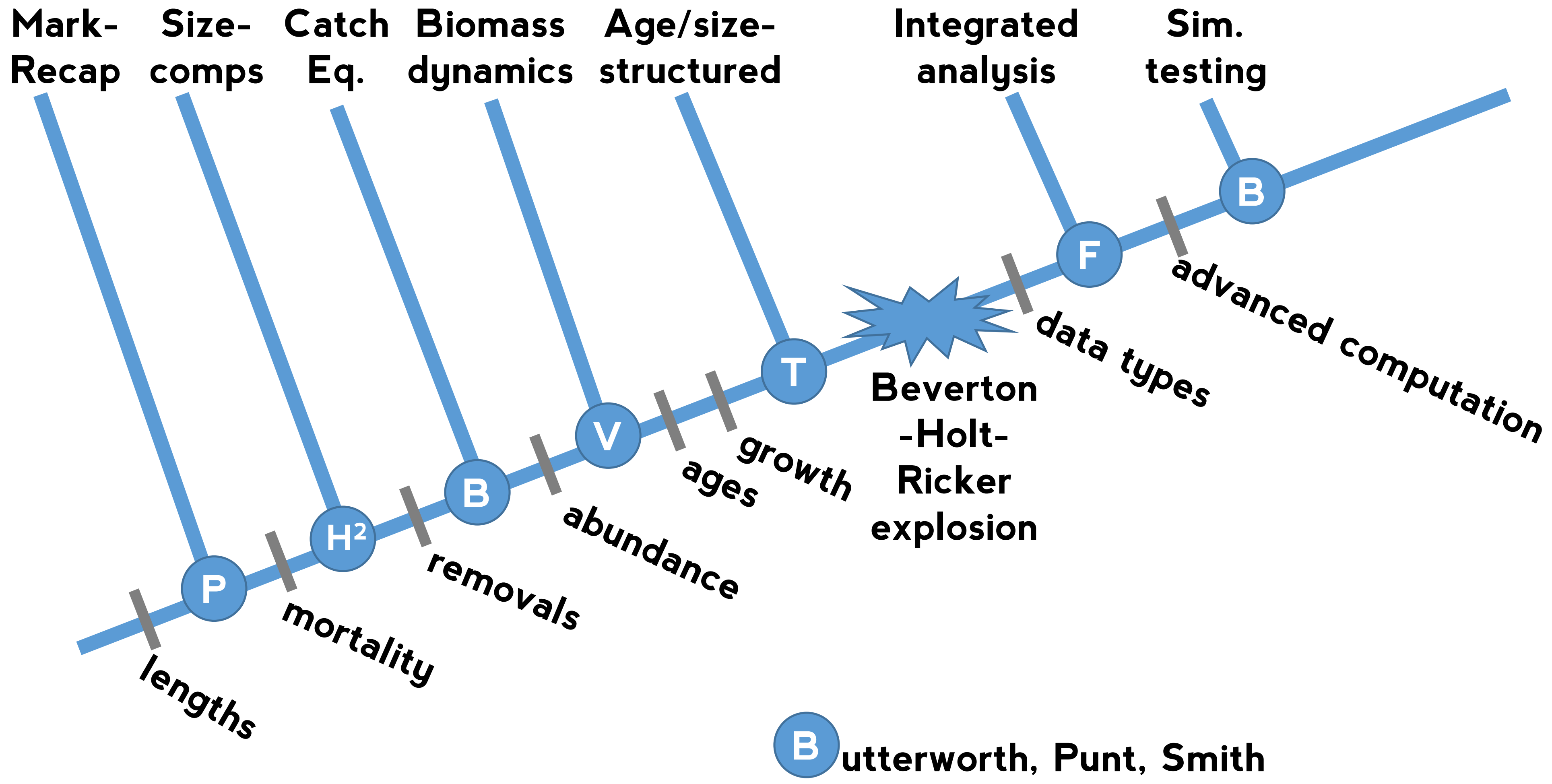

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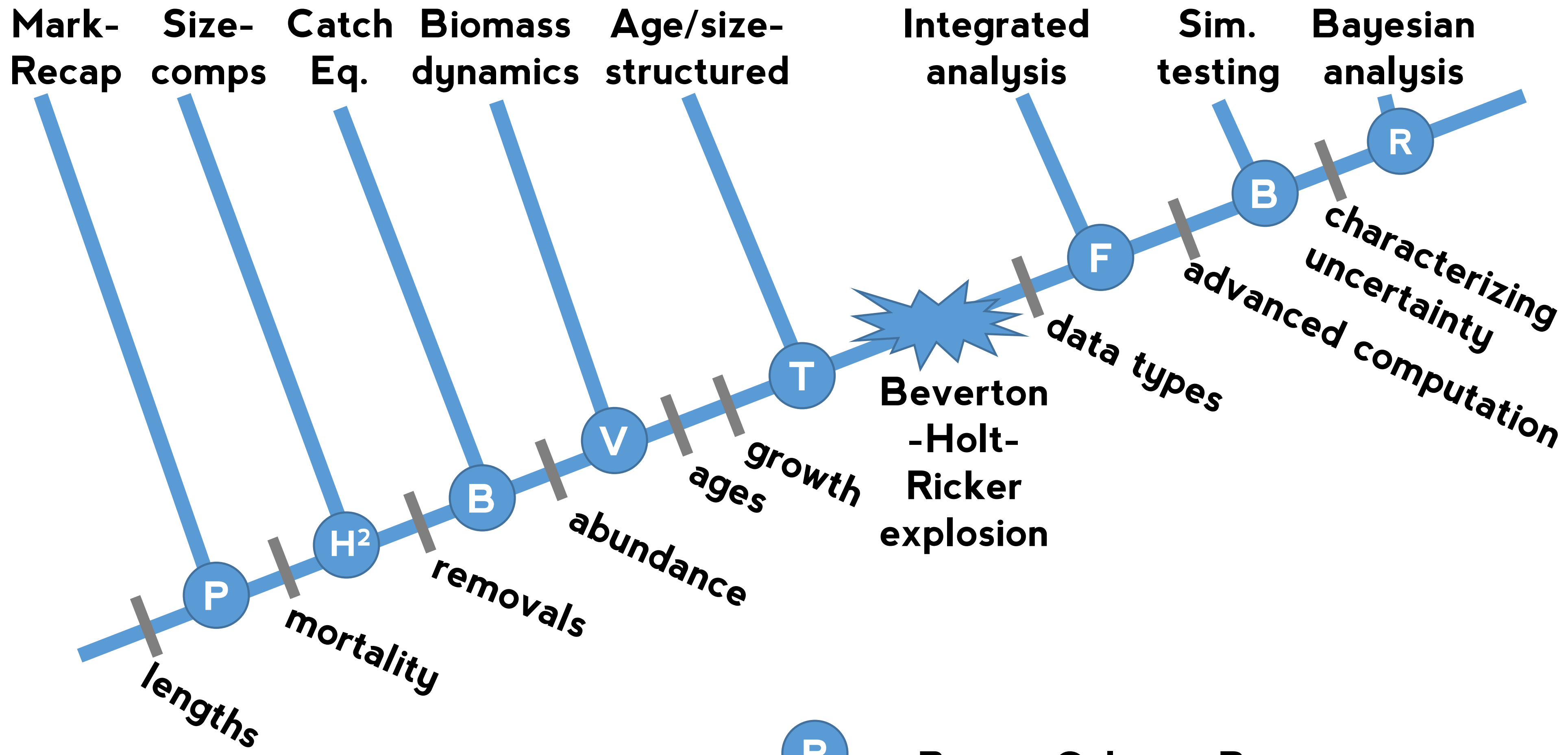
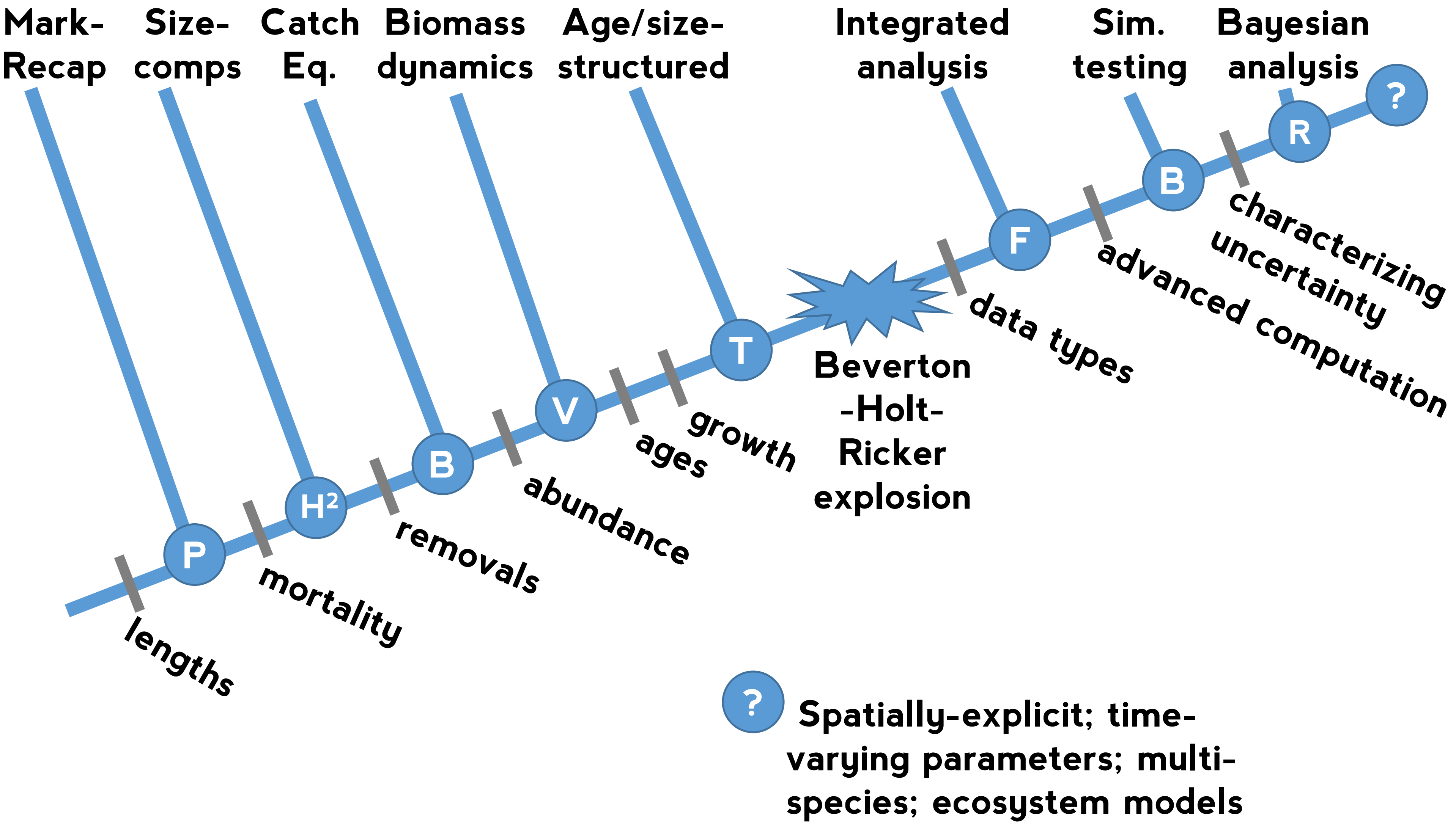
Evolution of fisheries models



