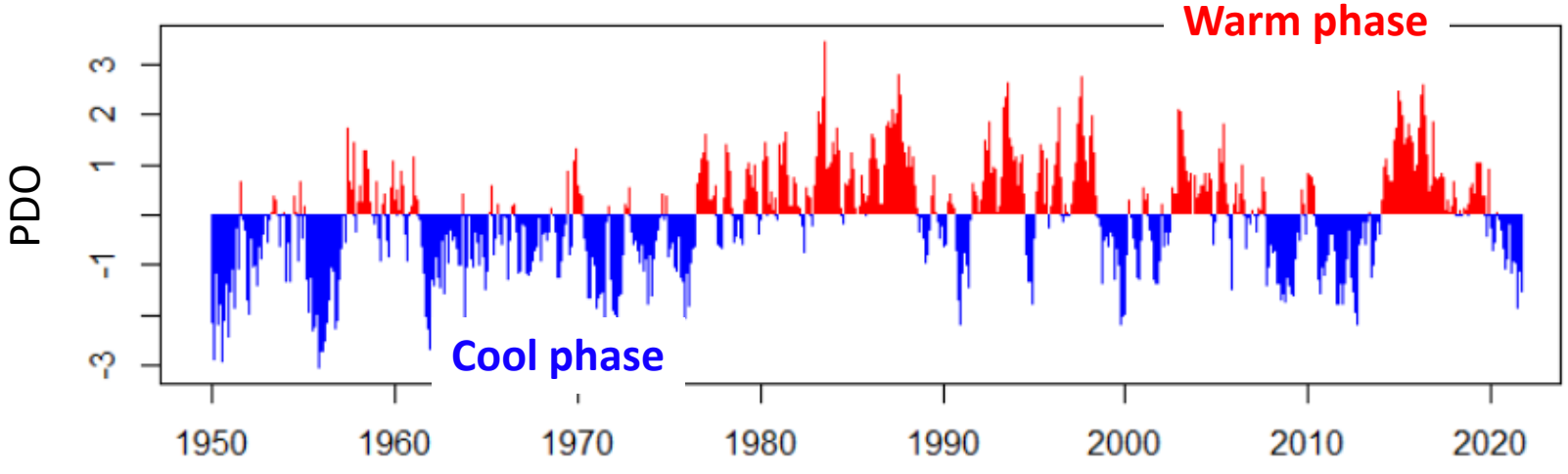
Are current hatchery strategies designed to engage with future ocean variation?

(this will be very Chinook salmon-centric)

Brian Beckman
NWFSC, NMFS, Seattle

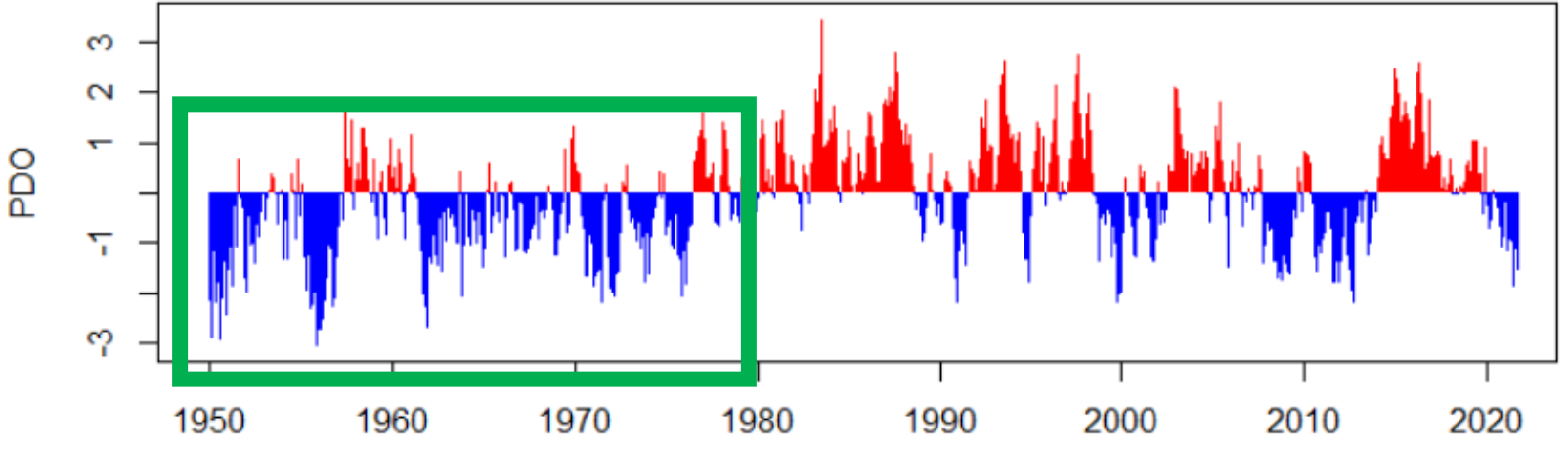
The ocean has been variable and unpredictable but “stable” flipping between two states



https://psl.noaa.gov/pdo/

I stole this slide from Burke’s talk

Hatchery production strategies were developed during a period of predictably ”good” ocean conditions



https://psl.noaa.gov/pdo/

Trajectory of hatchery production strategies in the Puget Sound

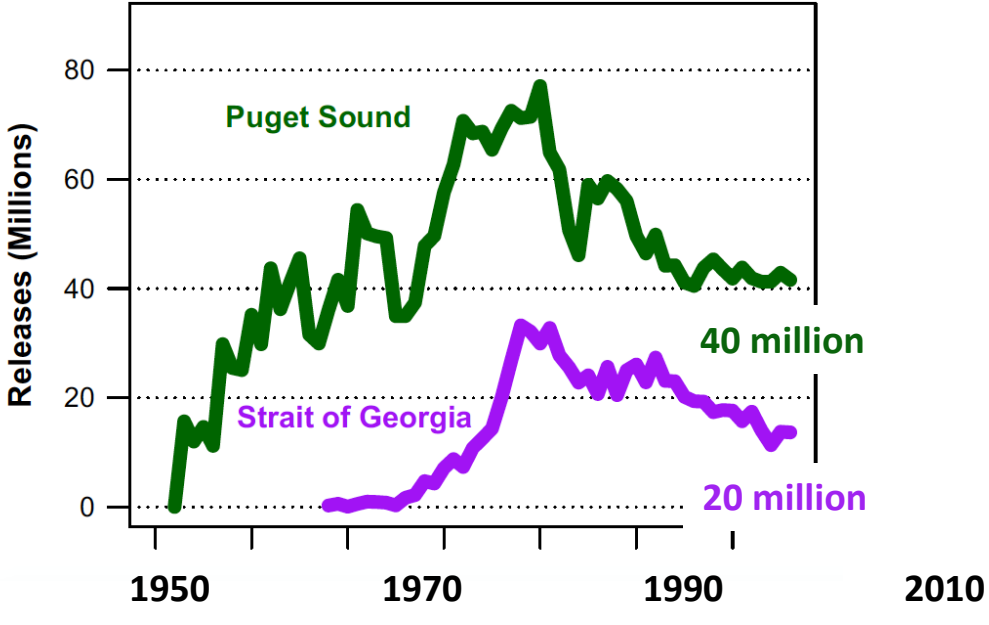
esa

ECOSPHERE

Ecological implications of changing hatchery practices for Chinook salmon in the Salish Sea

BENJAMIN W. NELSON,[1,2,†] ANDREW O. SHELTON,[3] JOSEPH H. ANDERSON,[4] MICHAEL J. FORD,[3] AND ERIC J. WARD[3]

