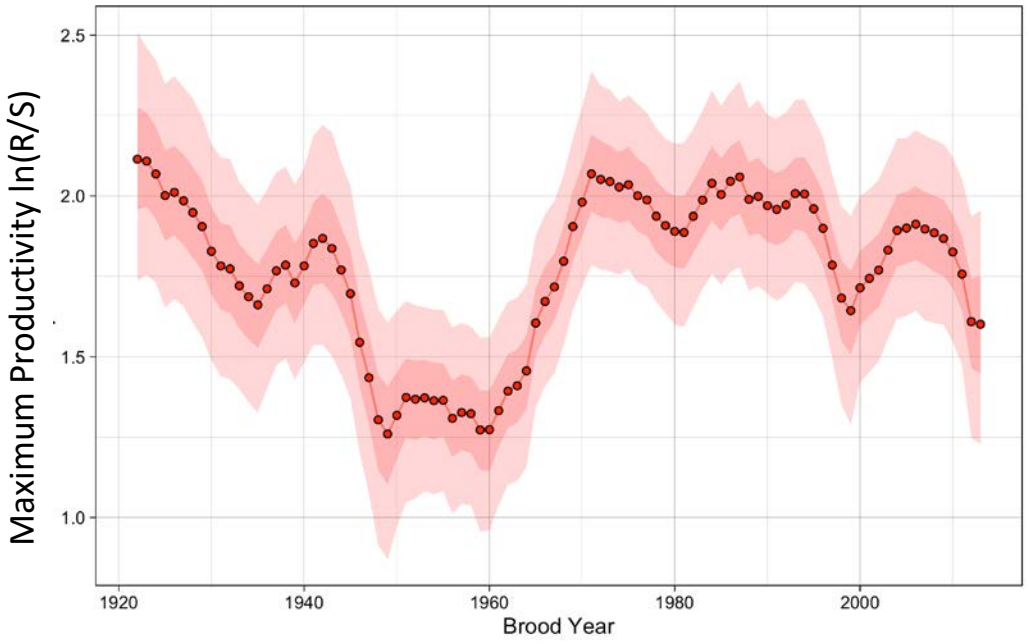
Nonstationarity and dynamic reference points

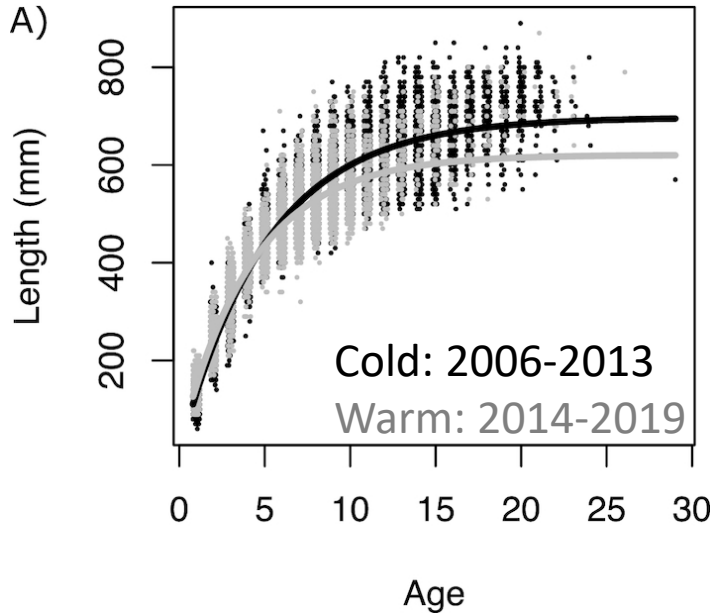
Nonstationarity

- Observed in a wide range of Alaskan species
- Can arise in different population processes (axes of change)
  - Growth, natural mortality, average (or variability in) recruitment, fecundity and age at maturity

Chignik Lake Sockeye Salmon (GOA)