Rev. Bayes, Gelman, Punt, Hilborn

Evolution of fisheries models



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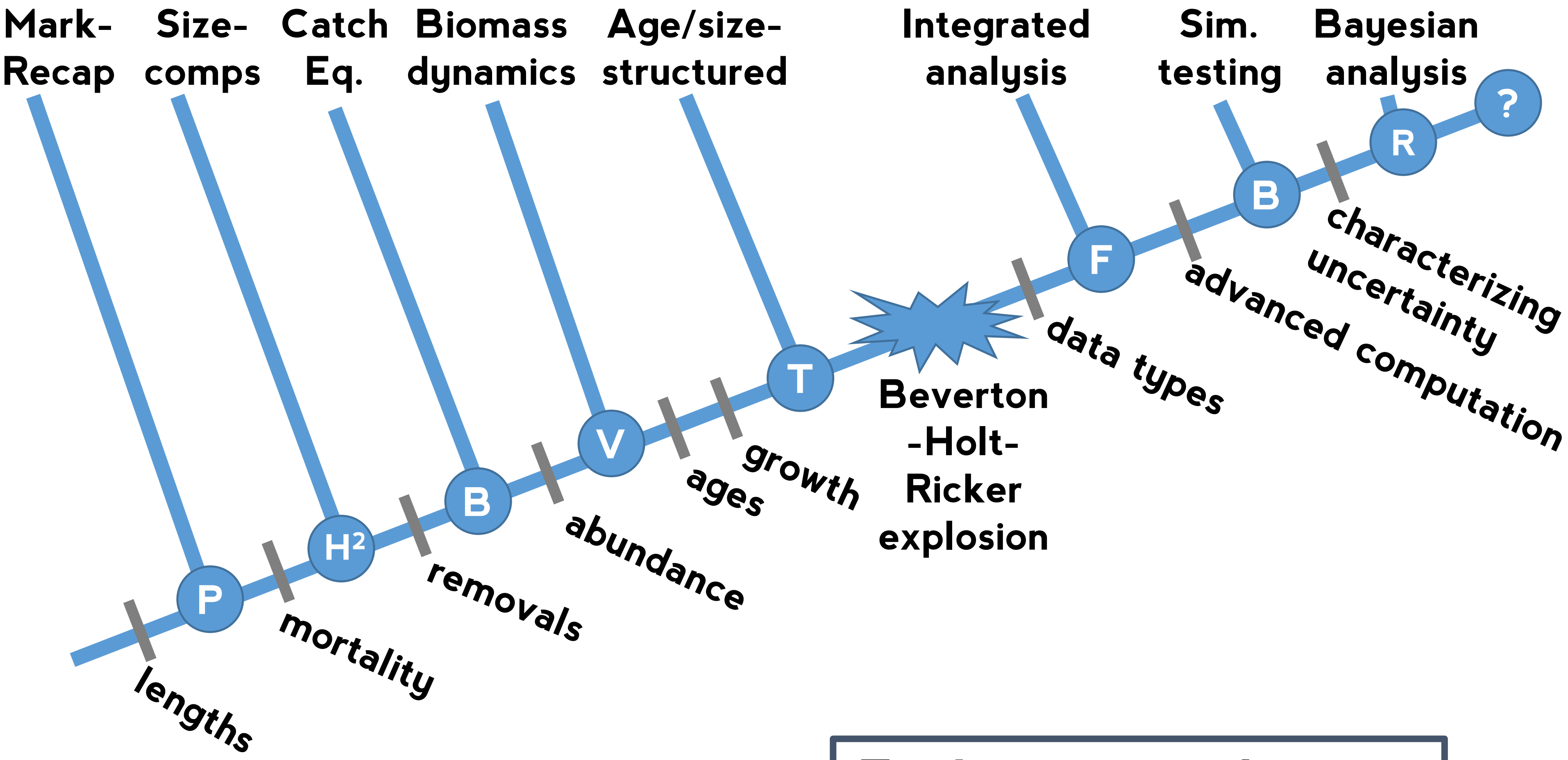
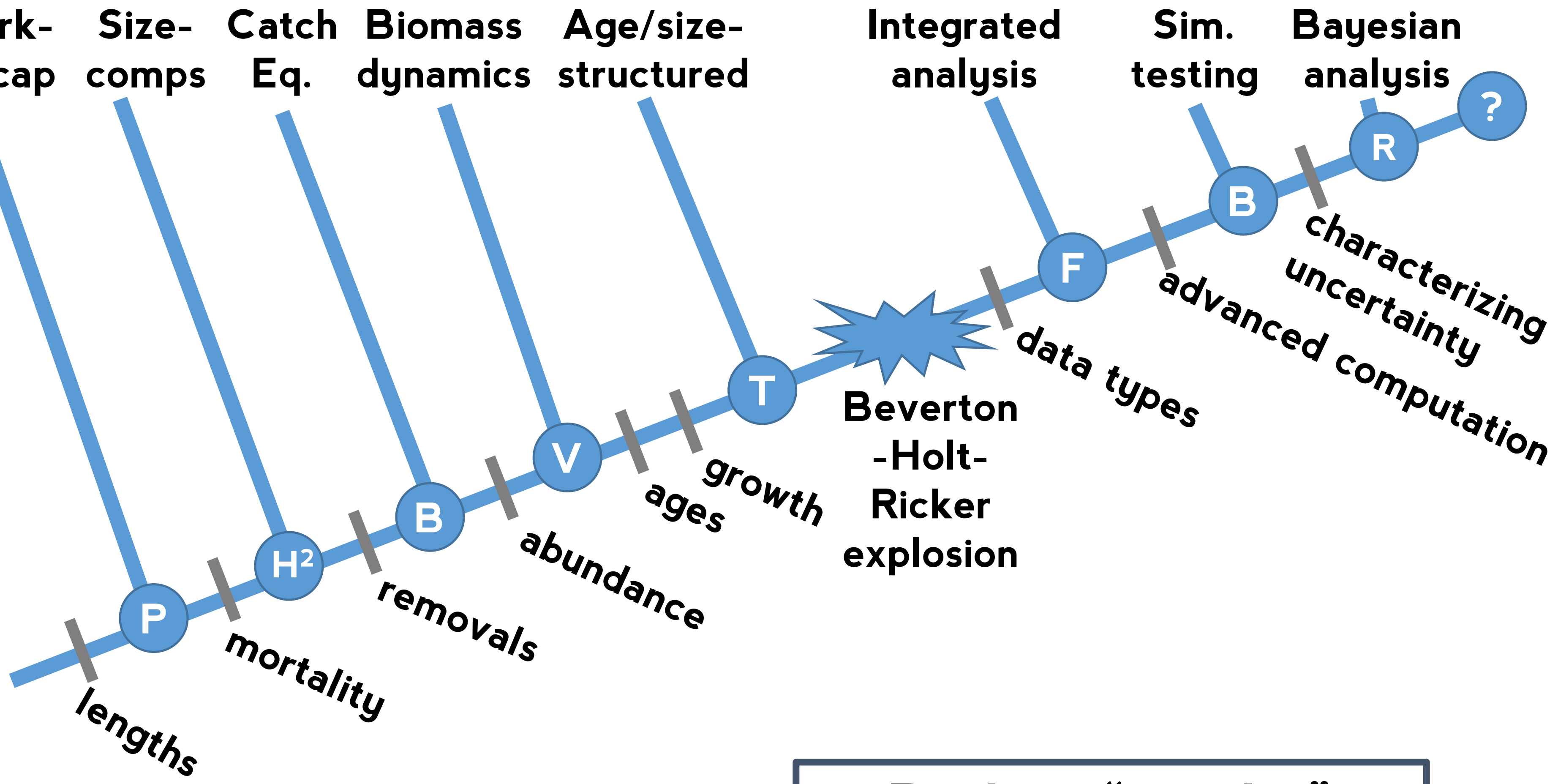
Evolution of fisheries models



Evolving towards more sophisticated, complex, & data-needy models

Evolution of fisheries models



Reality: "simpler" models needed more than ever.