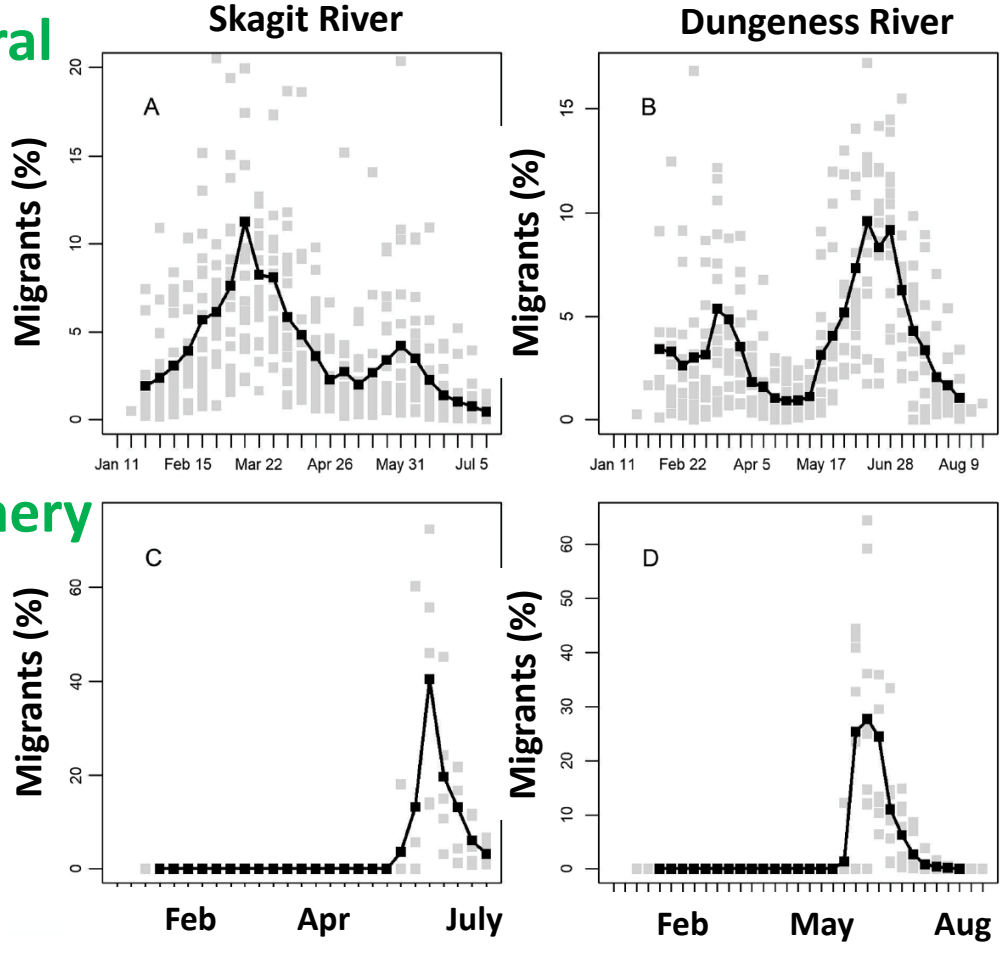
Chinook Salmon Hatchery Releases (millions)



Current natural fish migration timing is variable and extended (6 months)
Current hatchery fish timing is unimodal and short (6 weeks)

Natural

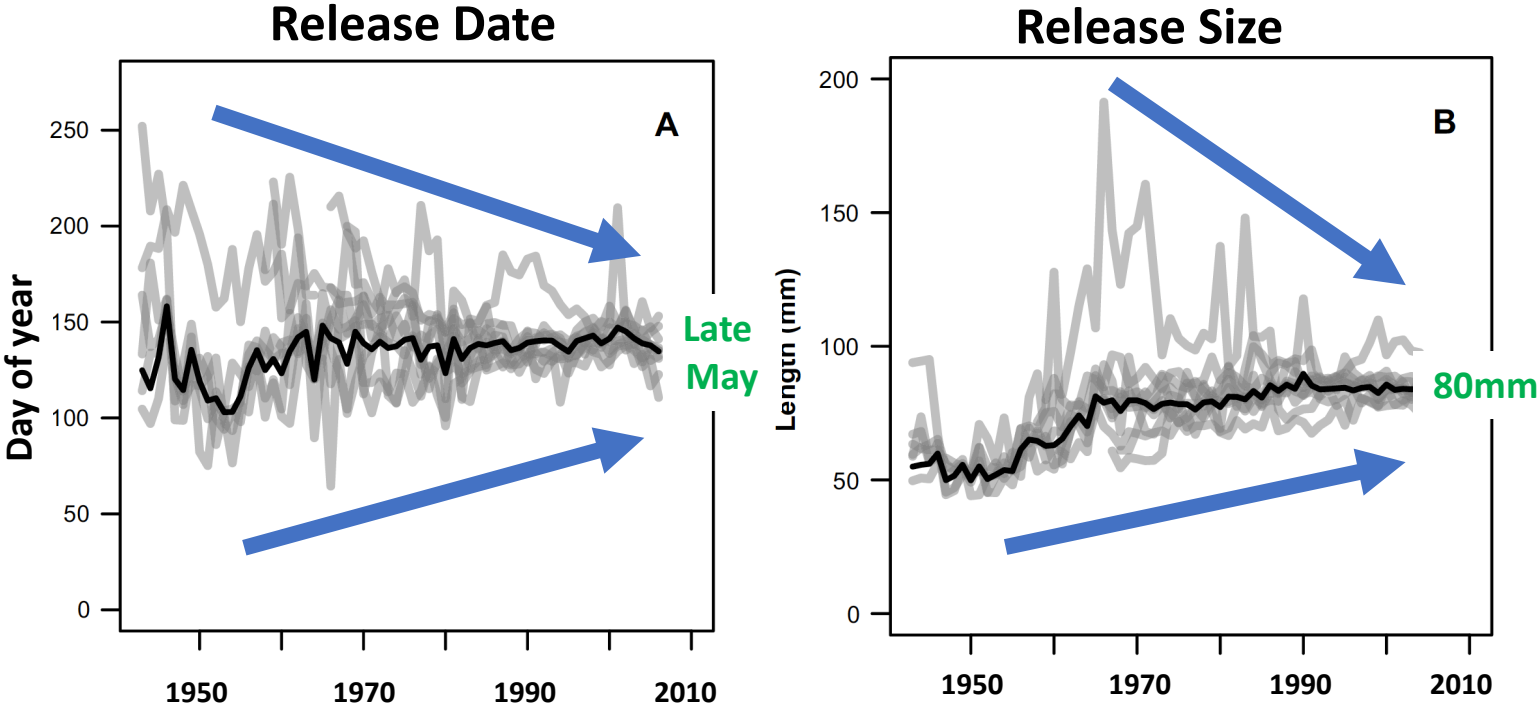
Hatchery



Abundance of migrating Chinook salmon smolts at weirs/traps

Nelson et al. 2019

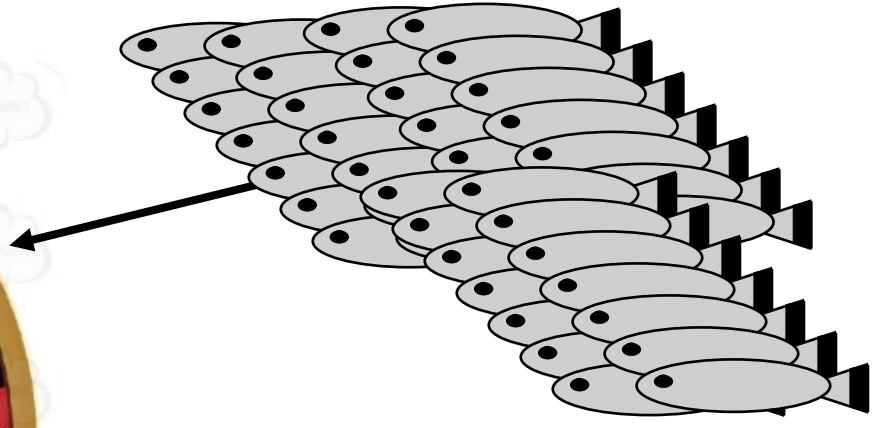
Variation in hatchery release time and release size of Chinook salmon in Salish Sea has decreased and become unimodal



from CWT records

Nelson et al. 2019

Puget Sound strategy: release of a uniform group of smolts in the early summer

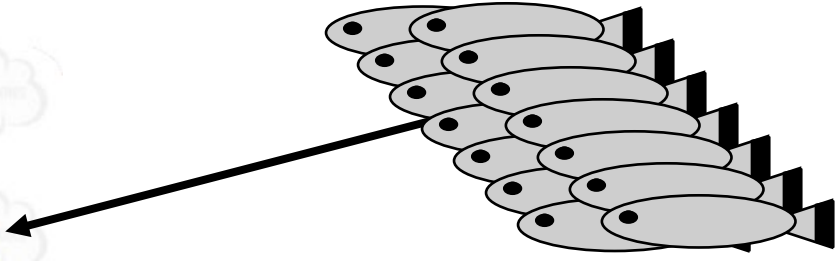


Forty million on:
5 June at 40 fpp

Based on:

- **A history of success**
- **Size/time release studies**

A common Col R strategy is a single release of yearlings in the spring

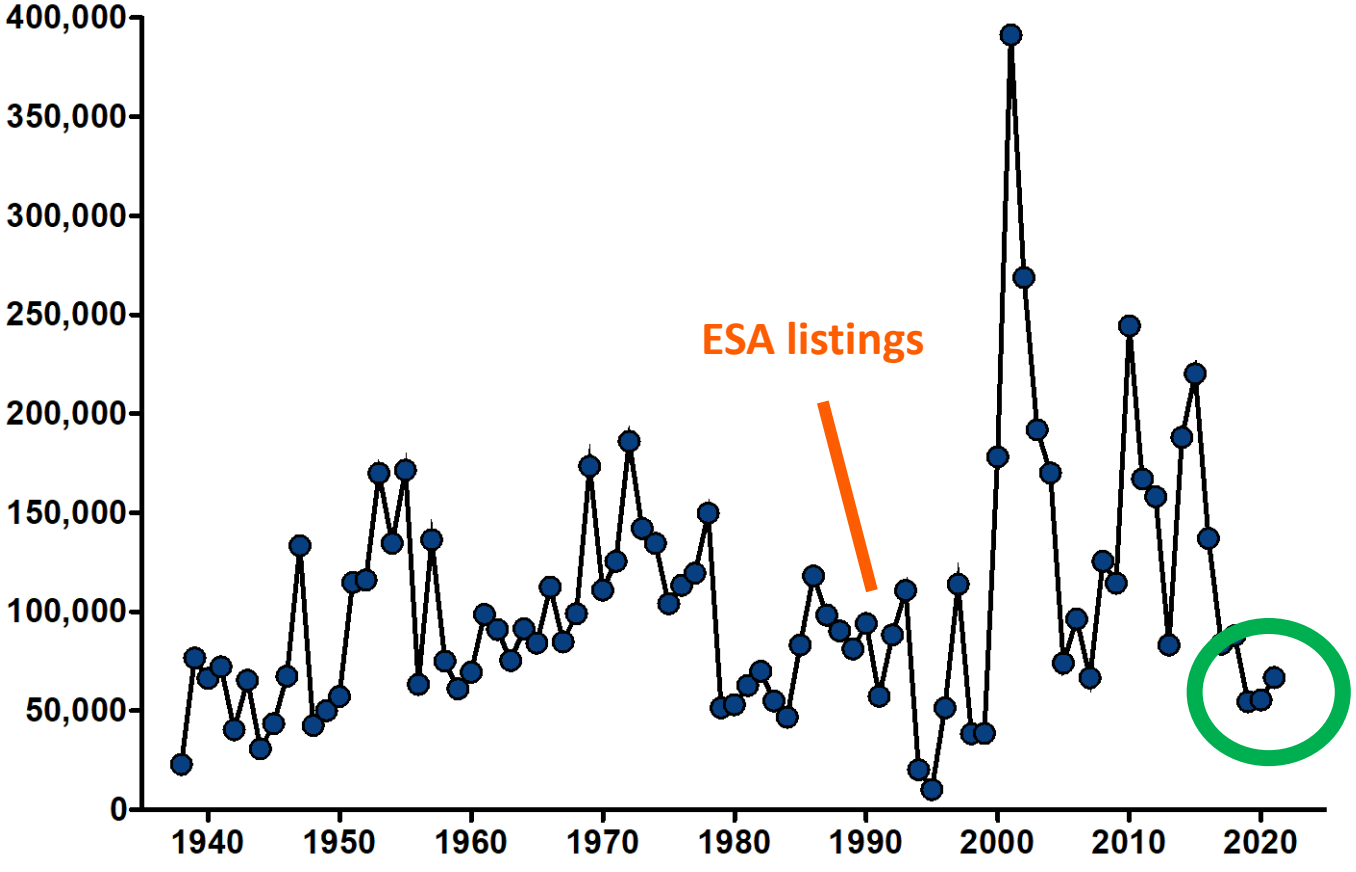


One million on:
5 April at 18 fpp

Based on:
- **A history of success**
- **Size/time release studies**

Are current hatchery strategies always successful?
Or, is there a consistent return of fish?

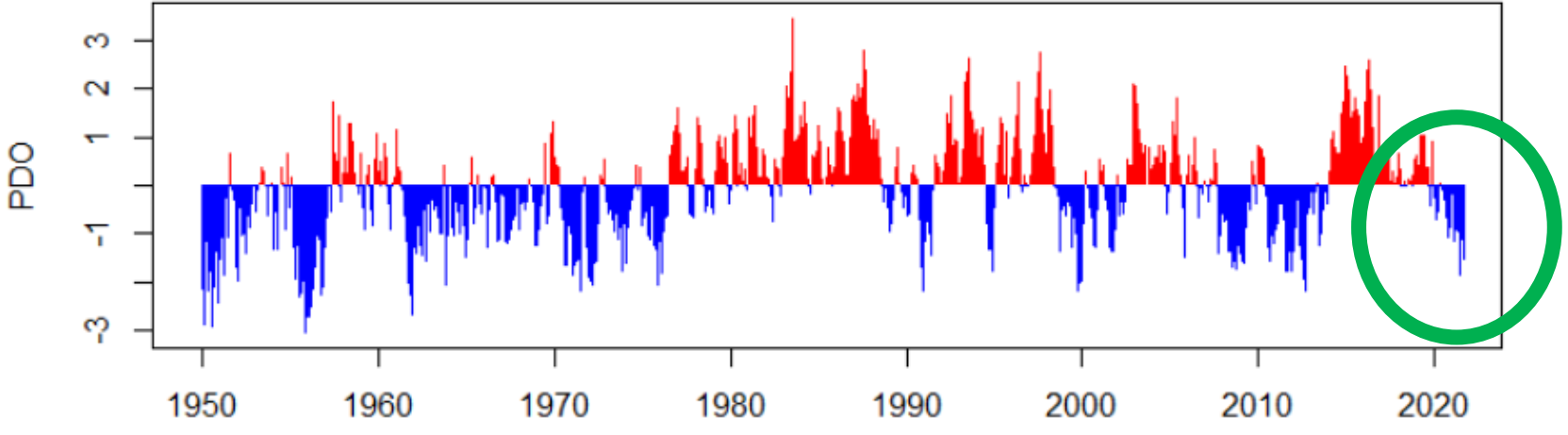
Spring Chinook salmon count at Bonneville, 2019 – 2021
Do we have a problem?



http://www.cbr.washington.edu/dart/query/adult_graph_text

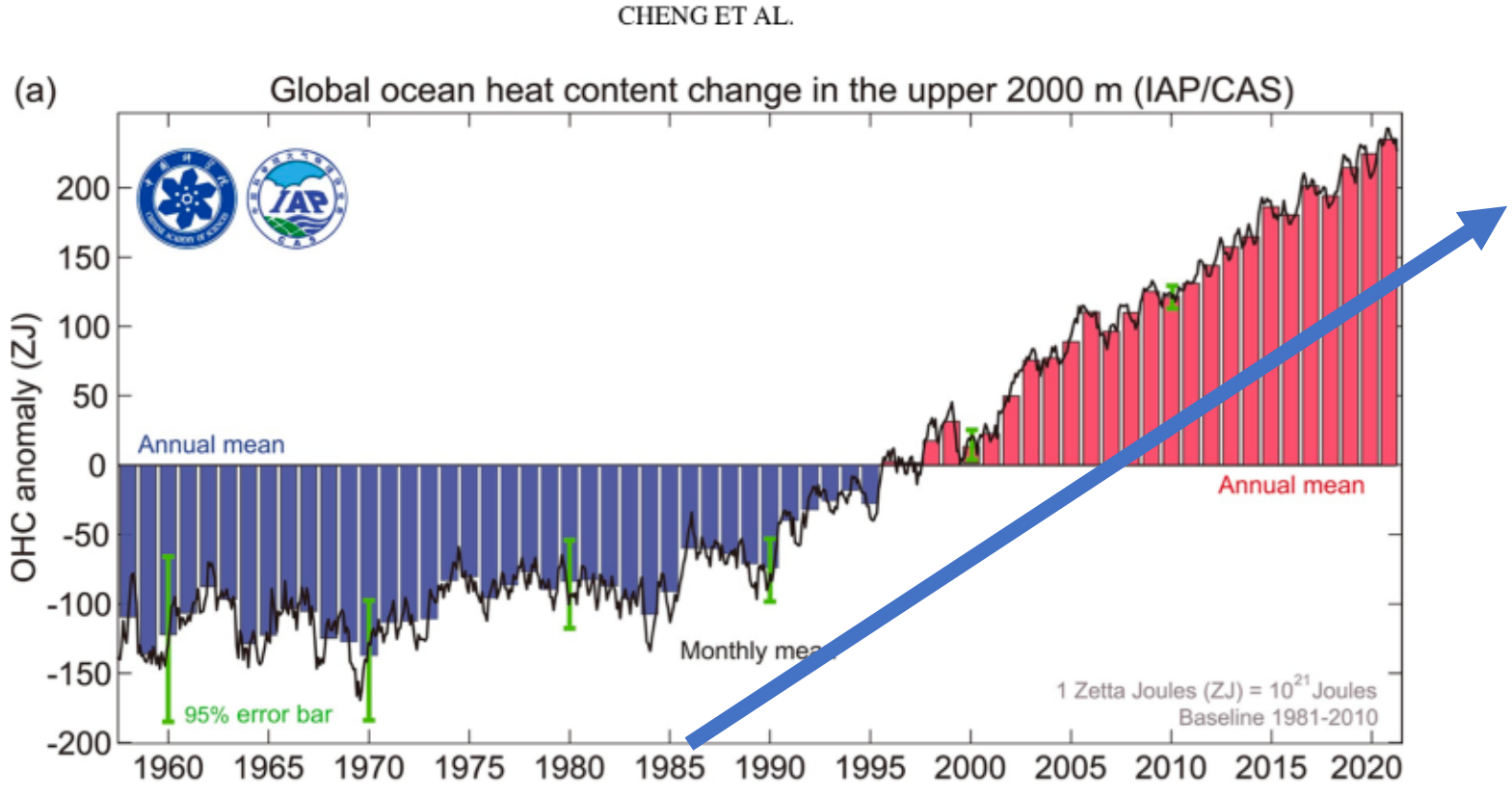
Current hatchery strategies may result in poor returns but stability of ocean ecosystem has ensured success when ocean conditions return to a cool and productive regime 2020??