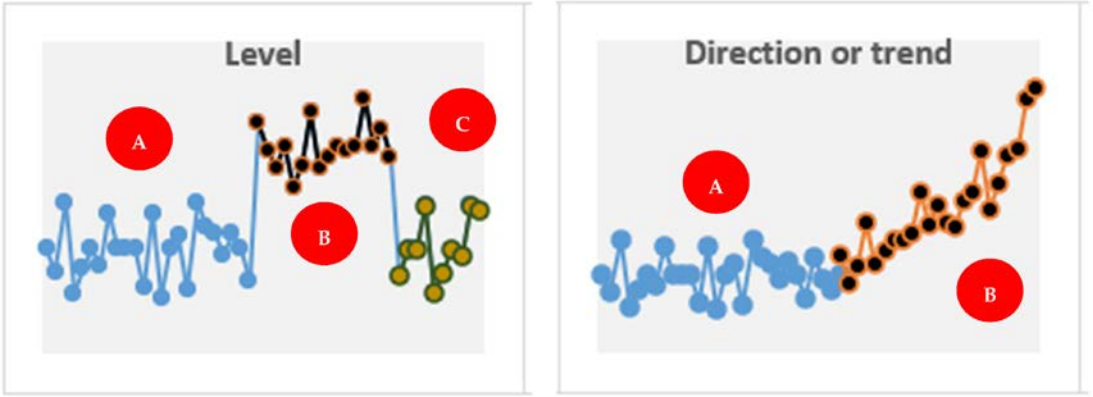
Bering Sea Walleye Pollock



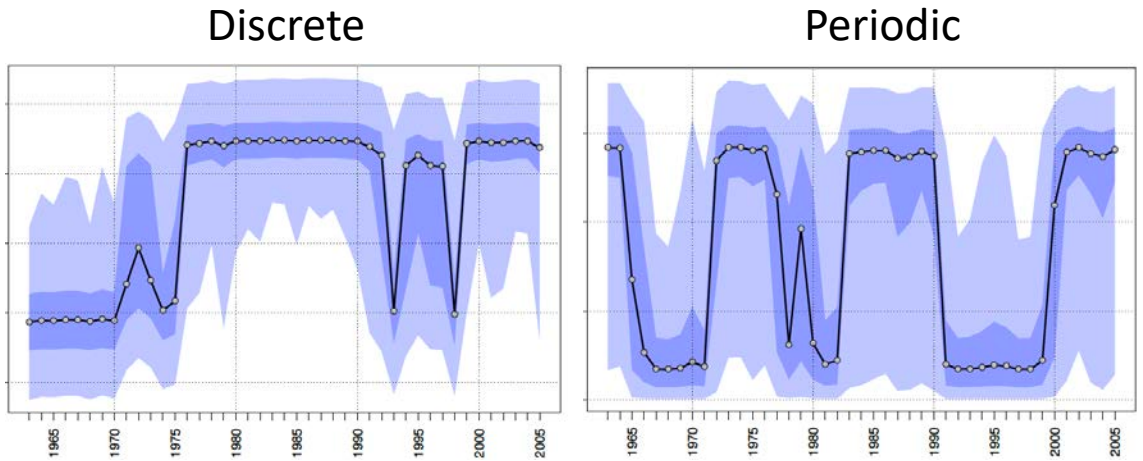
Oke et al. (2022)

Nonstationarity

- Dynamic processes may be
  - Directional or periodic
- Demographic regimes can vary in
  - Duration, frequency, and/ magnitude
- Challenging to detect with confidence
  - And often ***only*** after a time lag
- Difficult to predict
- Key question:
  - How should management respond?

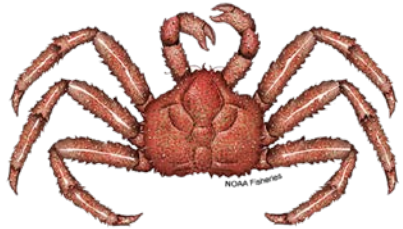


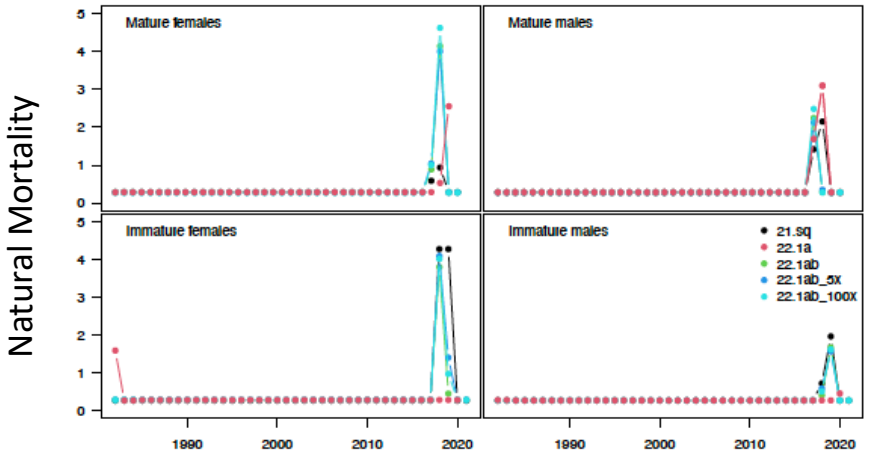
Siddiqui and Raza (2022)



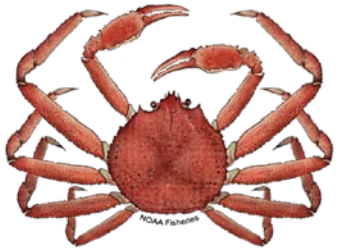
Cunningham et al. (2015)