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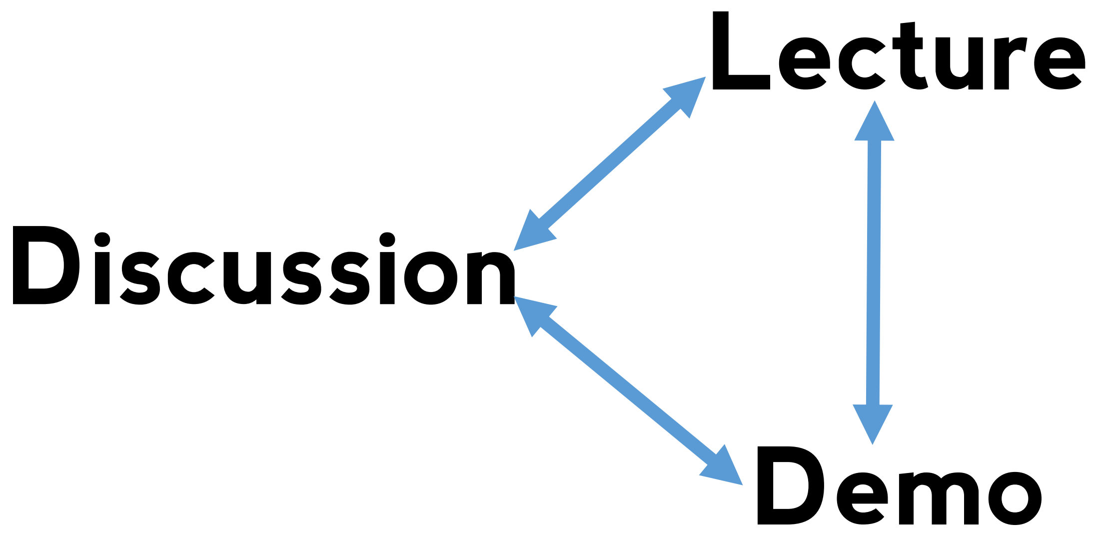
Overview of workshop

- Understanding concepts & fundamentals:
  - Life history relationships
  - Characterizing uncertainty in method output
  - Establishing reference points or benchmarks
- Method use and accessibility
  - A tour of data-limited methods
  - Identifying appropriate methods
  - Applications and demonstrations
- Testing methods
  - Management Strategy Evaluation
  - Best Available Scientific Information
- Data-limited assessment & management frameworks
  - ICES
  - FishPath



Data-limited fundamental: Common terms

What is data-limited? Why not “data-poor?

“Data”-limited methods

Data availability

- Quantity
- Quality
- Coverage
  - Temporal
  - Spatial

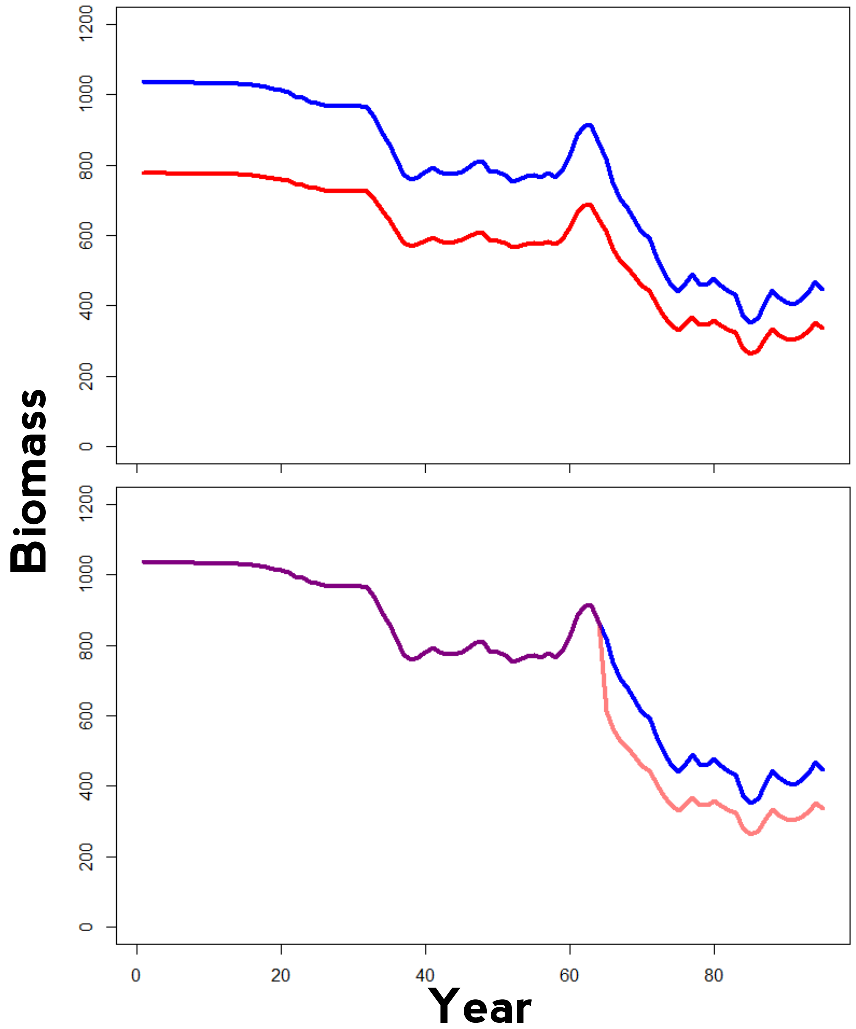
Resources

- Time
- Funding
- Analysts
- # stocks
- Management needs

Uncertainty

“Limitations” to do fancy, complex models
Varies locally

Population dimensions: Scale, Status, & Productivity



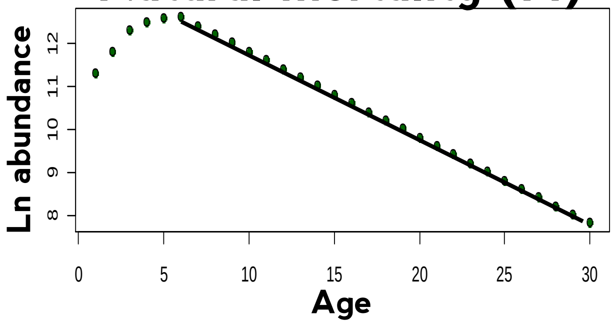
Scale: Absolute level of biomass

Status: Relative level of biomass

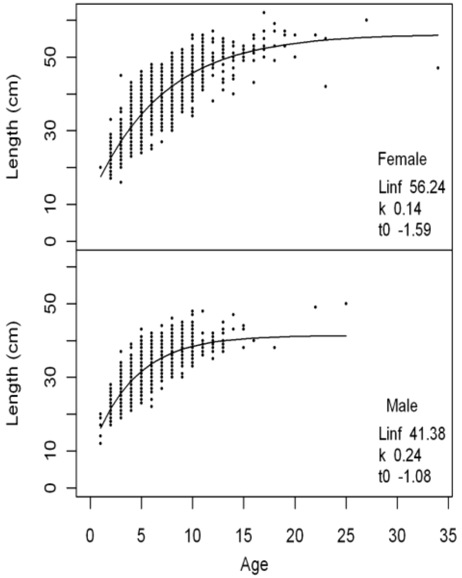
Productivity: Rate of new biomass

Biology and stock assessment: parameters

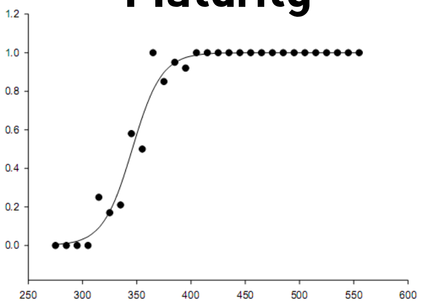
Natural mortality (M)



