

Science, Service, Stewardship



The impacts of access rules and synchrony in productivity in multi-fishery systems

Dan Holland – Northwest Fisheries Science Center

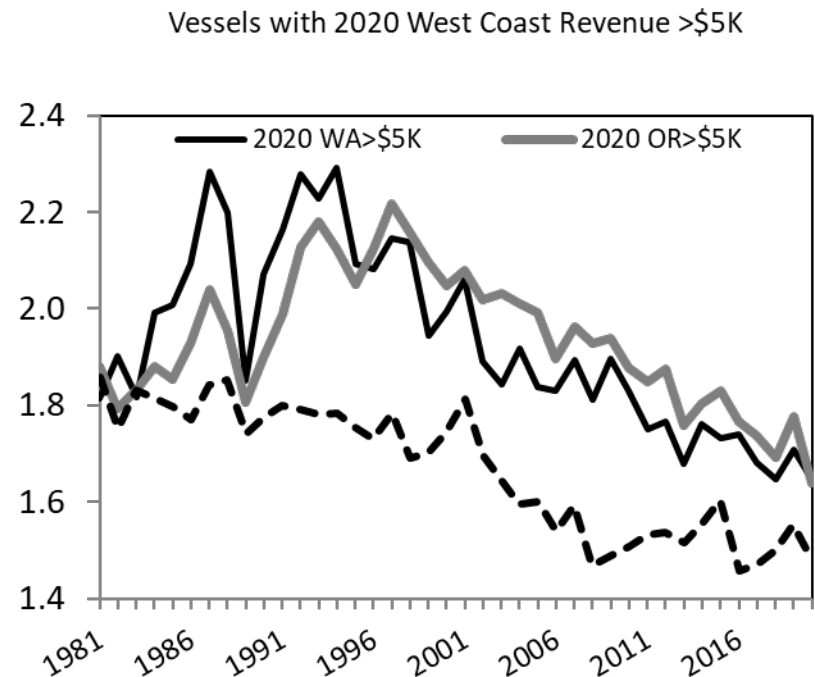
Kiva Oken – Northwest Fisheries Science Center

Andre Punt – University of Washington, SAFS

**NOAA
FISHERIES
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- Diversification of fishery revenue can reduce interannual variation in revenue and thereby lower financial risk (e.g., Kasperski and Holland, 2013; Cline, Schindler, and Hilborn, 2017; Sethi, Reimer and Knapp 2014; Anderson, Ward and Shelton 2017)
- Average fishery diversification levels on the US West Coast have been declining over time – due in part to implementation of limited access programs in many fisheries
- Diversification is costly (buying gear and permits) and can complicate fishery management - so understanding impacts of access rights and diversification strategies is important



Source: 2022 California Current Integrated Ecosystem Assessment

Approach & Key Findings

- We use a bioeconomic model of a three fishery system to explore the how synchrony in productivity and flexibility in access (allowing more diversification) impact profitability and financial risk for fishers with different diversification strategies
- We find:
 - Regulators face trade-offs in restricting fishery access between ensuring profitability of fisheries and reducing risk and income inequality for individual fishers
 - Individual fishers can reduce revenue variability by combining fisheries with asynchronous productivity but also with longer-lived species with life histories that reduce variability

Stylized model of key West Coast fisheries based on...



Dungeness Crab

- random recruitment
- season Dec-Aug & annual depletion of 70-90% of adult males in 6-8 weeks
- highest value fishery on West Coast



Salmon

- random recruitment/returns
- harvest is hatchery driven
- season May-Oct (limited to project wild stocks)



Groundfish

- delay-difference population dynamics with stock-recruit relationship
- fishery modeled on sablefish
- year-round fishery