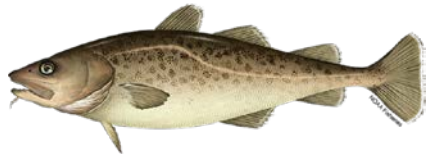
Nonstationarity: Case Studies

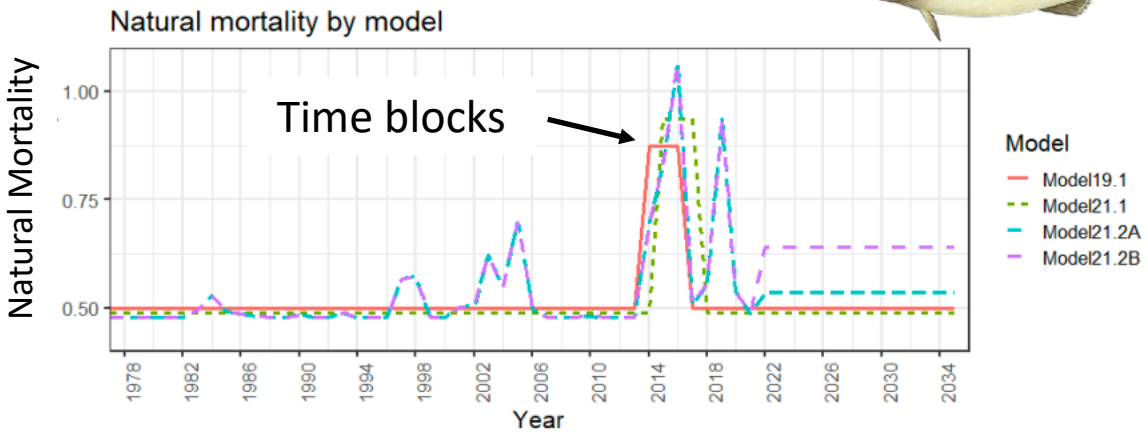




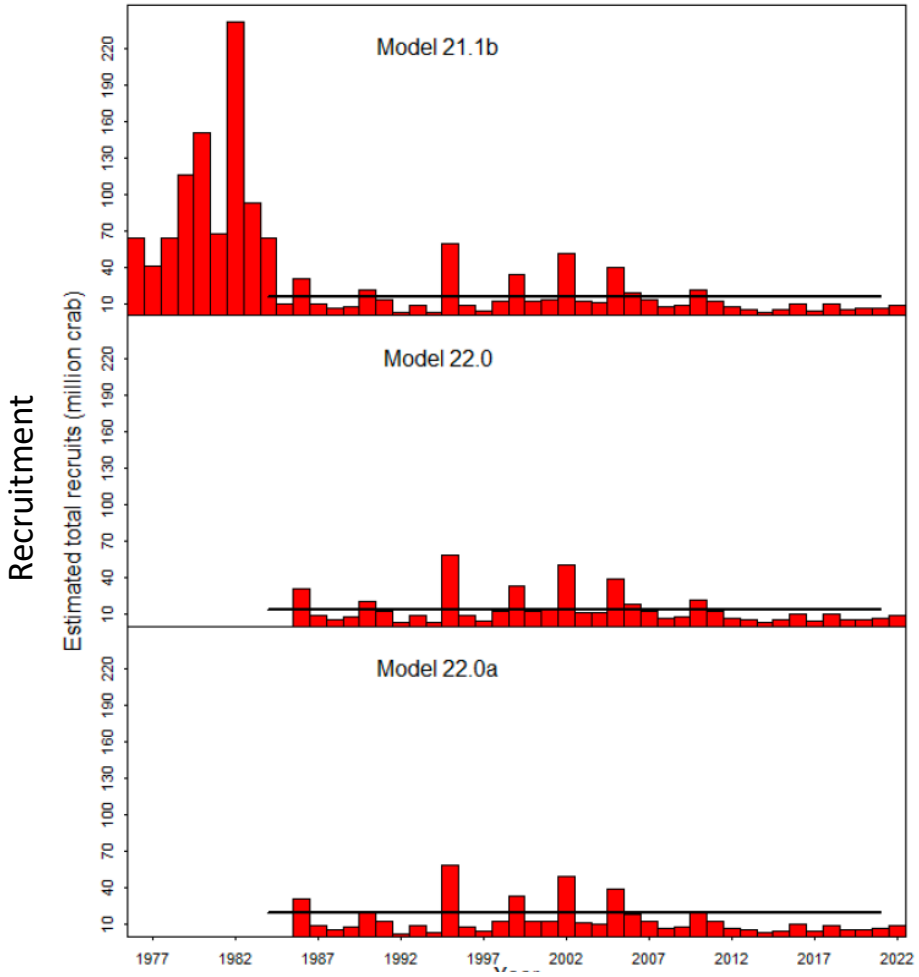
Snow Crab SAFE (2022)