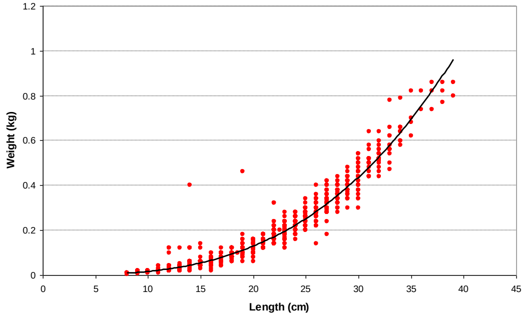
Age & growth



Maturity

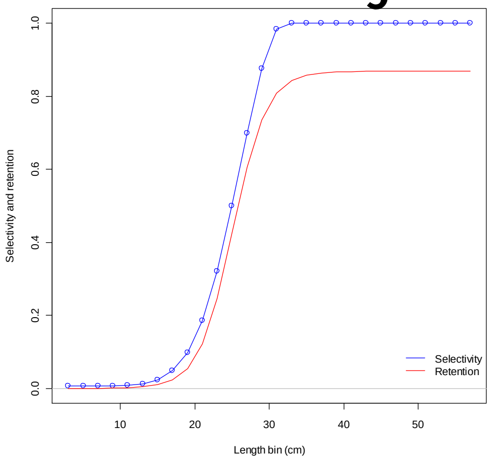


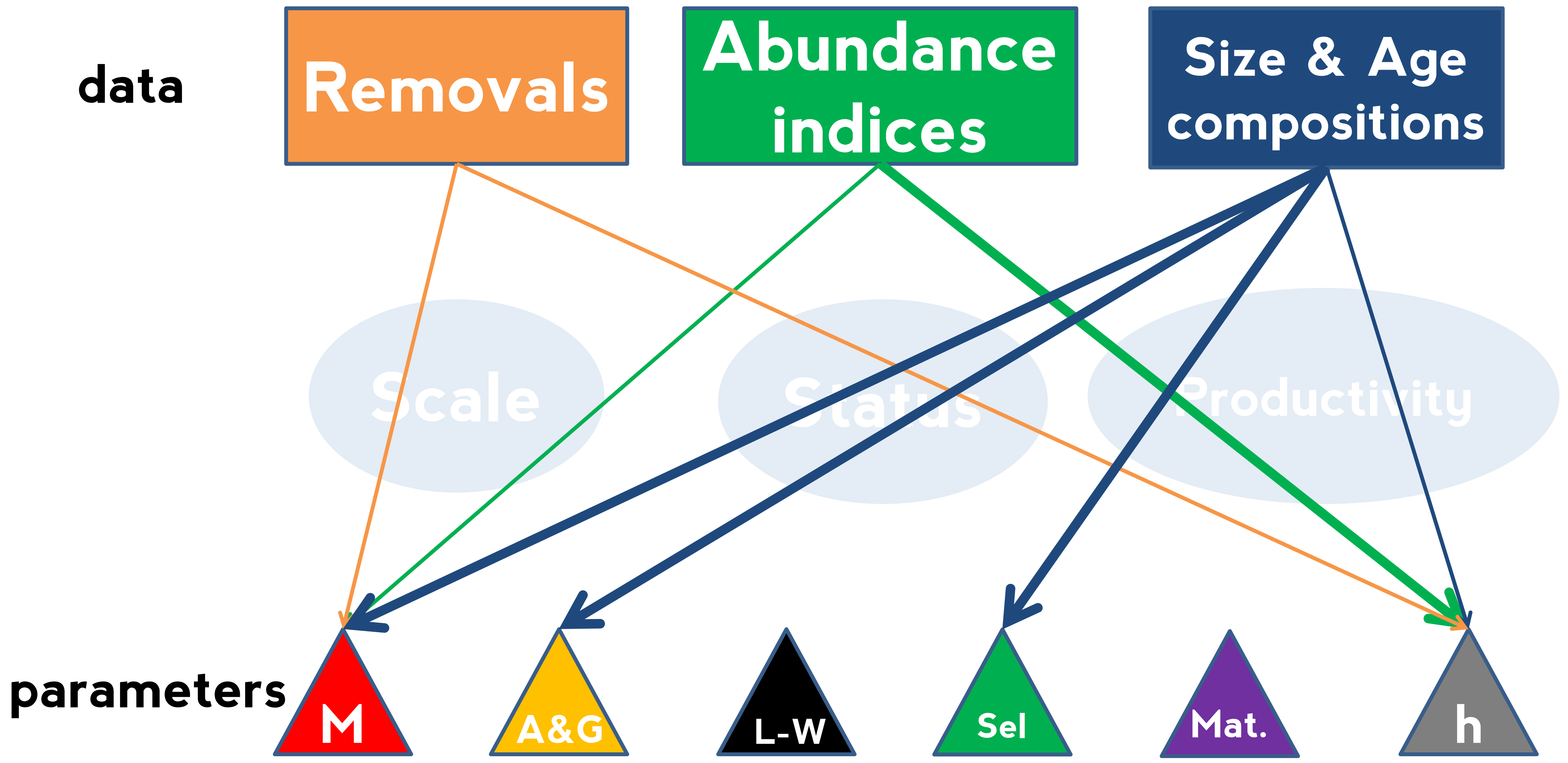
Length-weight



Stock-recruitment

Selectivity

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Removals
Abundance indices
Size & Age compositions
Scale
Status
Productivity
parameters
M
A&G
L-W
Sel
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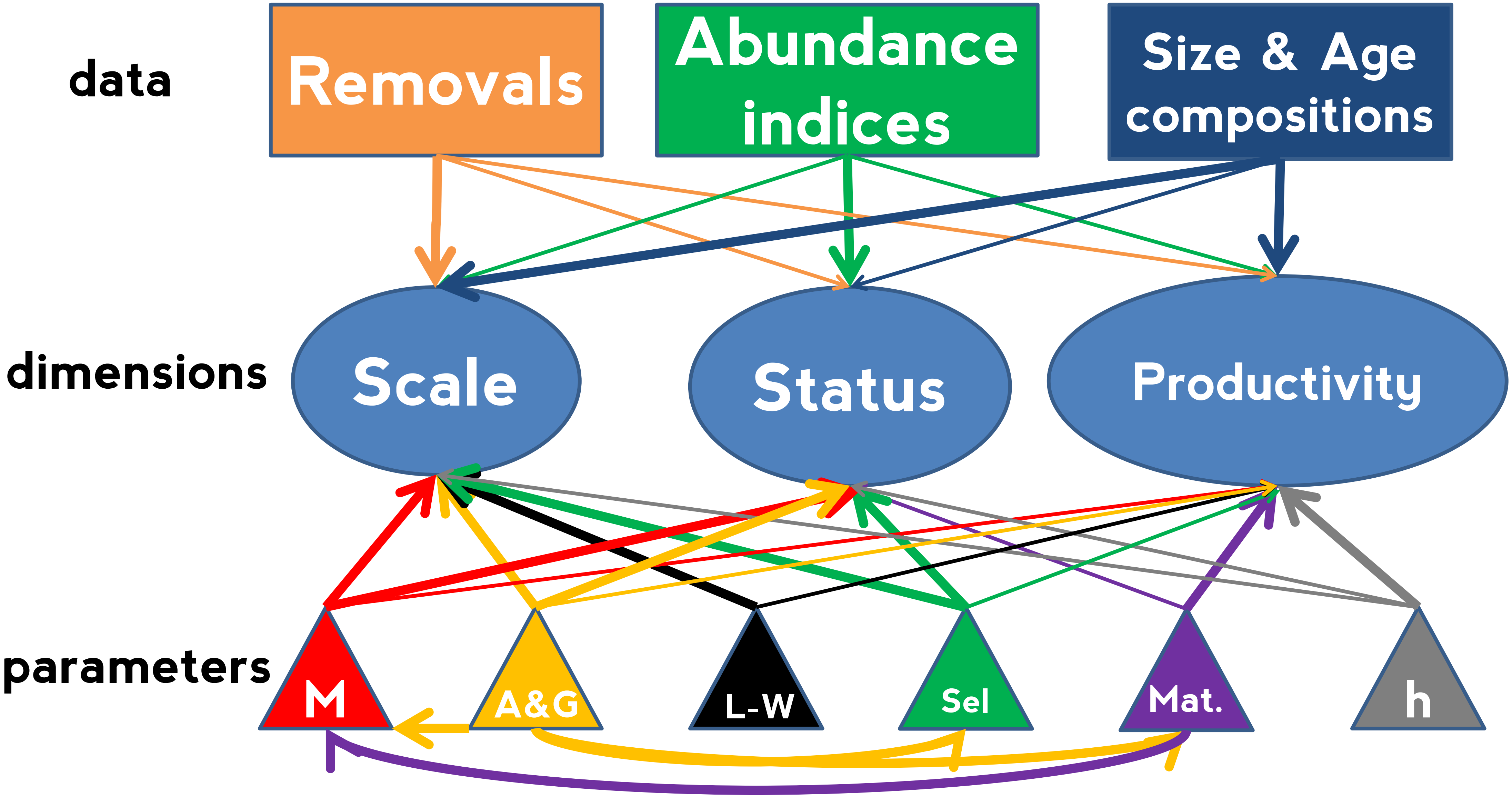
data
Removals
Abundance indices
Size & Age compositions
dimensions
Scale
Status
Productivity
parameters
M
A&G
L-W
Sel
Mat.
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Data-limited fundamentals:
Life history parameters

Relationships among life history parameters

"Endpoints"

L_∞/T_{max}

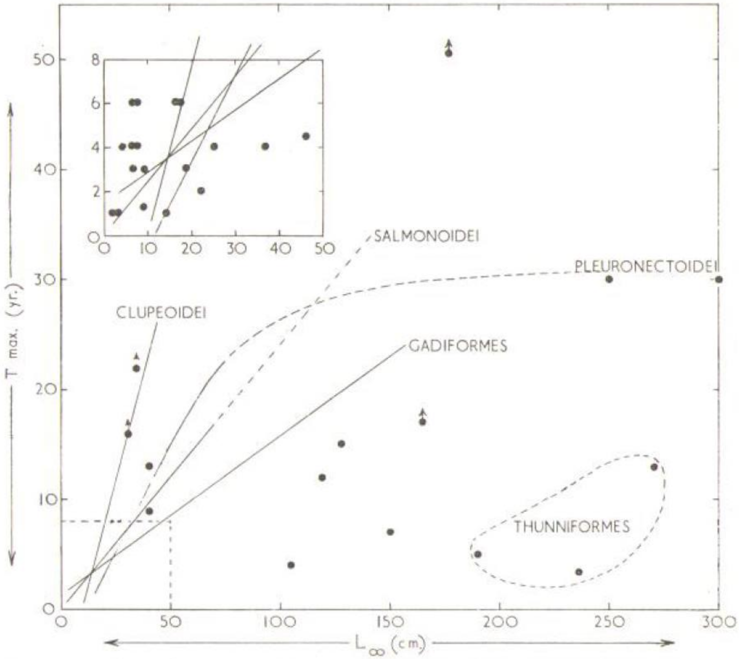


FIG. 5. Relation between maximum age (T_{max}) and asymptotic length (L_∞) in various species not included in Fig. 4 (from Table I). The lines are those for the four groups shown in Fig. 4.