=> Maintain current strategies based expectations of a stable ocean?



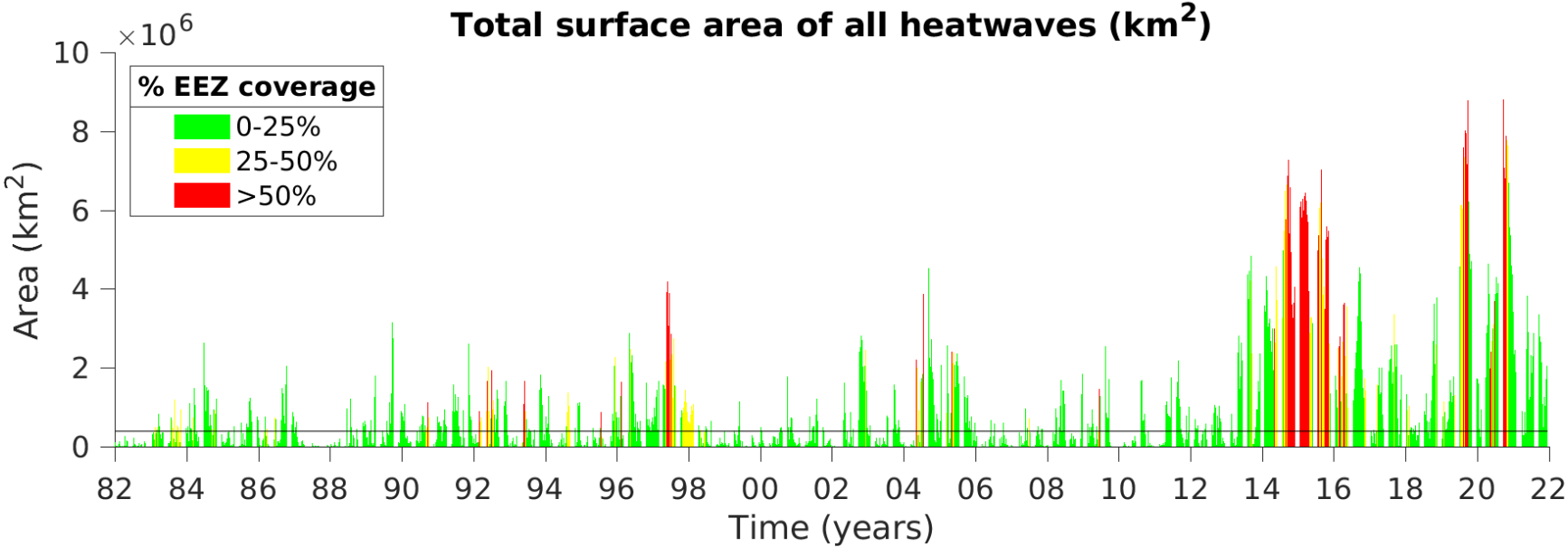
https://psl.noaa.gov/pdo/

Patterns of ocean variation are changing



Cheng et al. 2022

Heat waves are increasing in frequency and magnitude



2020-21 California Current Ecosystem Status Report
NOAA California Current IEA Team

COMMENT

DOI: 10.1038/s41467-018-03163-6 OPEN

Emerging risks from marine heat waves

Thomas L. Frölicher[1,2] & Charlotte Laufkötter[1,2]

The forecast is for even more heat waves

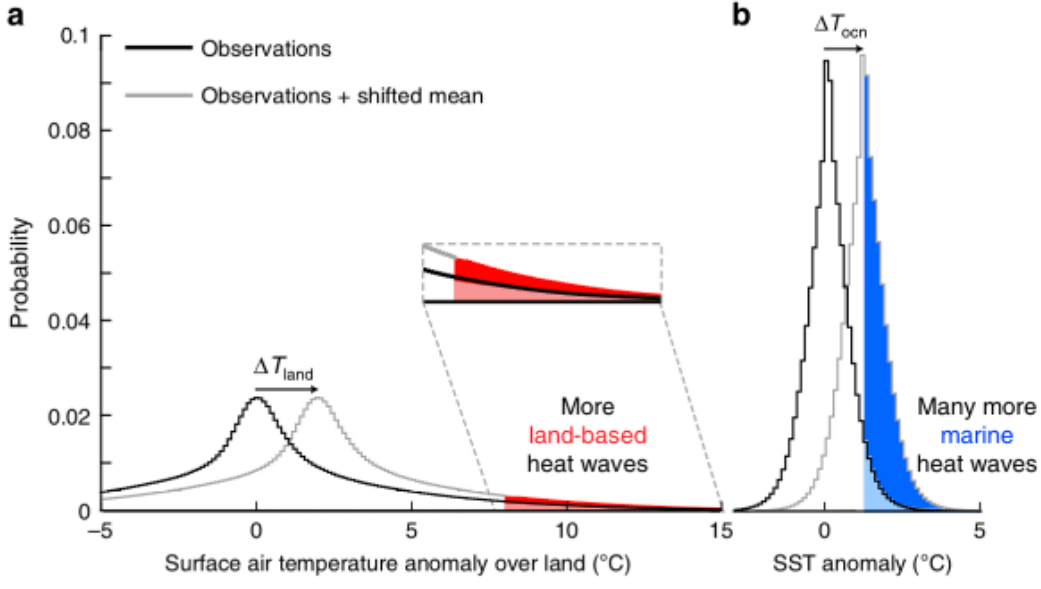
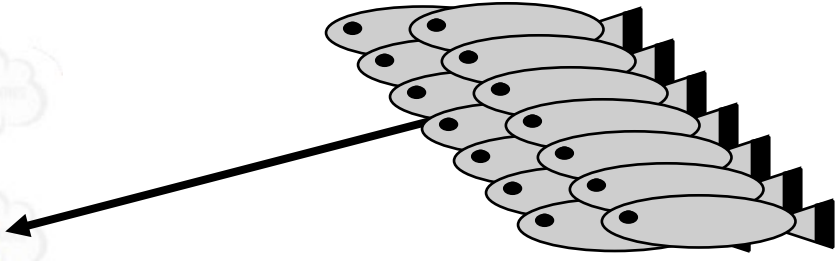


Fig. 2 The effect of a simple shift towards a warmer climate on the probability of land-based and marine heat waves. **a** shows the observed distribution of the linearly detrended and deseasonalized local daily surface air temperature anomalies over land using the CRU-NCEP-v8 data set[21,22]; **b** as for **a** but for local daily sea surface temperature anomalies using NOAA's daily Optimum Interpolation sea surface temperature data set[11]. Solid black lines show the distributions over the 1982–2016 period and solid gray lines indicate the same shape of the distributions, but the land is shifted by $\Delta T_{land} = 2°C$ and the ocean by $\Delta T_{ocn} = 1.33\,°C$. Here we assume $\Delta T_{land}/\Delta T_{ocn} = 1.5$[20]. A heat wave is defined as temperature exceeds the 95th percentile (red and blue shaded areas). The inset highlights the changes in land-based heat waves

There is an increasing trend in marine heat
Variability is increasing
The variation is becoming more intense

The ocean is becoming more unpredictable
Marine conditions are exceeding historic norms
Might the PDO “flip” become unstable?