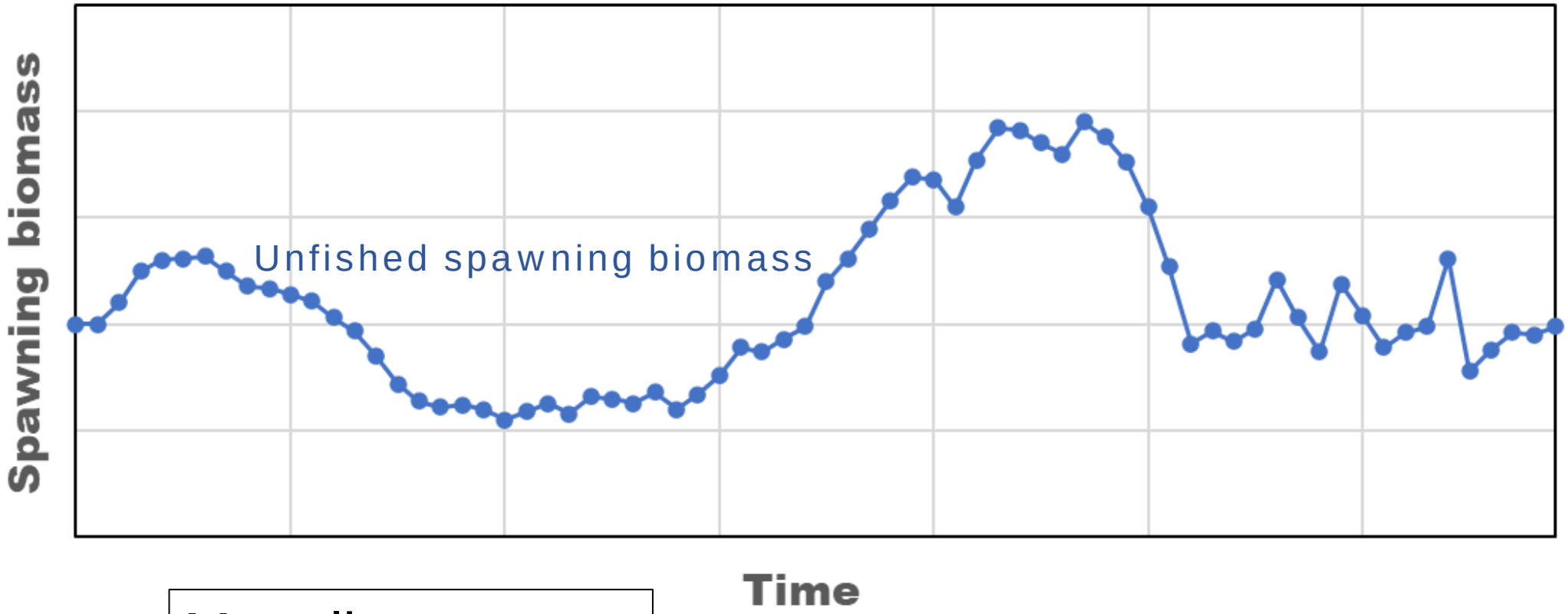


GOA Pacific Cod SAFE (2021)