"Course of events"

M/K

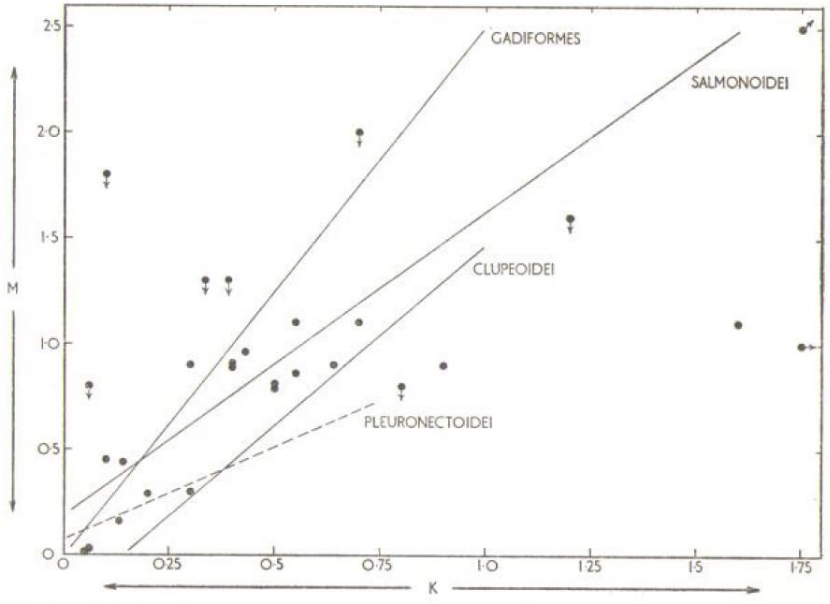


FIG. 7. Relation between natural mortality coefficient (M) and rate of curvature of growth curve (K) in various species not included in Fig. 6 (from Table I). The lines are those for the four groups shown in Fig. 6.

"Reproductive drain?"

$[L_{mat}/L_\infty]/T_{max}$

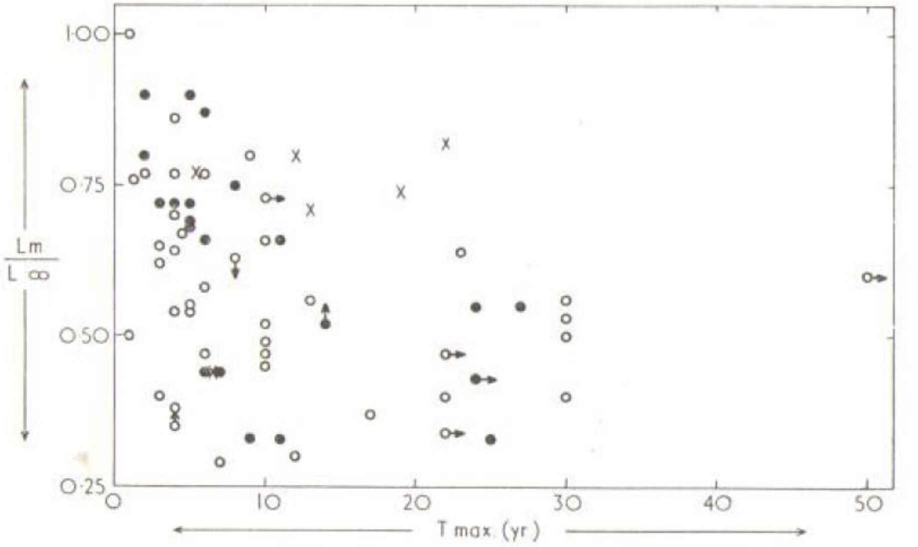
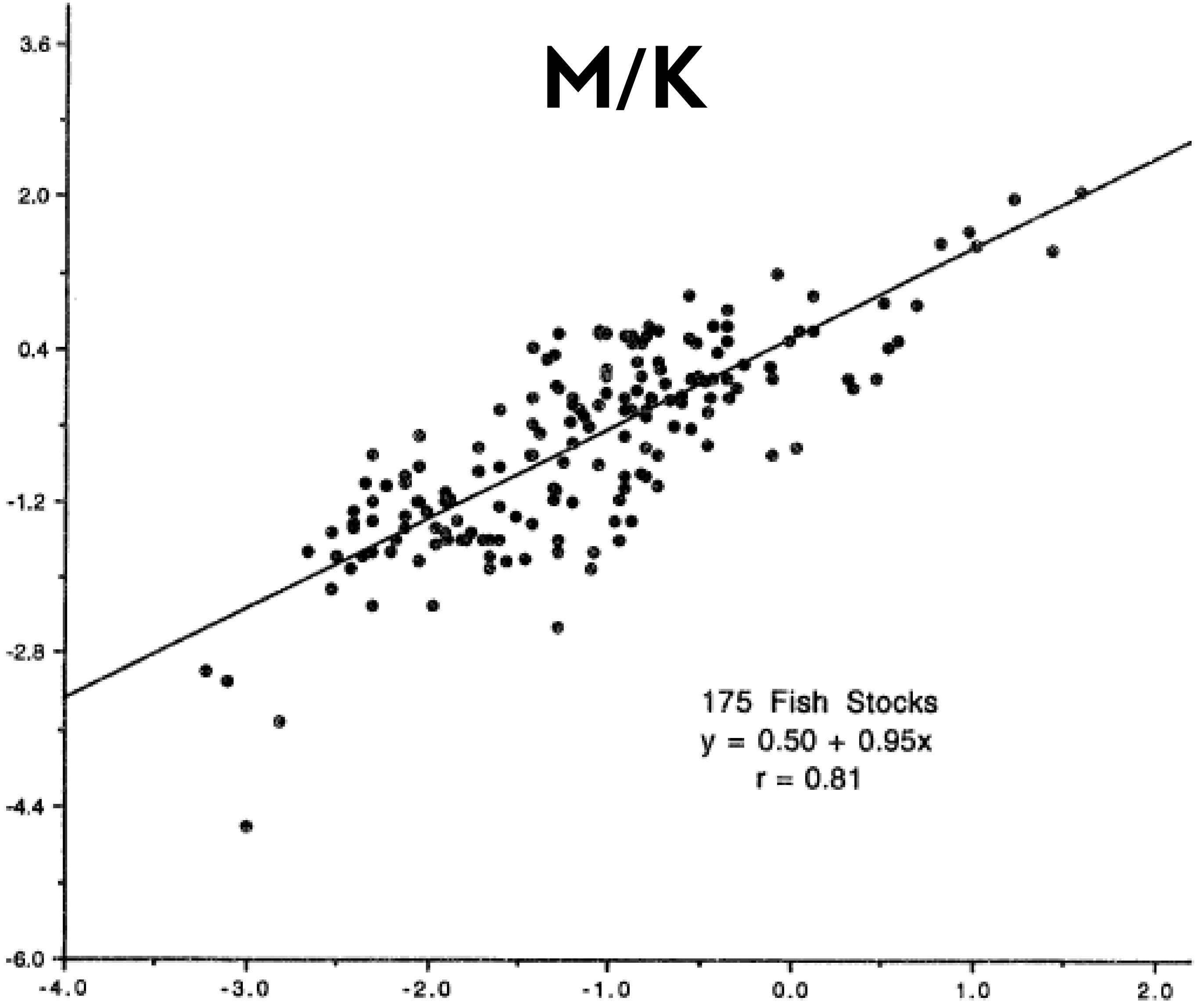