Do we want to continue with the current strategy (the big bet) or perhaps consider some alternatives?



One million on:

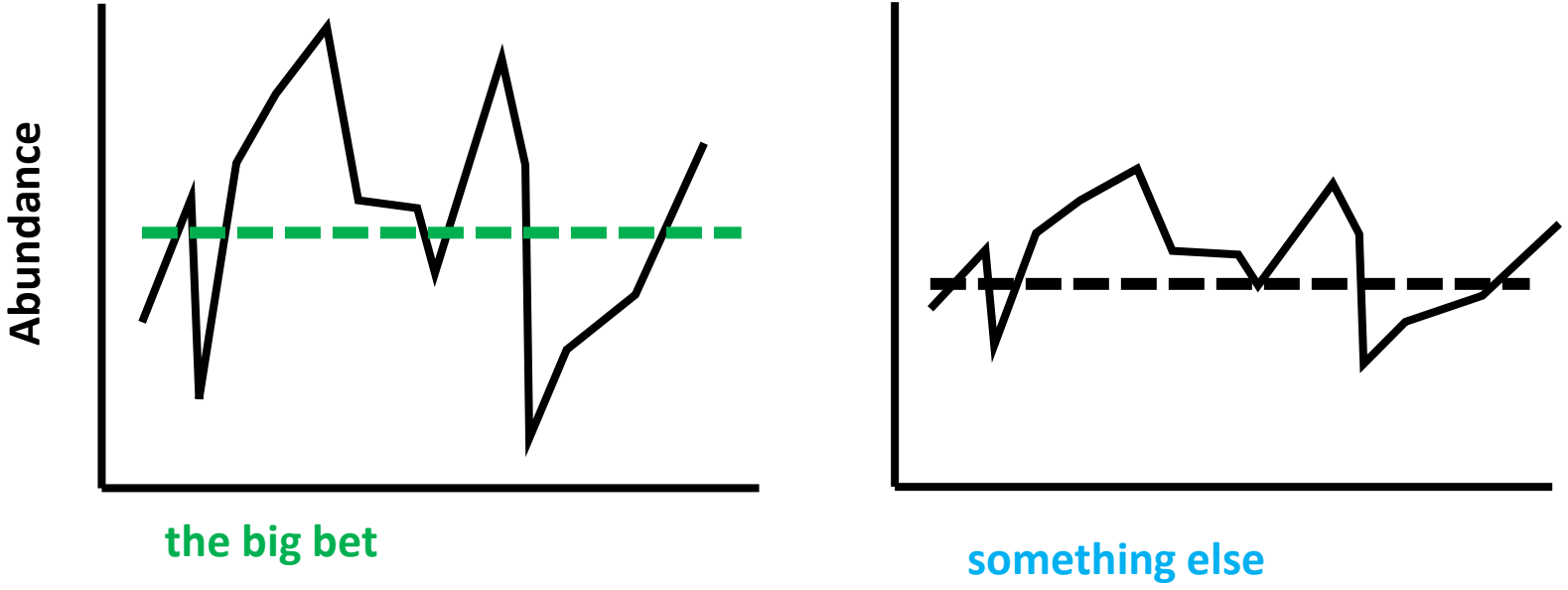
15 April at 18 fpp

Based on:

- **A history of success**
- **Size/time release studies**

Are hatchery goals 1) maximizing return every year or 2) minimizing variance in return between years?

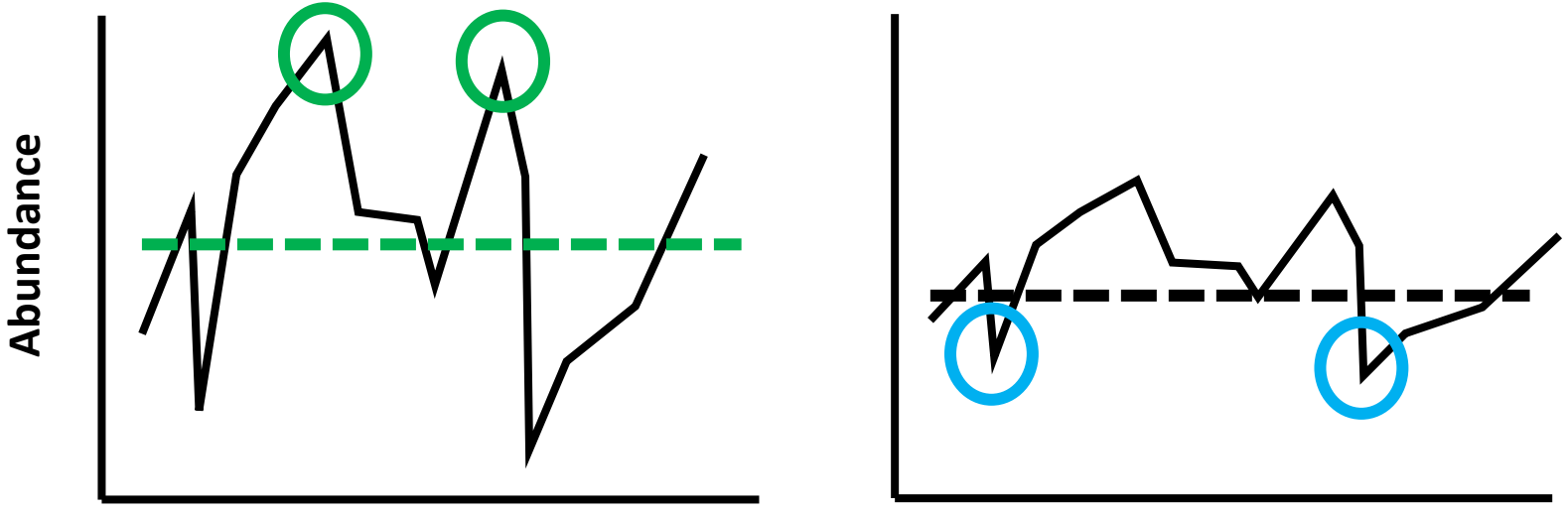
Are there alternative production strategies that might produce different patterns of variance?



Are there alternative production strategies that might produce different patterns of variance?

Annual mean is higher
Max annual catch is higher

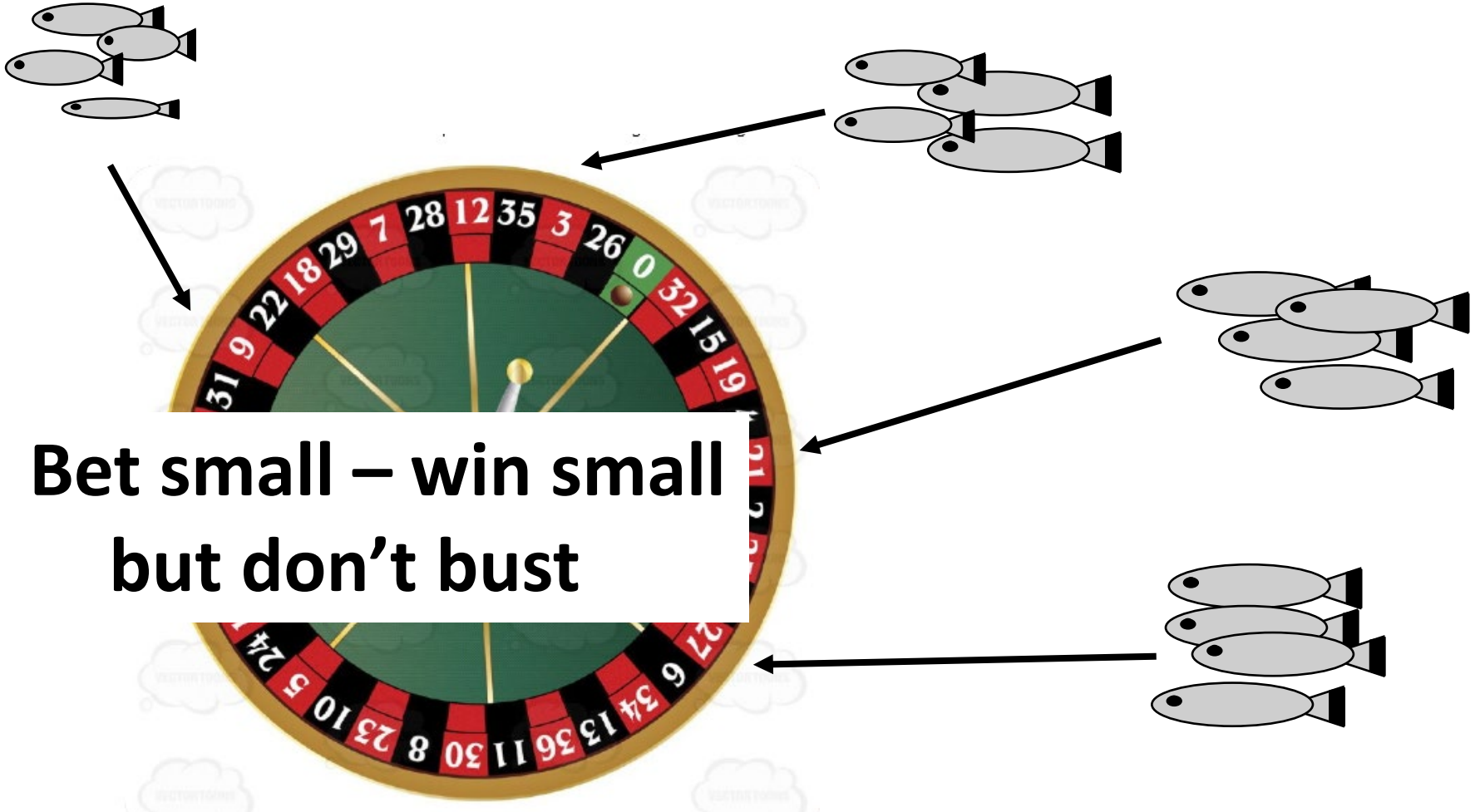
<u>Minimum</u> annual catch is higher
Variance is lower