Fleet Structure

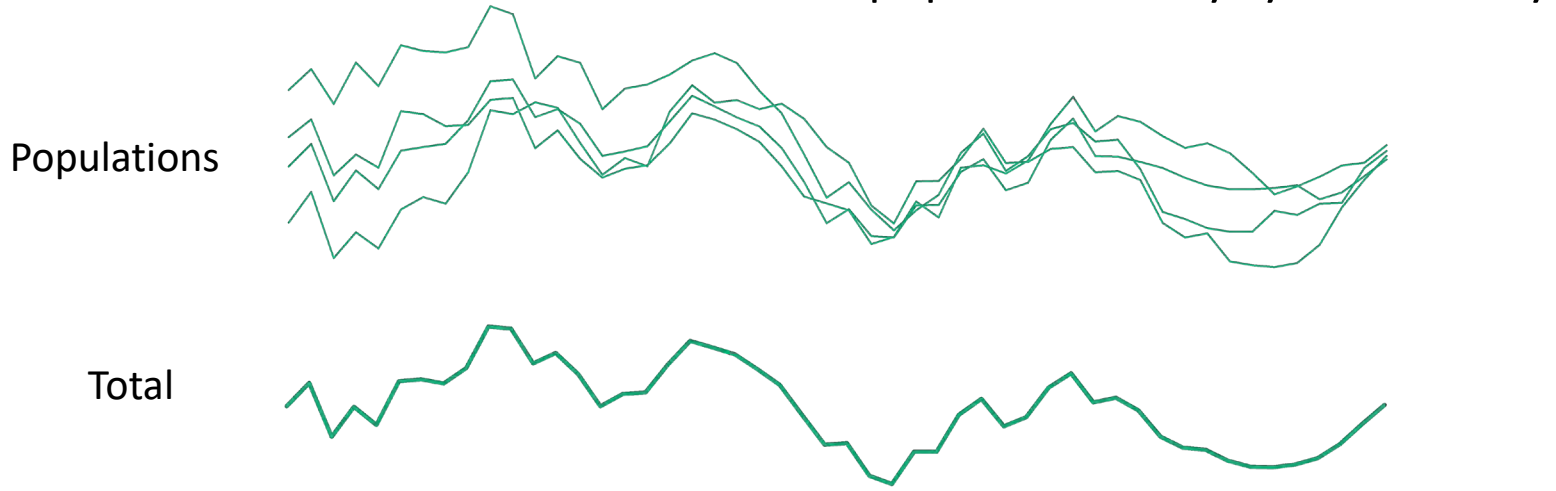
- Six Fleets
 - 3 Specialists fleets (Crab, Salmon, Groundfish)
 - 3 Diversified fleets (Crab-Salmon, Crab-Groundfish, Crab-salmon-groundfish)
 - Heterogeneous costs by vessel (so fleet movement between fisheries is gradual and marginal vessels make zero profit on average)
- Regulator determines number of permits and season length but vessels choose fisheries (or not fishing) weekly based on access right and which fishery is more profitable

Treatments

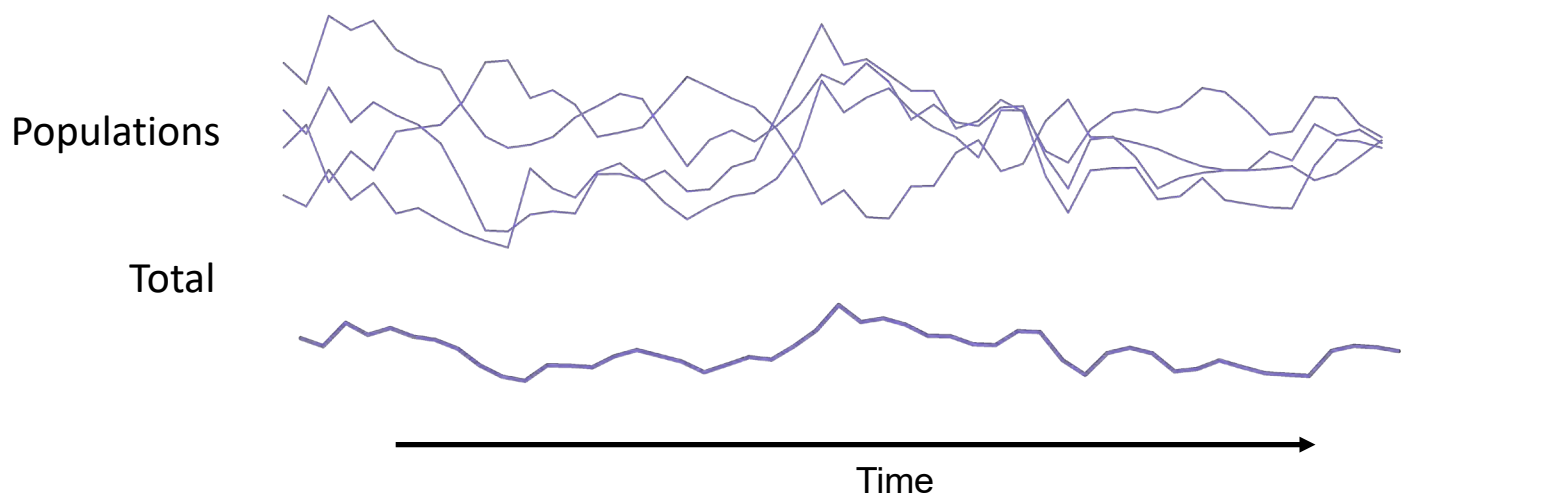
- Varied productivity dynamics by adjusting the correlation in recruitment among the three populations (synchrony, asynchrony, independent).
- varied the number of vessels holding permits for a single fishery vs. multiple fisheries while keeping the total number of vessels constant.
- Simulated fisheries for 50 year and ran 10,000 50-yr simulations for each scenario