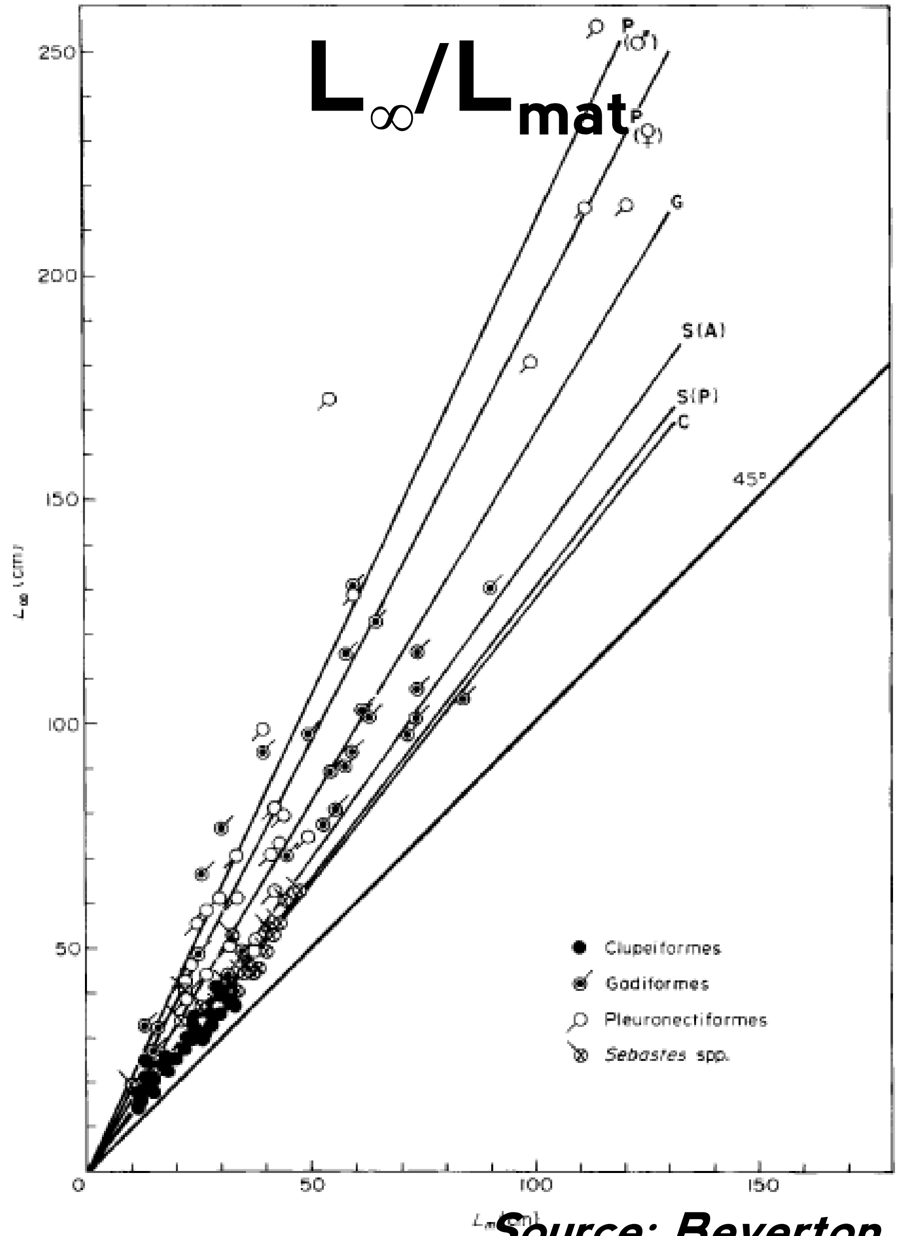
FIG. 8. Size at maturity (L_m) and longevity. Plot of ratio L_m/L_∞ against T_{max}. ● = Salmonoidei, x = Clupeoidei; other species shown as ○.