the big bet

something else

250k each on: ???? at ????

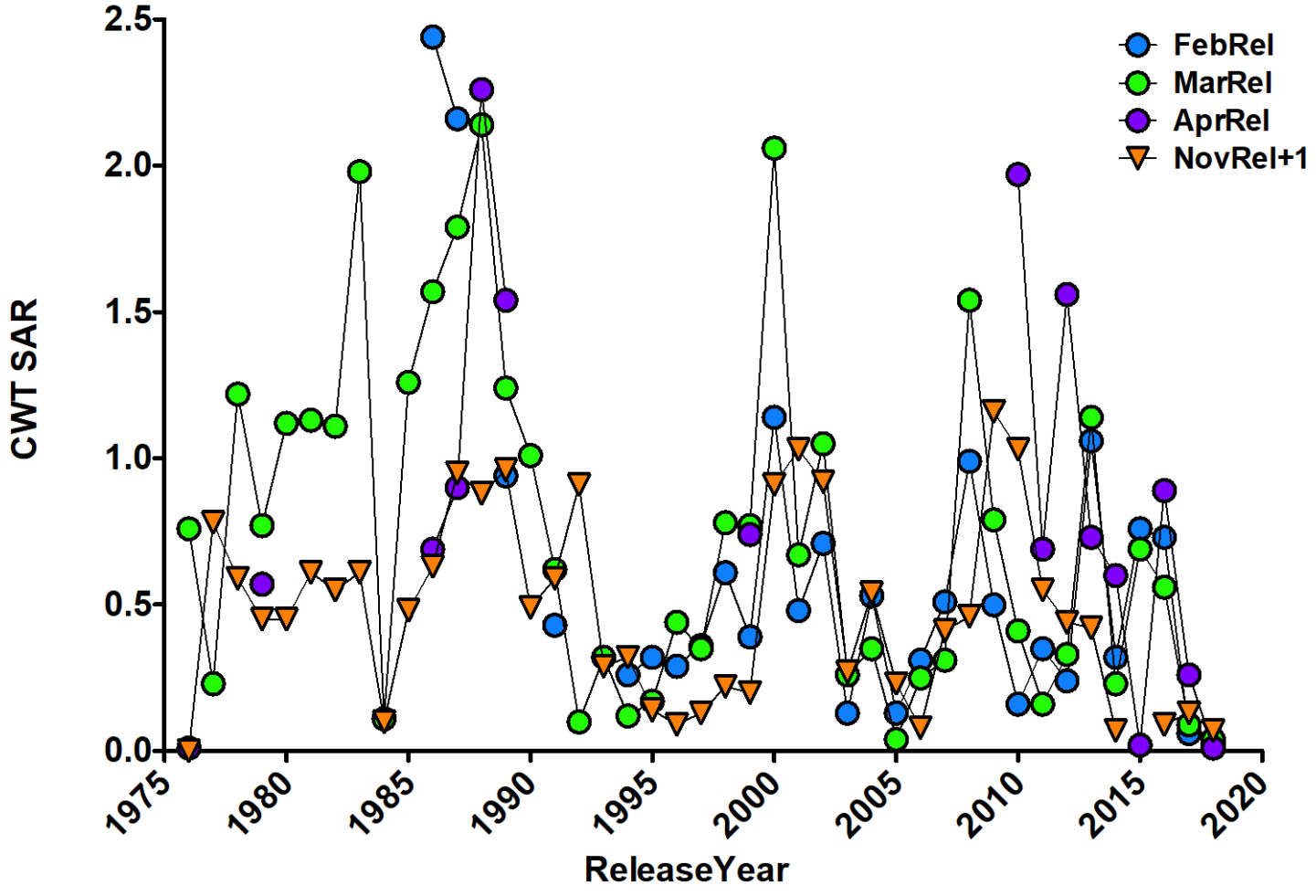


What data do we have on ”small bets”

Willamette spring Chinook salmon, ODFW
4 hatcheries, varying release dates, several decades of CWTs

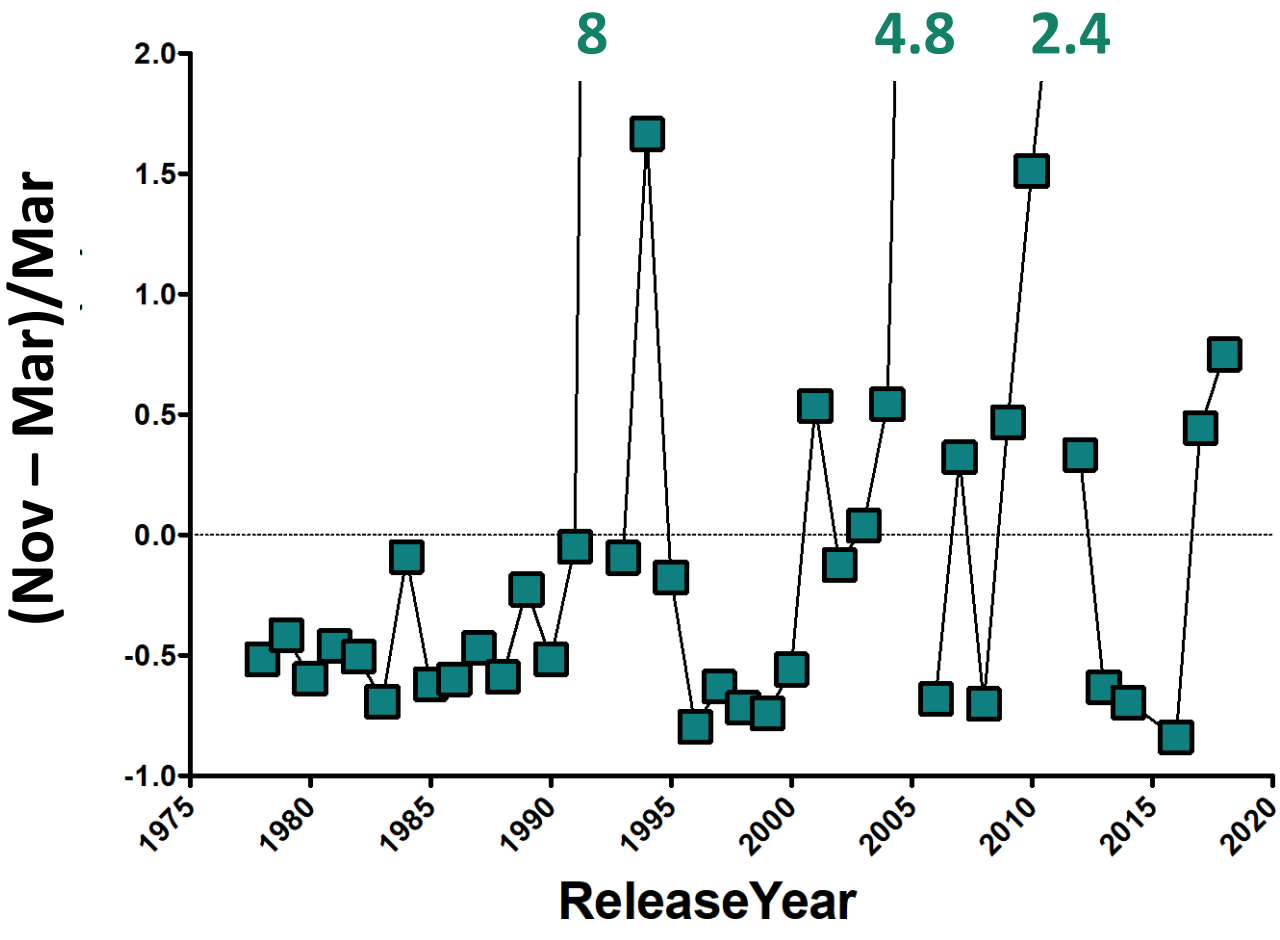
Mining RMIS

Willamette River spring Chinook Hatchery SAR by release month



RMIS

How does November compare to March? Fold-difference, Nov - March



On average, March release SAR is higher,
~ 30% of the time November release SAR is higher