Synchrony in Productivity of Fisheries Impacts Risk Reduction

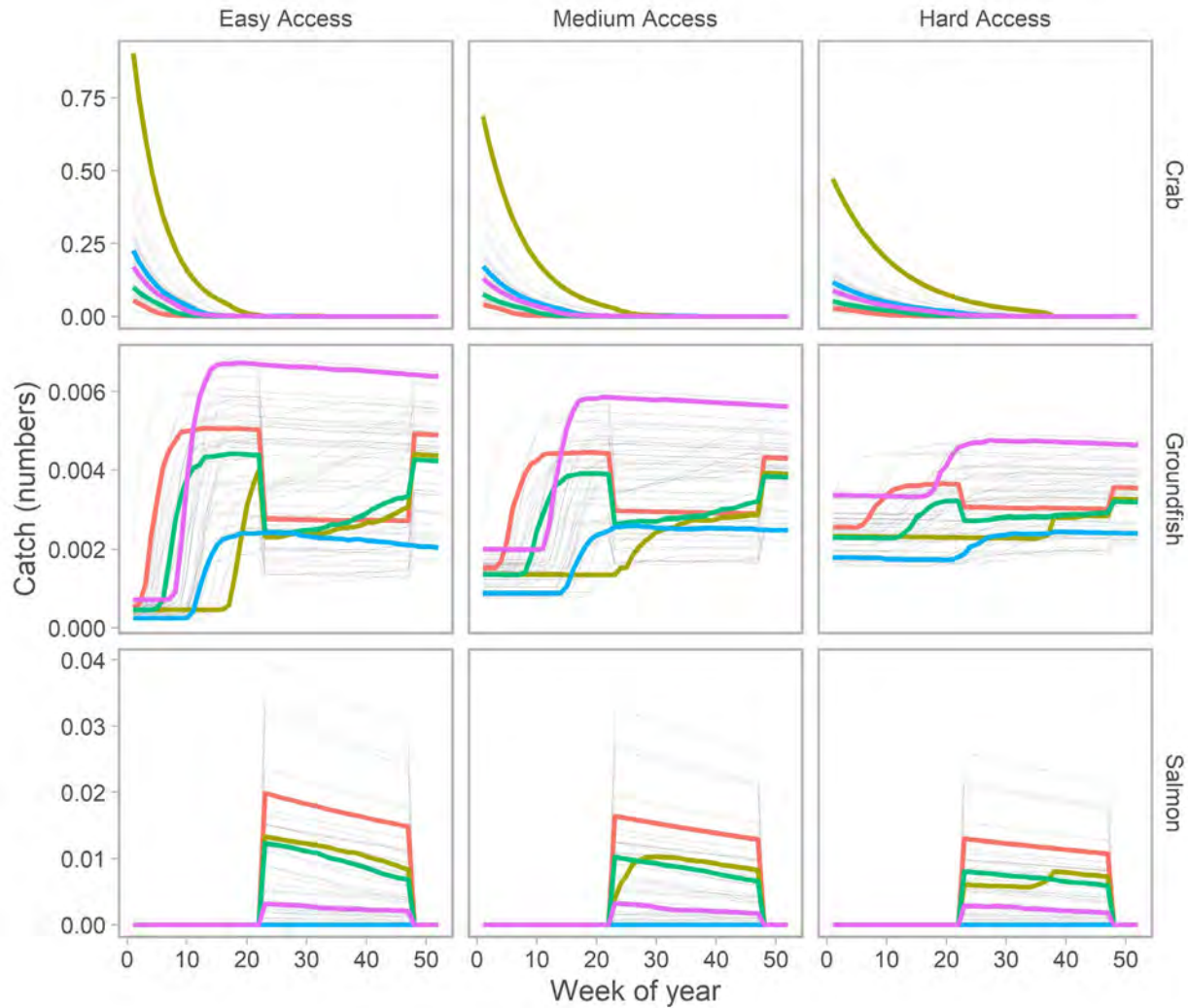
Portfolio effects are weaker when populations vary synchronously