Source: Beverton and Holt 1959

Life history invariants and assembly rules

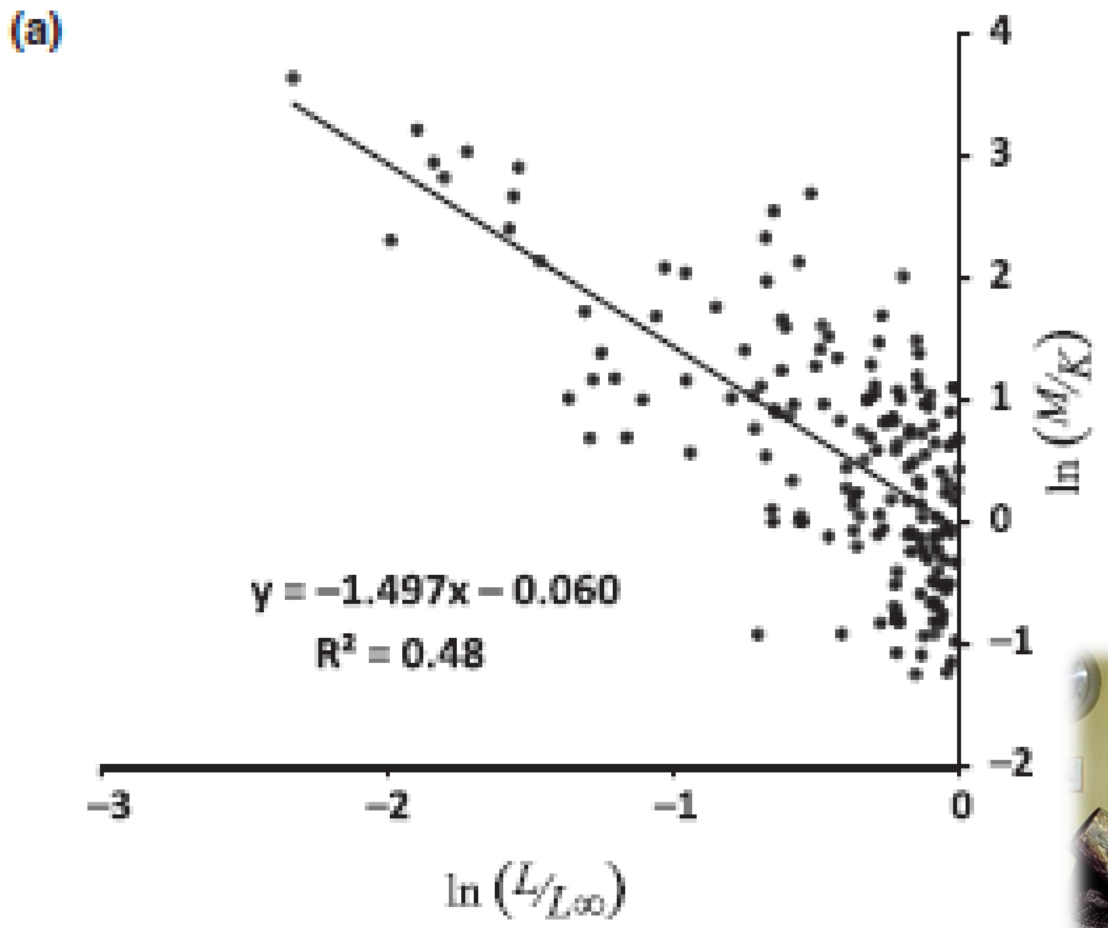


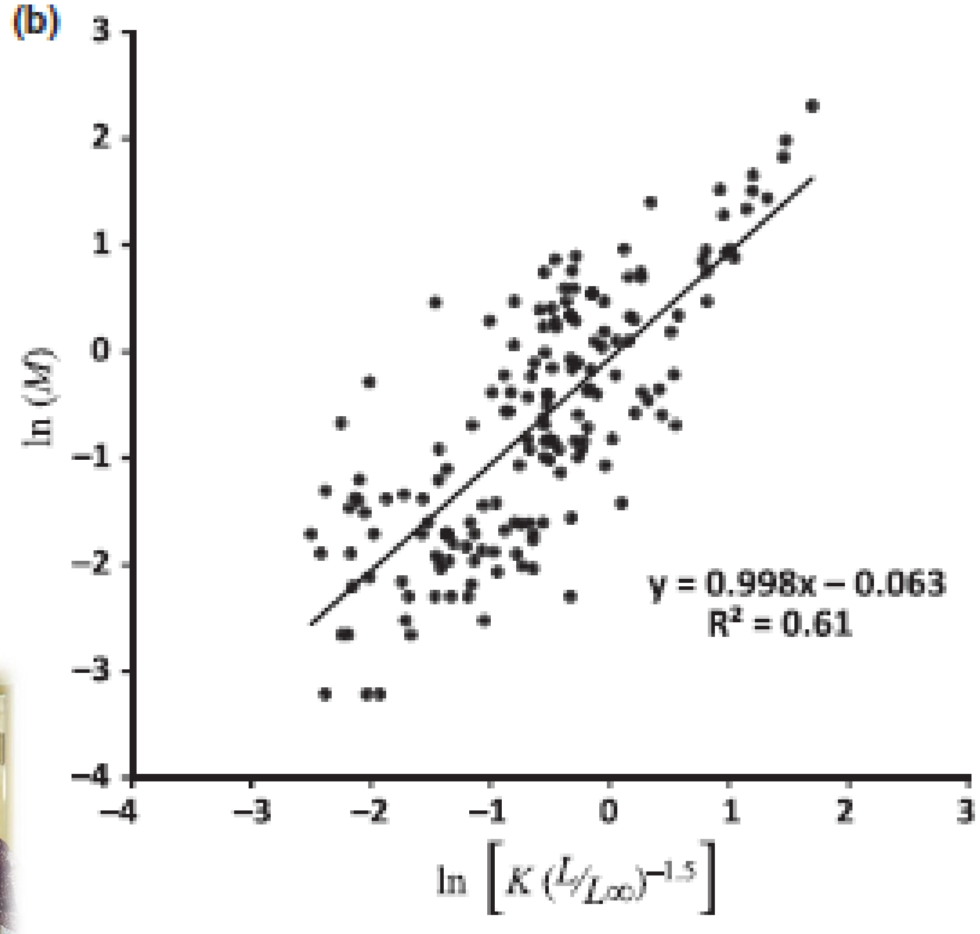
Source: Charnov et al. 1993



Source: Beverton 1992

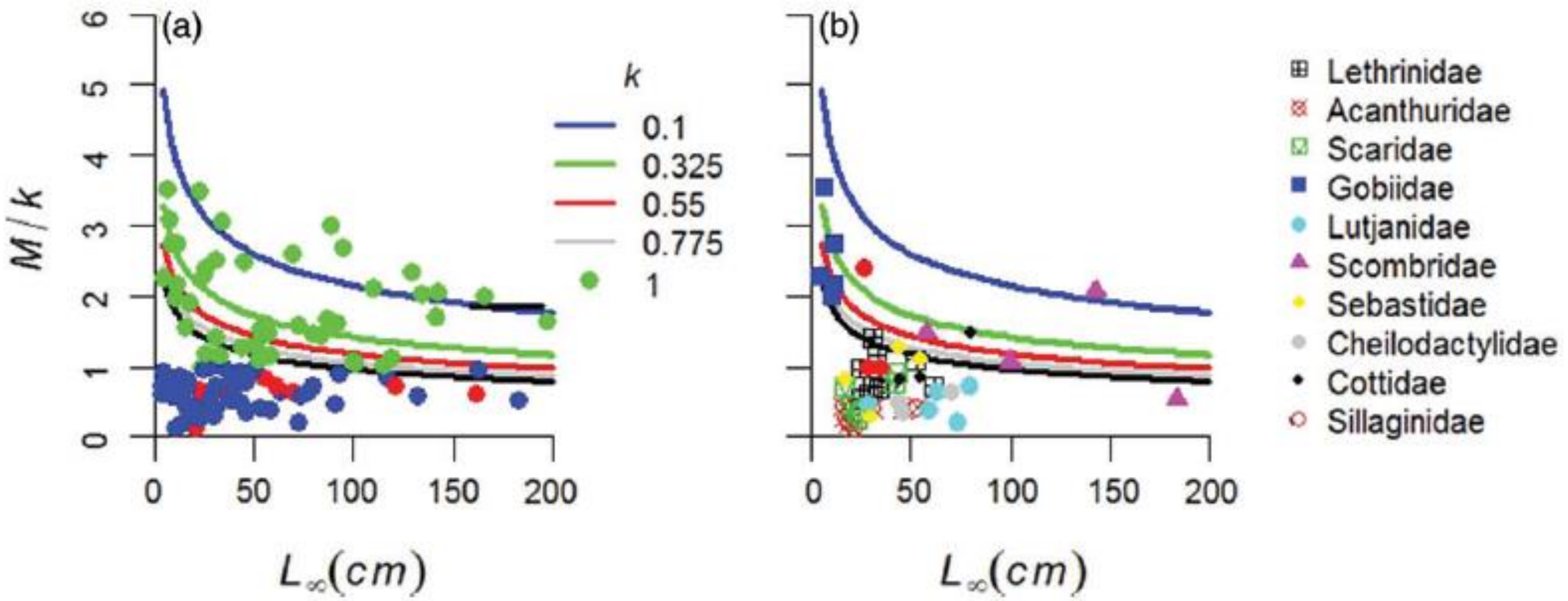
Life history invariants and assembly rules





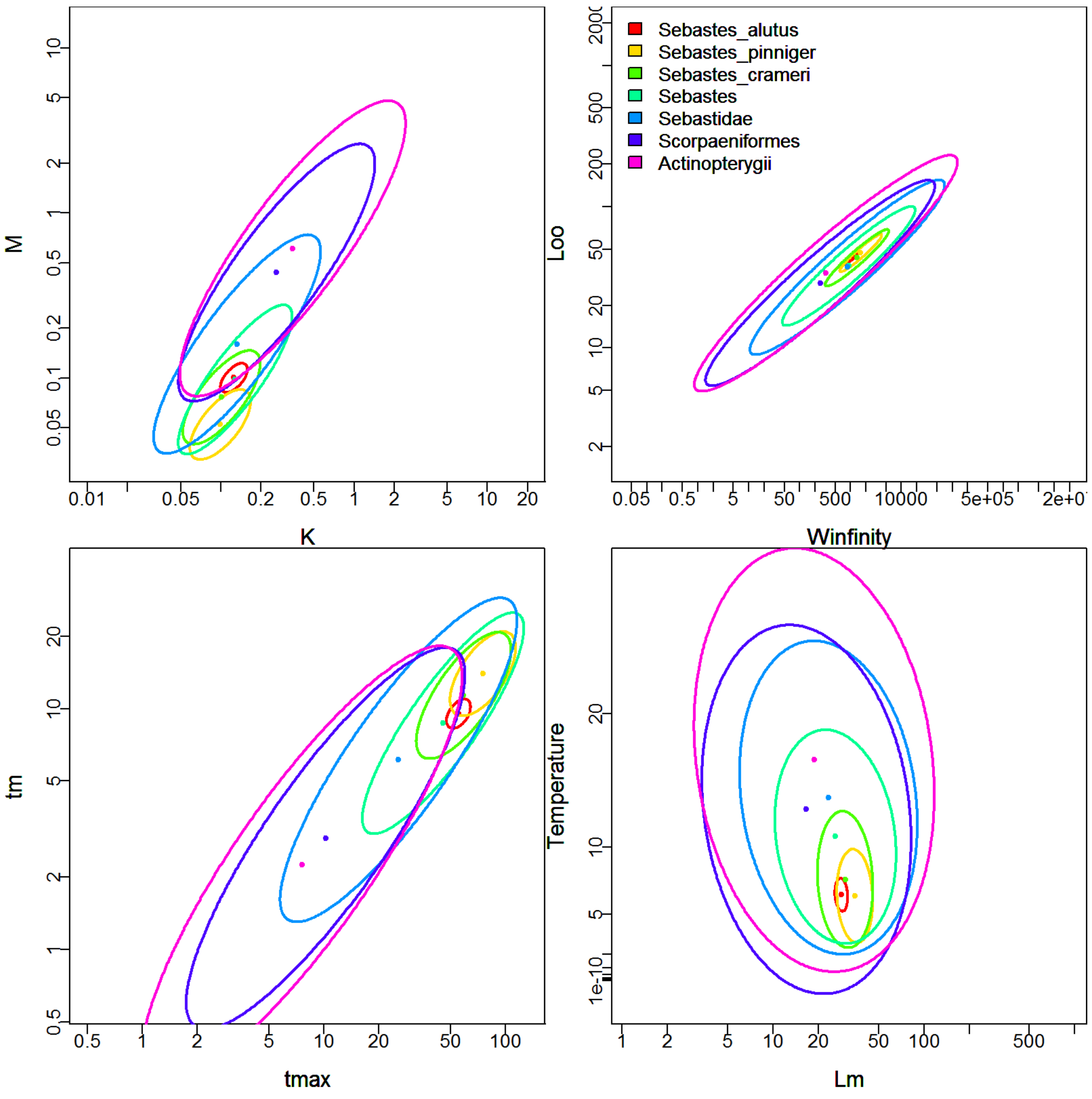
Source: Charnov et al. 2013

Life history invariants and assembly rules



Source: Prince et al. 2014

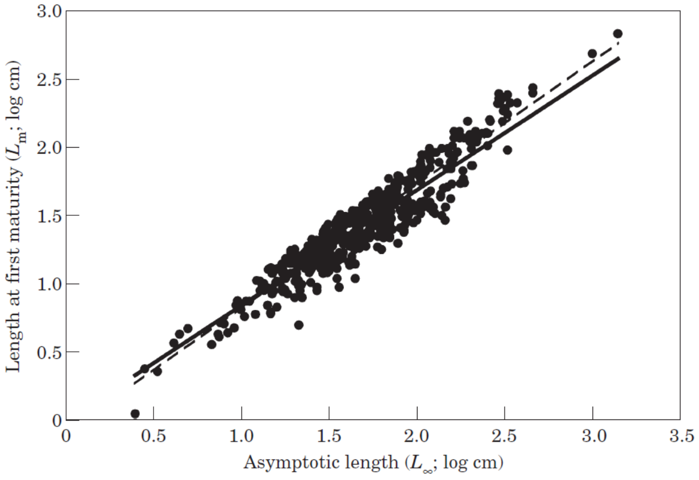
Building life history rules

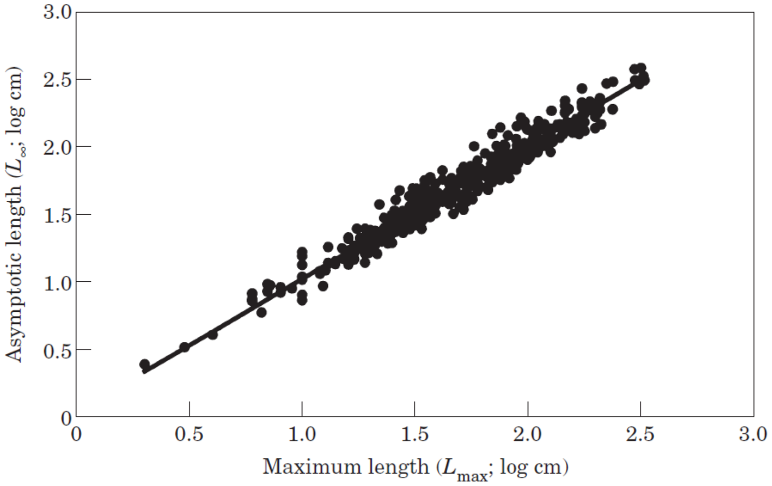


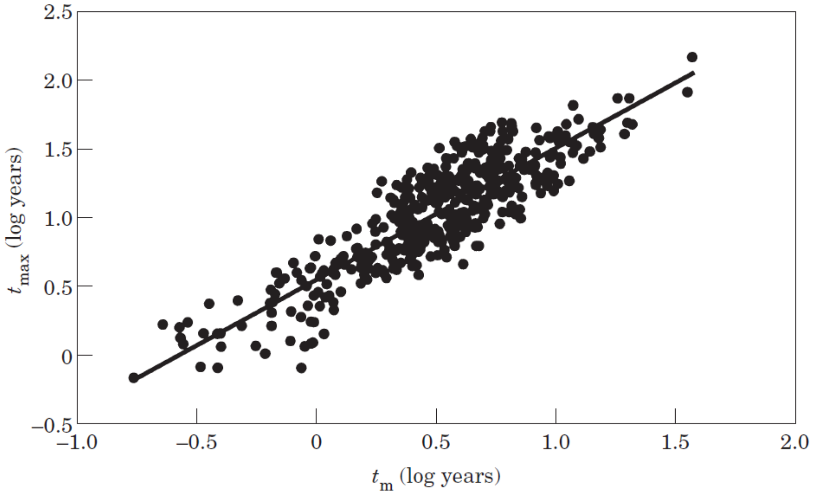
- Chicken and egg; “errors-in-variables”
- Taxonomic considerations important

Source: Thorson, Cope and Munch in prep.