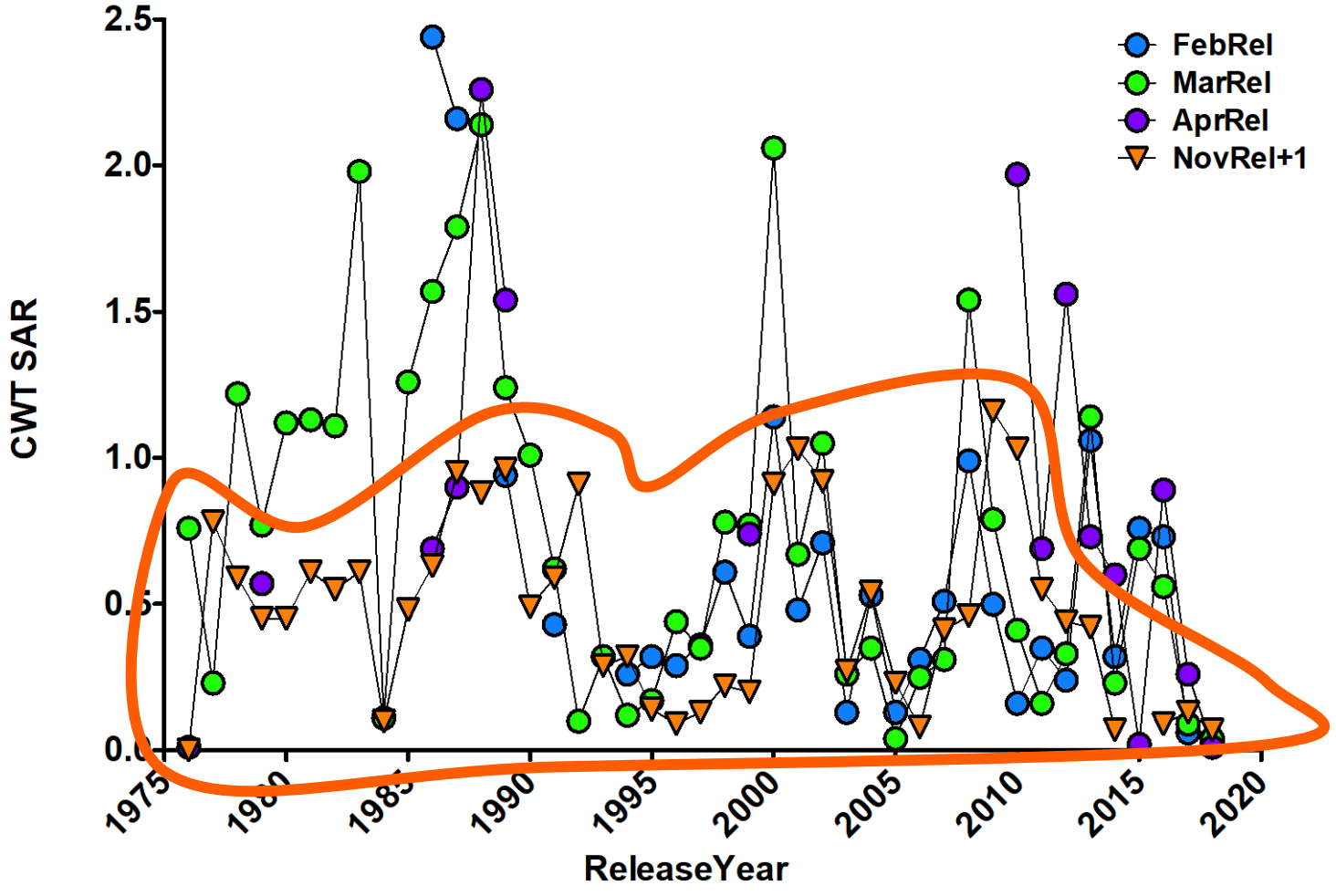
November is higher - 12

About the same - 6

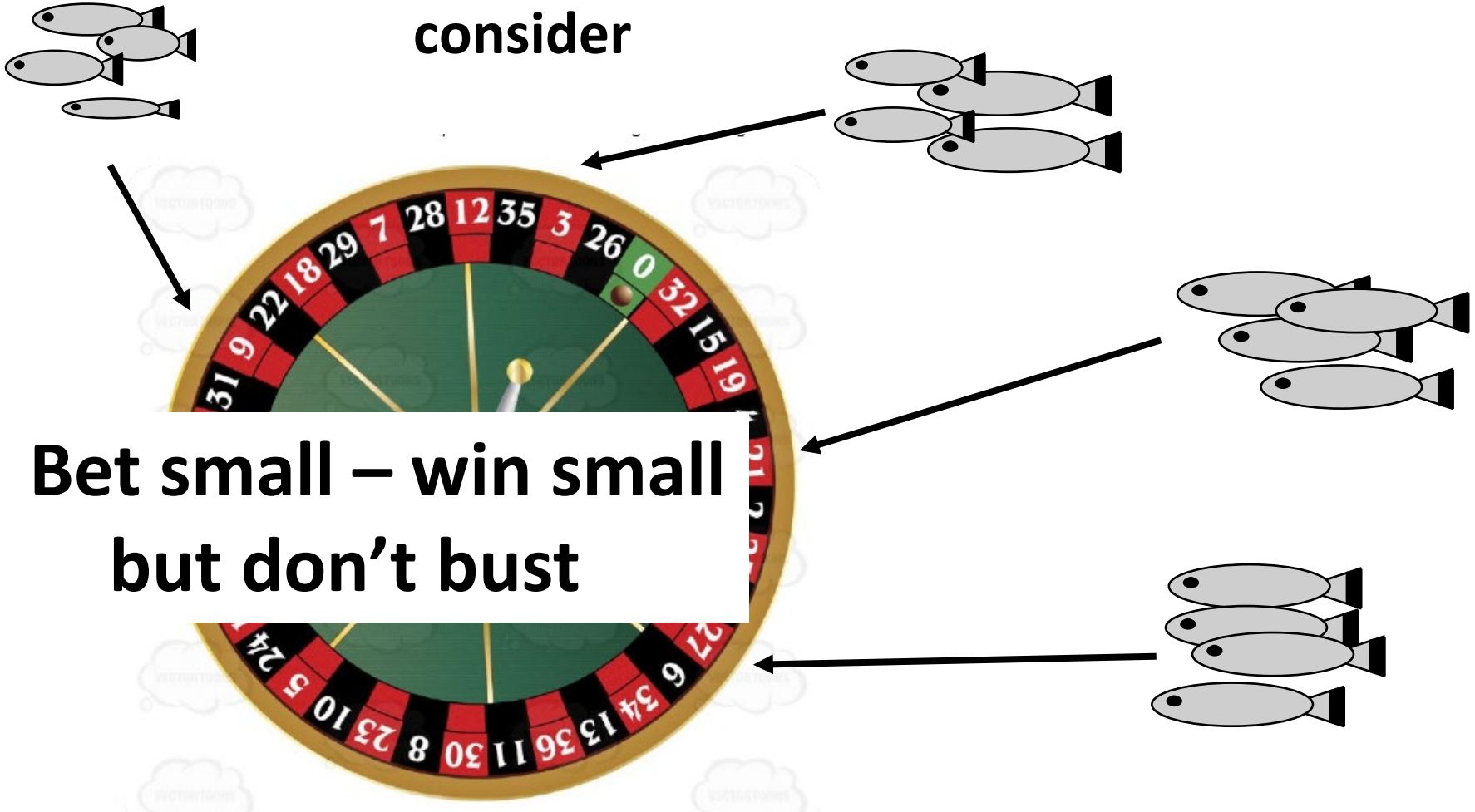
March is higher - 21

1978 – 2018, Willamette, Marion Forks, South Santiam, McKenzie
Spring Chinook salmon CWTs
lumped and averaged