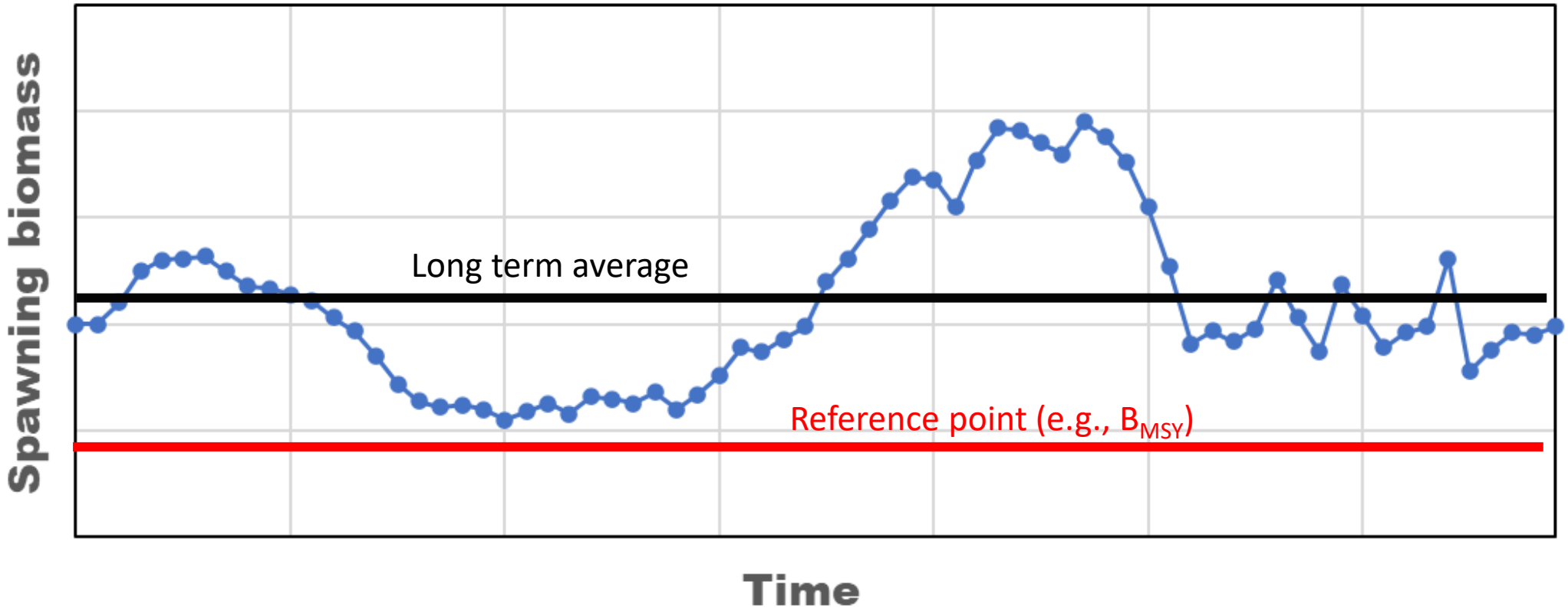
Bristol Bay Red King Crab SAFE (2022)