Empirical life history relationships

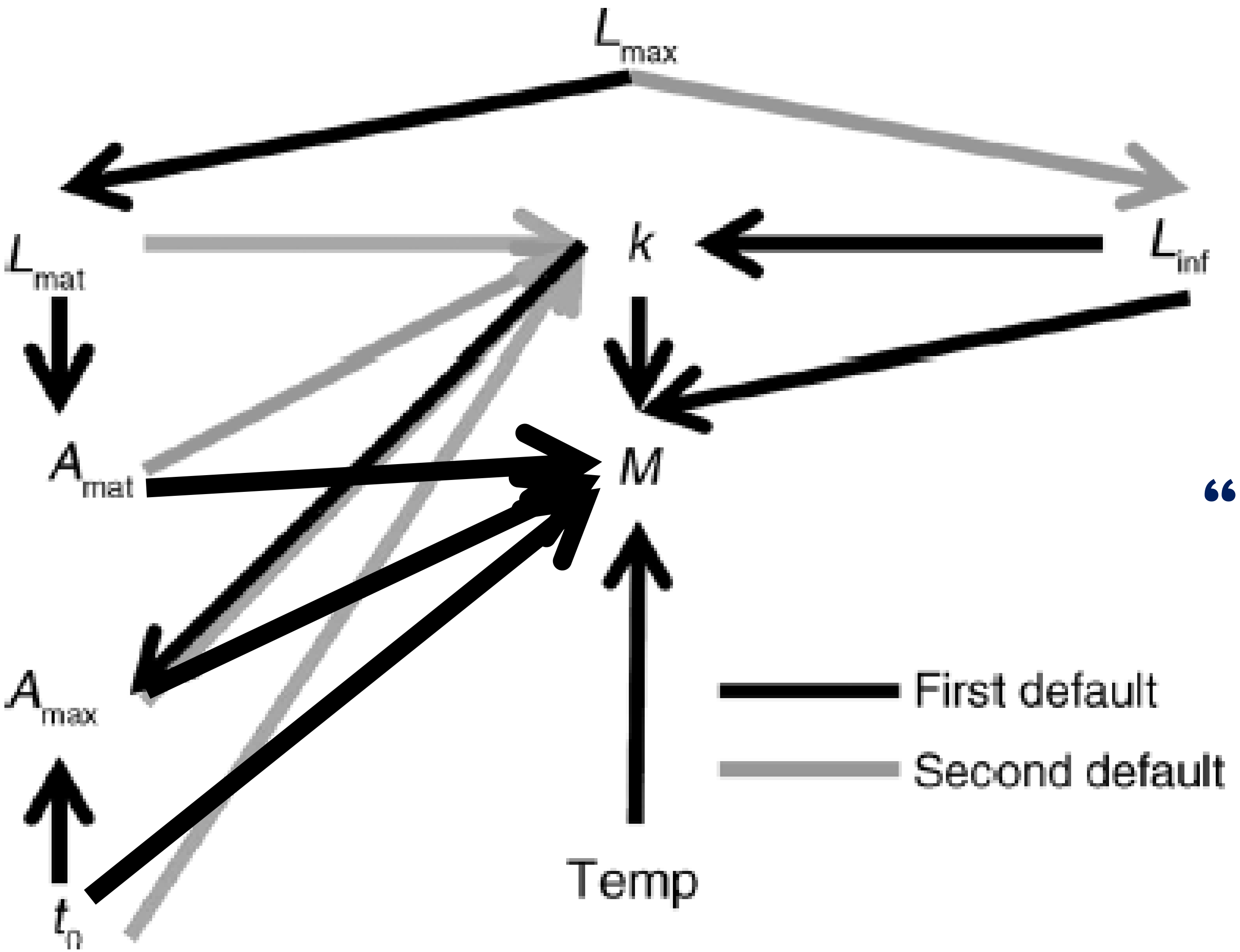






Source: Froese & Binohlan 2000

Empirical life history relationships:



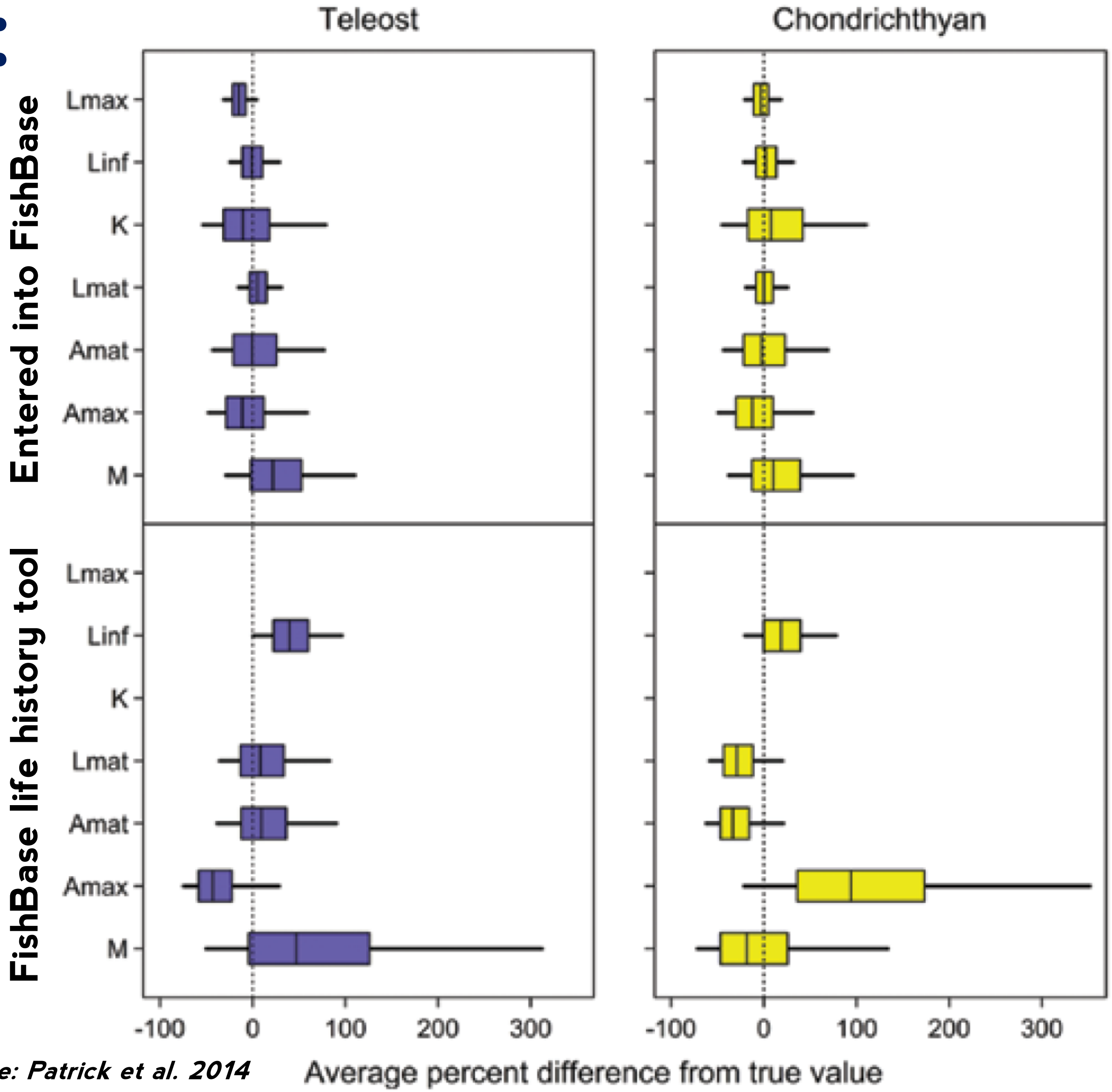
avoid the "daisy-chain"

Source: Thorson et al. 2013

Life history values: Where do they come from?

FishBase is a common source, but beware type of data

Other sources:
- Literature (how old?)
- Stock assessments
- Similar species



Source: Patrick et al. 2014

Summary: Life history relationships

- The building blocks of many assessment methods
- Invariant relationships may reduce dimensionality
  - Taxonomically
  - Parameterization
- Empirical relationships aid parameterization
- Uncertainty in values
  - Central tendency and variance
  - Time-varying/directional