November returns are never “great”

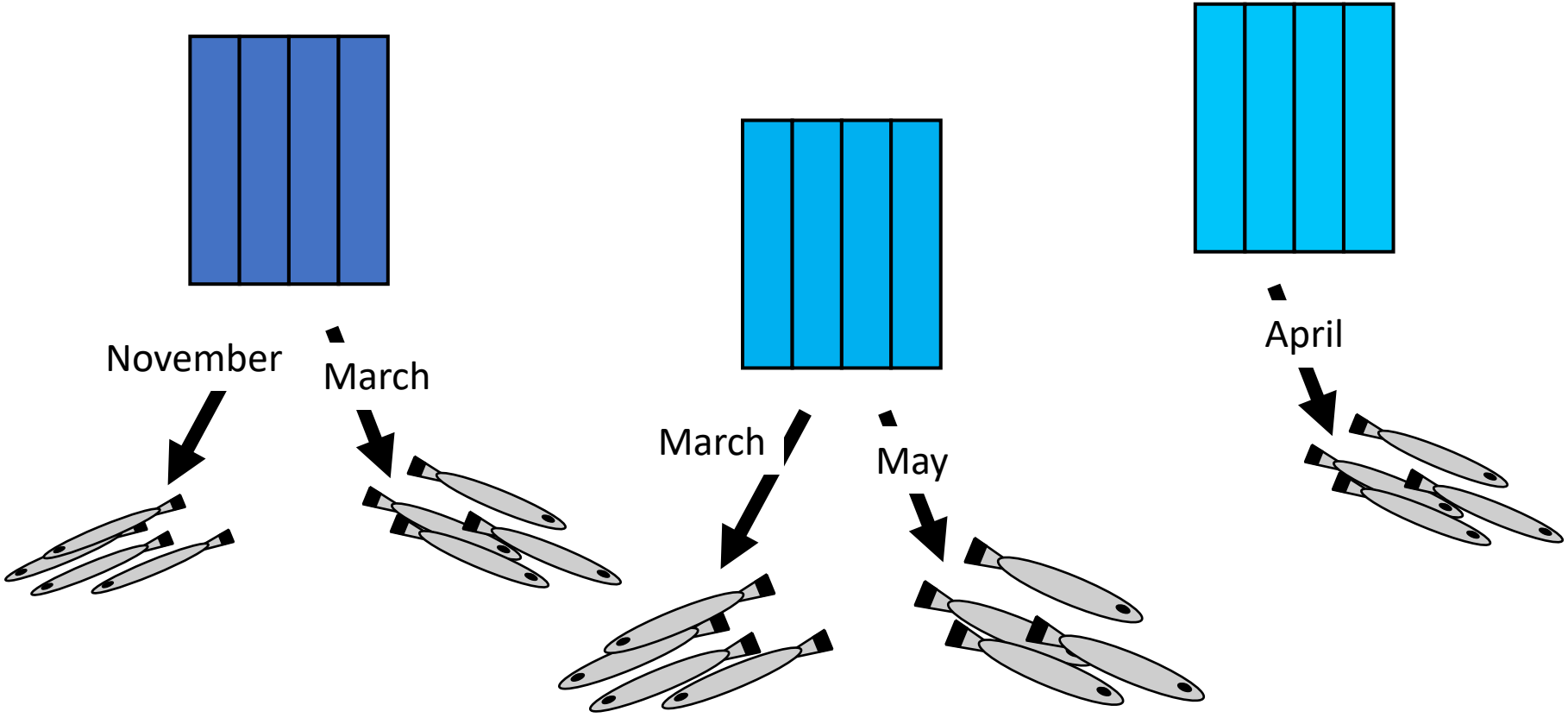


This is not a solution – it's an approach to consider



There are different ways to generate diversity, within a program or within a sub-basin between programs

=> No reason any one program needs to generate all diversity



There are opportunities to examine effects of current variation in release timing

Chinook programs with variable release timing (my knowledge):

- **Cowlitz, Lewis, Kalama spring Chinook salmon**
- **Upper Columbia summer Chinook salmon**
- **Snake River fall Chinook salmon**
- **Klamath River spring Chinook salmon**

There are other axes of diversity to explore

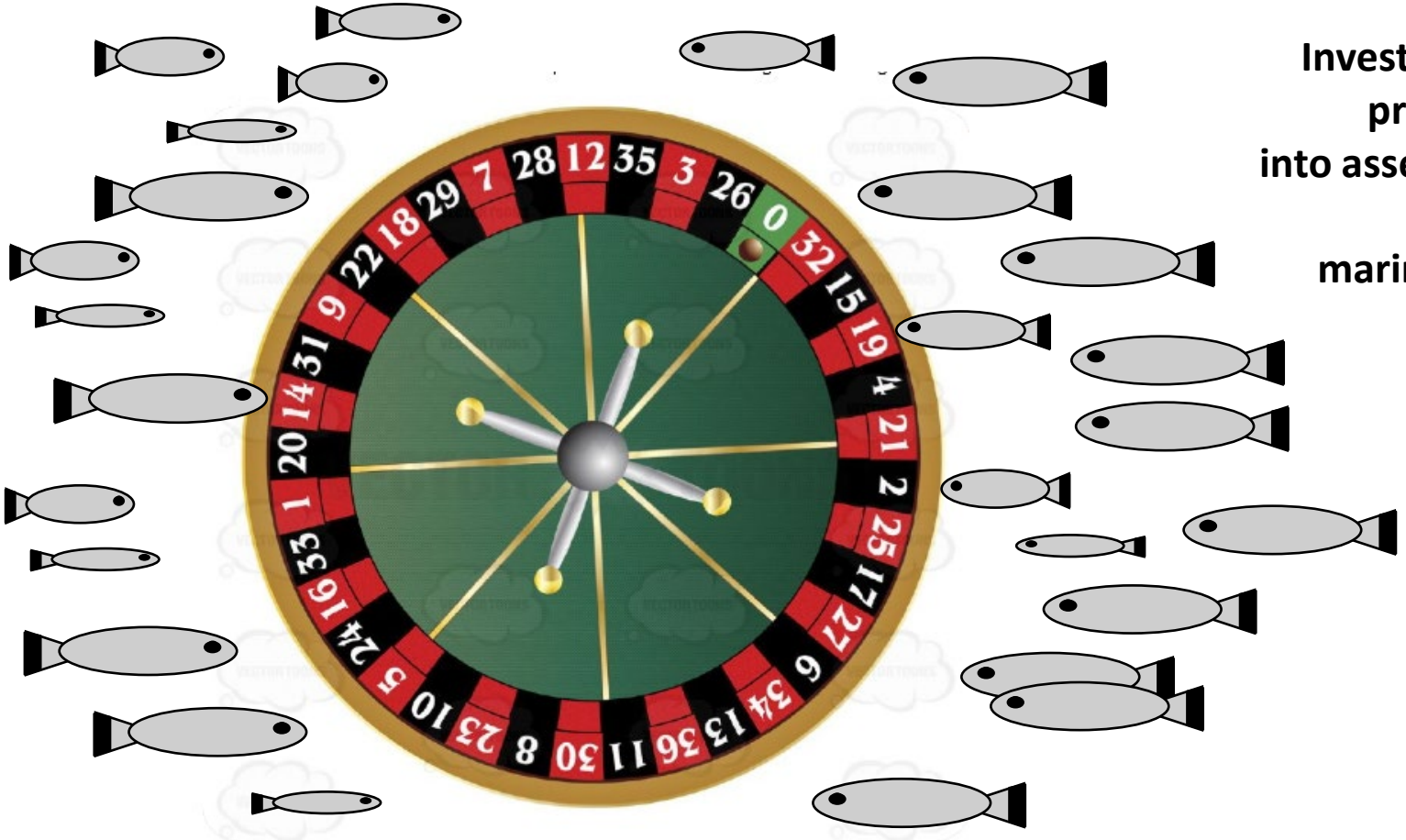
Size

Age (steelhead)

???

How do we make short-term management decisions, within varying and unpredictable marine conditions, while considering a long-term trend?

Do we need to be running a “continual experiment” to assess a variable and changing ocean?



Invest a portion of production into assessing diversity and marine survival?