Portfolio effects are stronger when populations vary asynchronously

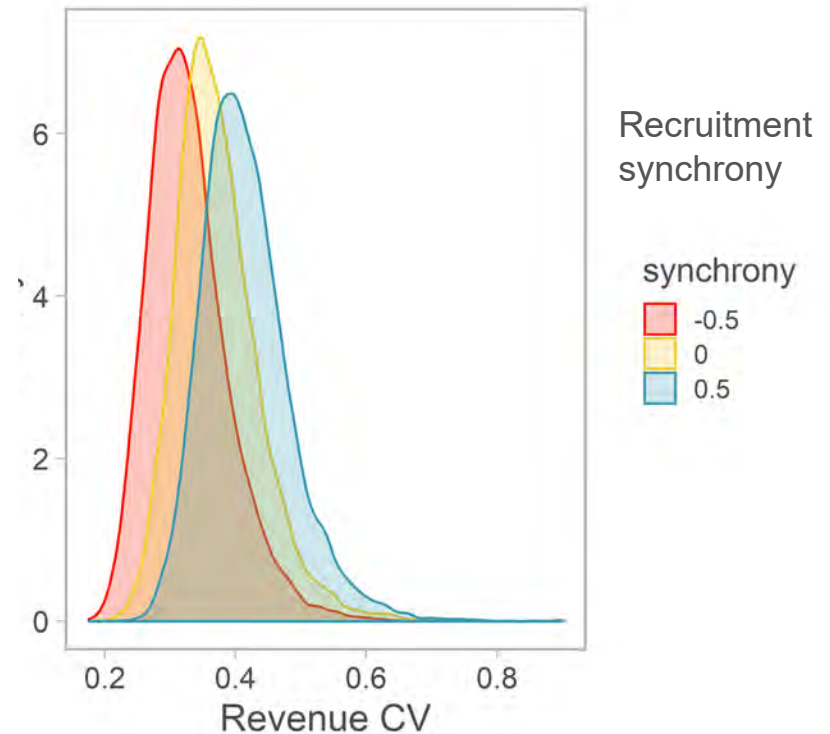
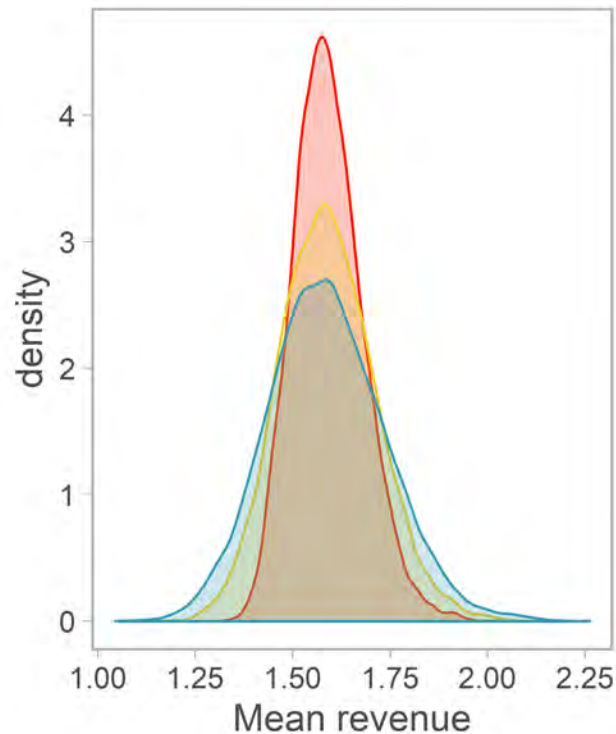