Natural variability in population processes



Mortality
Recruitment
Growth
Maturity/fecundity

Dynamic reference points – long term



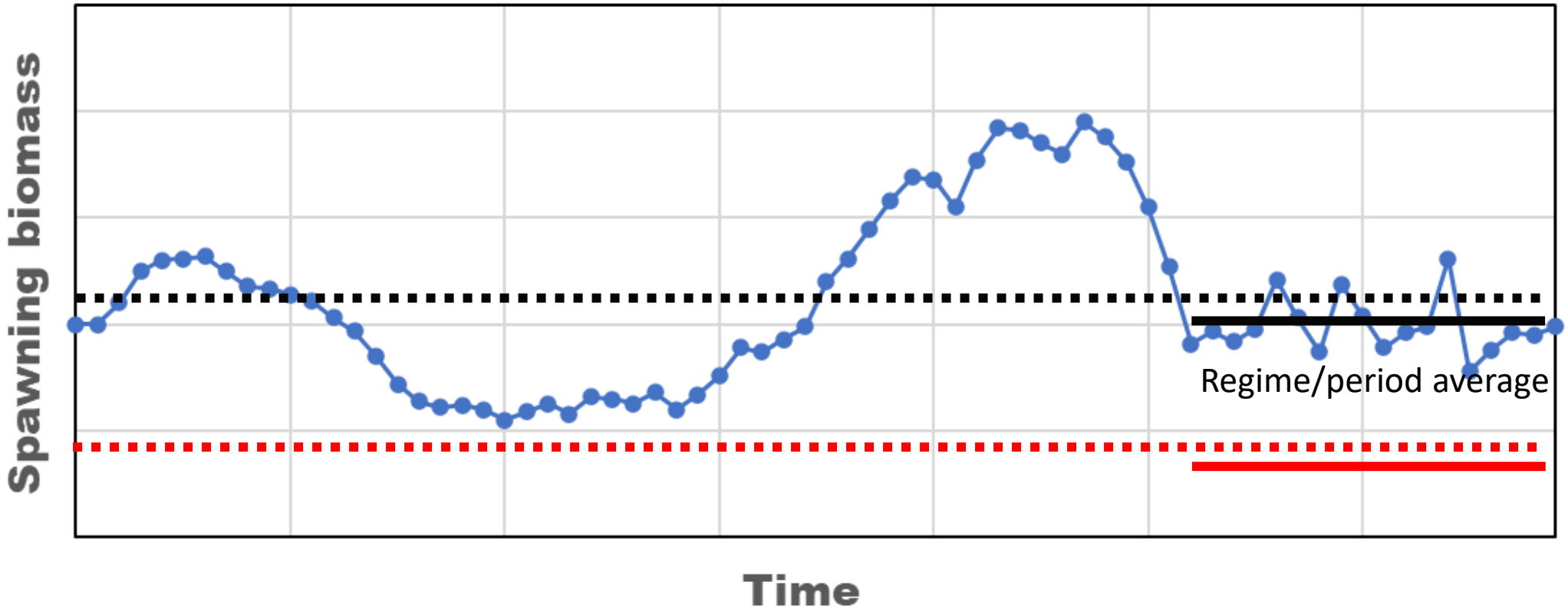
Pros

- Stable – changes very slowly over time
- Informed by all the data

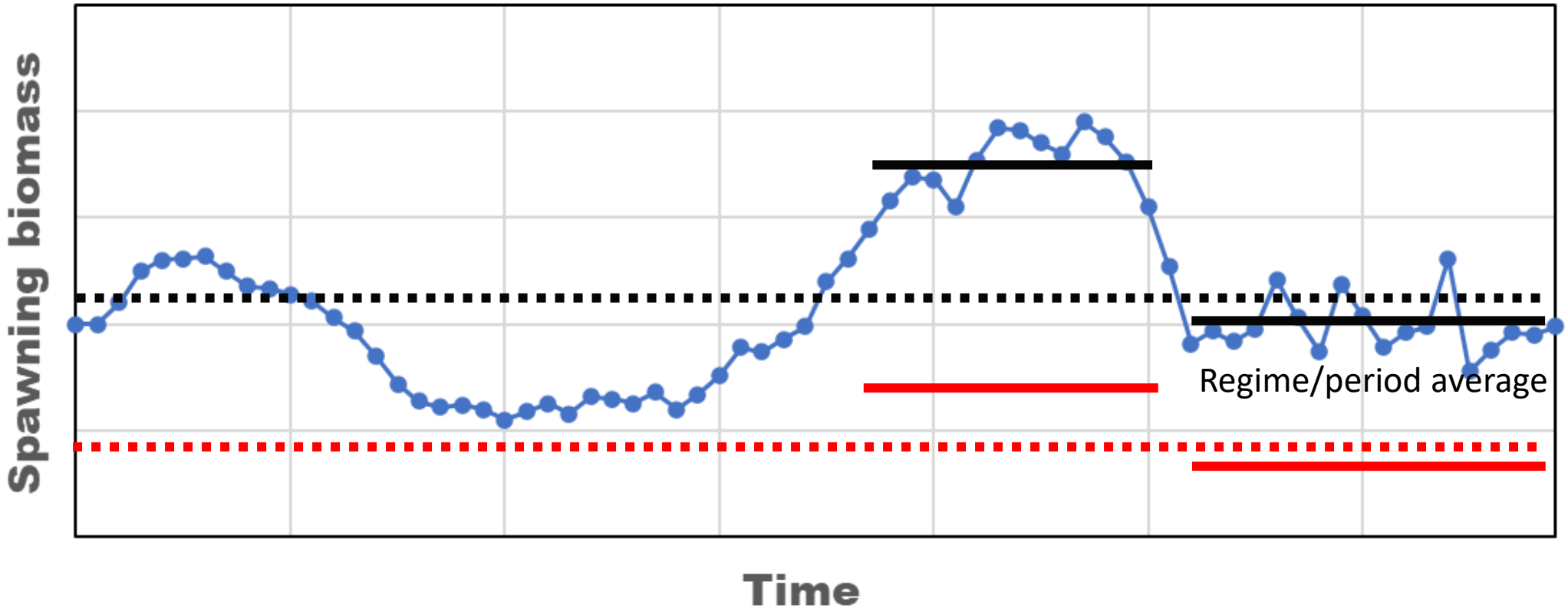
Cons

- Disconnected from current processes/biology
- May trigger reference points without fishing
- Depends on the choice of modelled period

Dynamic reference points – Regime/period



Dynamic reference points – Regime/period



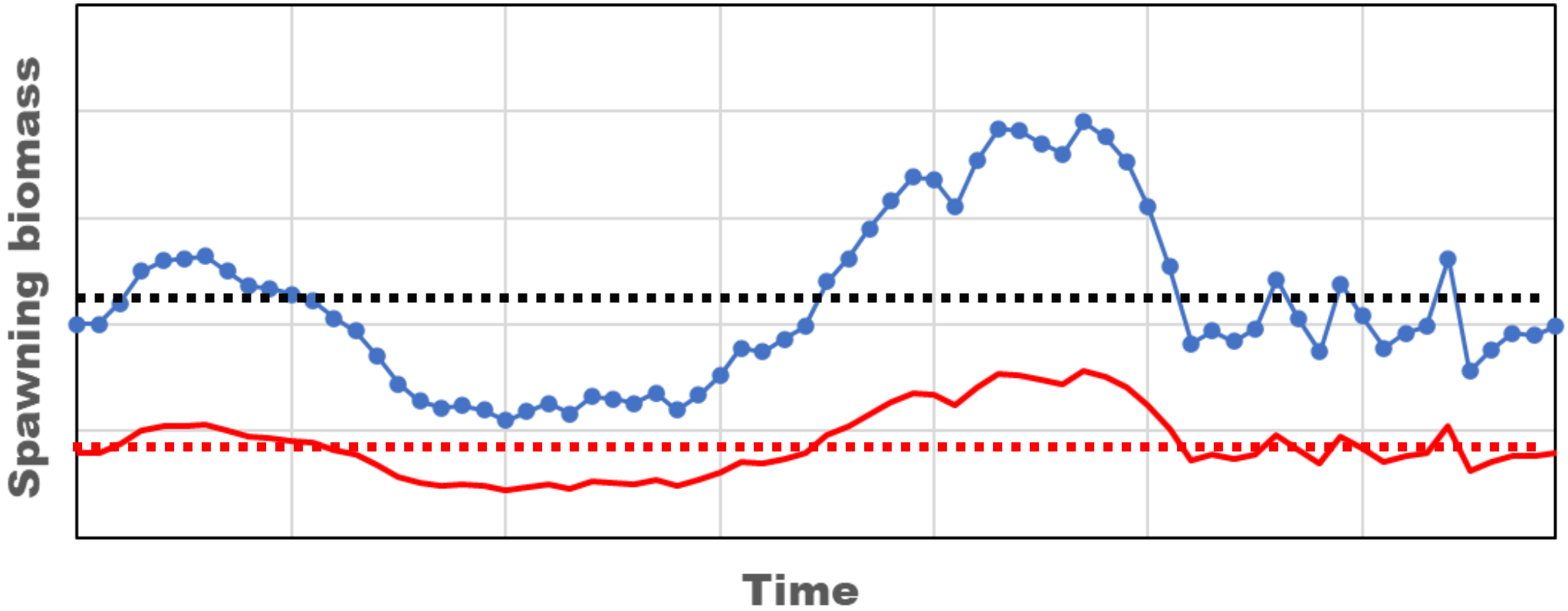
Pros

- Reflects recent average conditions

Cons

- Depends on the choice of modelled period
- How to decide when to change?
- What if there is an ongoing trend?

Dynamic reference points – Annual



Pros

- Reflects only recent conditions (biology and recruitments in the current age structure)
- Does not require identifying change points
- Independent of modelled period

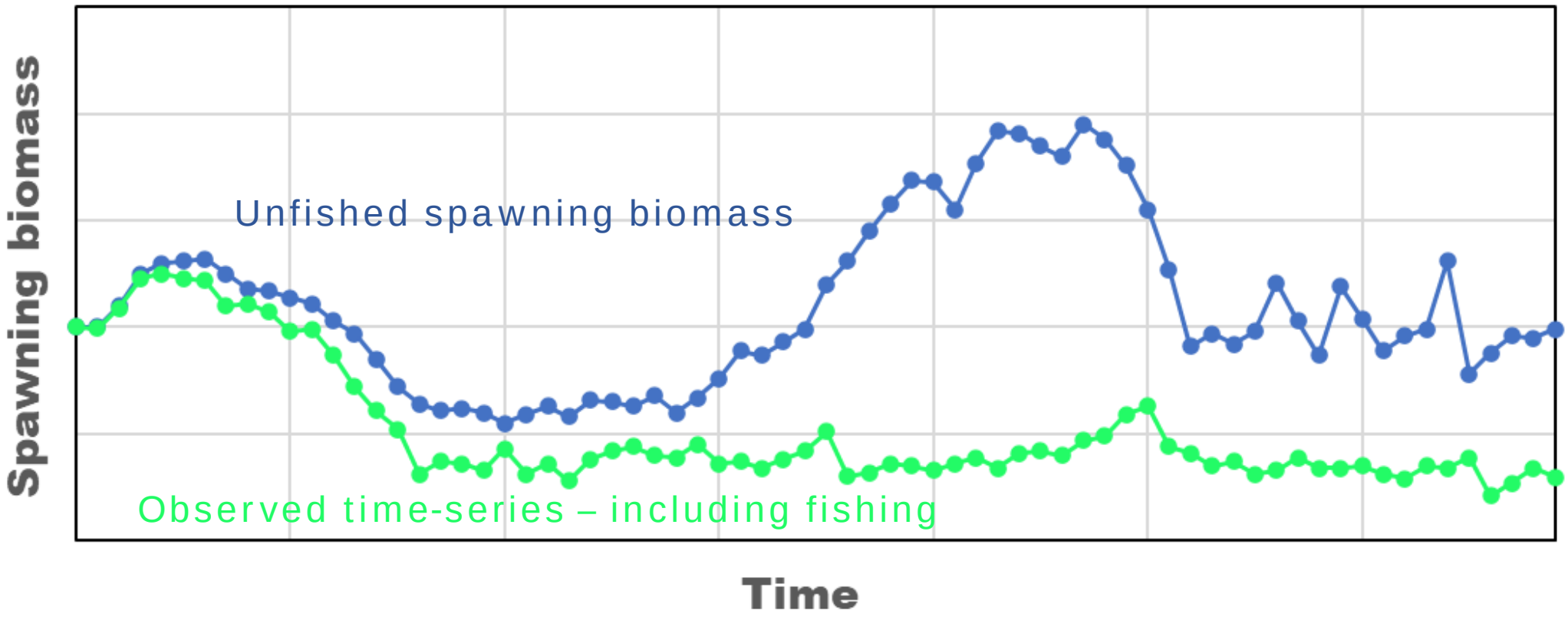
Cons

- Change each year
- May be subject to greater estimation error

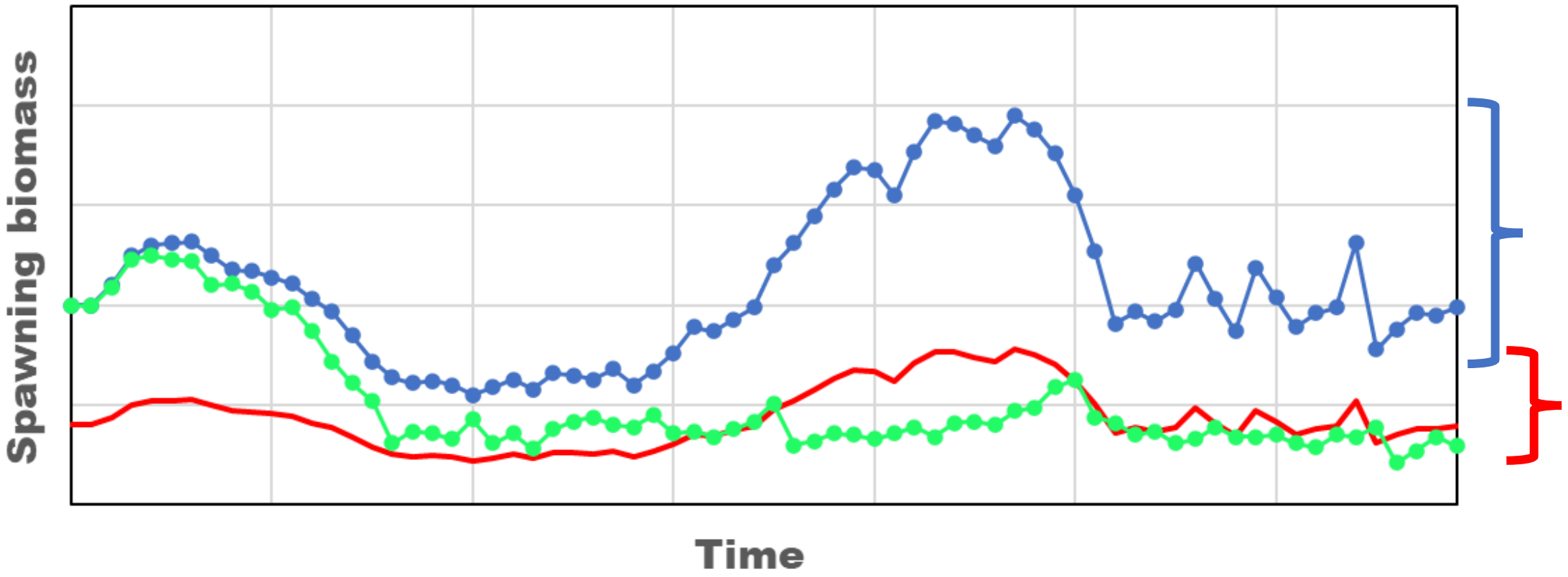
Point #1: All reference points are dynamic

- Some respond quickly to recent change and some hardly at all

Drivers of population processes



Drivers of population processes



Which drivers that should affect reference points and which should not?

Drivers that should **NOT** affect reference points

- Mortality due to fishing
- Density dependent effects on recruitment due to fishing
  - Assuming no stock-recruit relationship may be risky
- Fishing effects on growth and maturity

Drivers that should affect reference points

- Natural mortality (predation, disease, density dependence)
- Fluctuations in recruitment strength
- Density dependent growth and maturity

- Everything considered to be ‘normal’ given “prevailing ecological, environmental conditions”

Drivers that may require consideration

Mortality:

- Transient environmental (e.g., temperature), climate change or longer-term regimes, catastrophic events: recurring (e.g., disease), catastrophic events: unique (e.g., disease, oil spill), …

Recruitment, Growth, Maturity/fecundity:

- Transient environmental (e.g., annual temperature), climate change or longer-term regimes, …

Point #2: Classifying drivers is critically important

- We should think beyond selecting time-periods and consider the specific drivers of population processes when responding to changing populations

- May require consideration of scientific as well as socio-economic factors. When do we decide to manage to the ‘new normal’ as climate and ecosystems change?