Catch streams through year vary due to recruitment and access limits

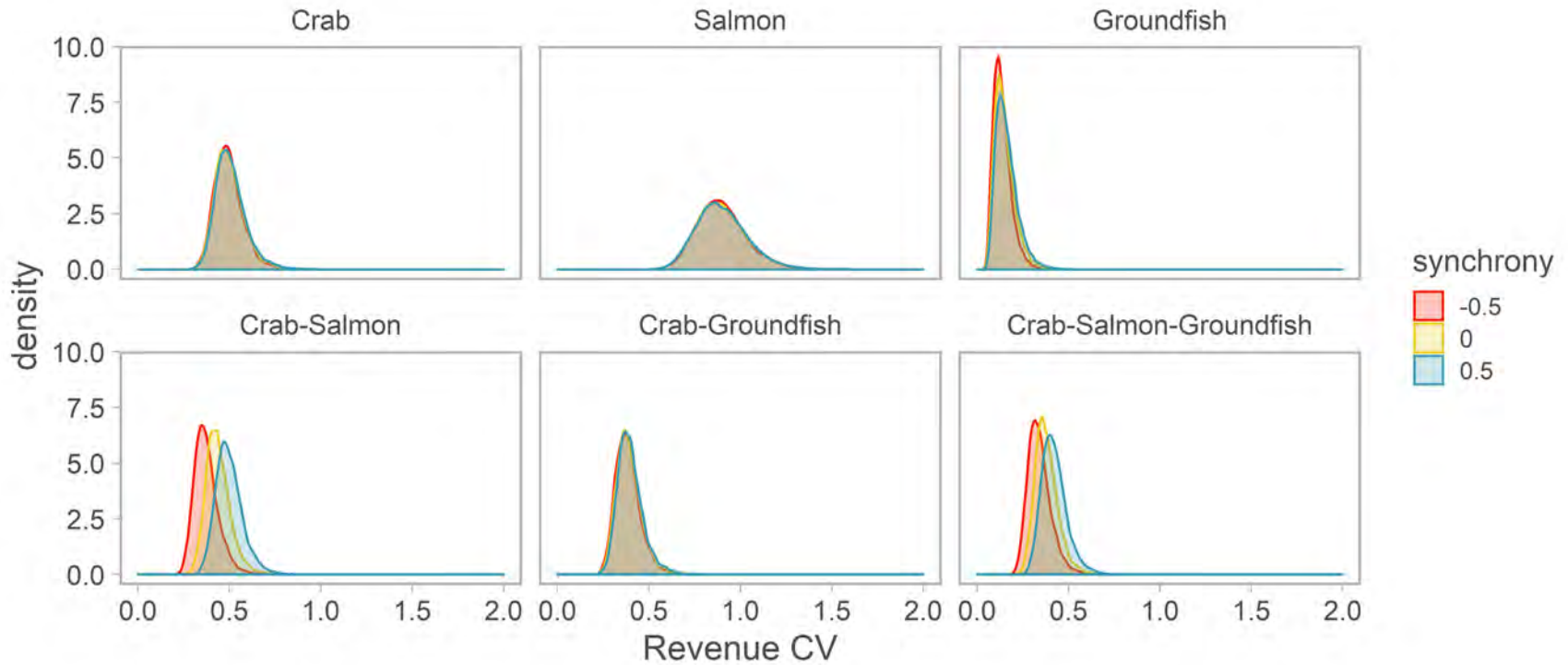


How does recruitment synchrony
influence revenue patterns?

- Average revenue stays about the same as synchrony increases.
- Synchrony increases variability across simulations.
- Synchrony increases variability across years within a simulation.

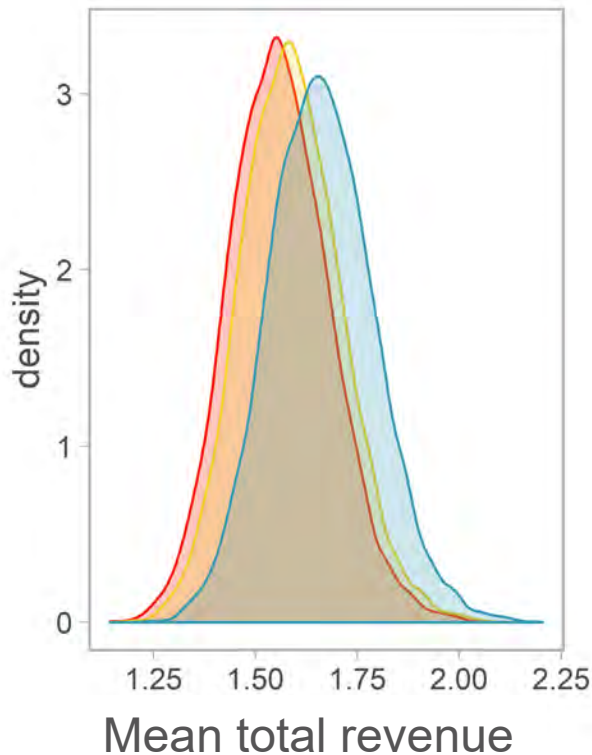


- Specialists see no change in variability
- Neither does crab-groundfish fleet because recruitment does not drive groundfish revenue
- Permit portfolios with crab & salmon responsible for change in variability



How does fishery access influence
revenue patterns?

More (easy) access means less total revenue for the fishery system

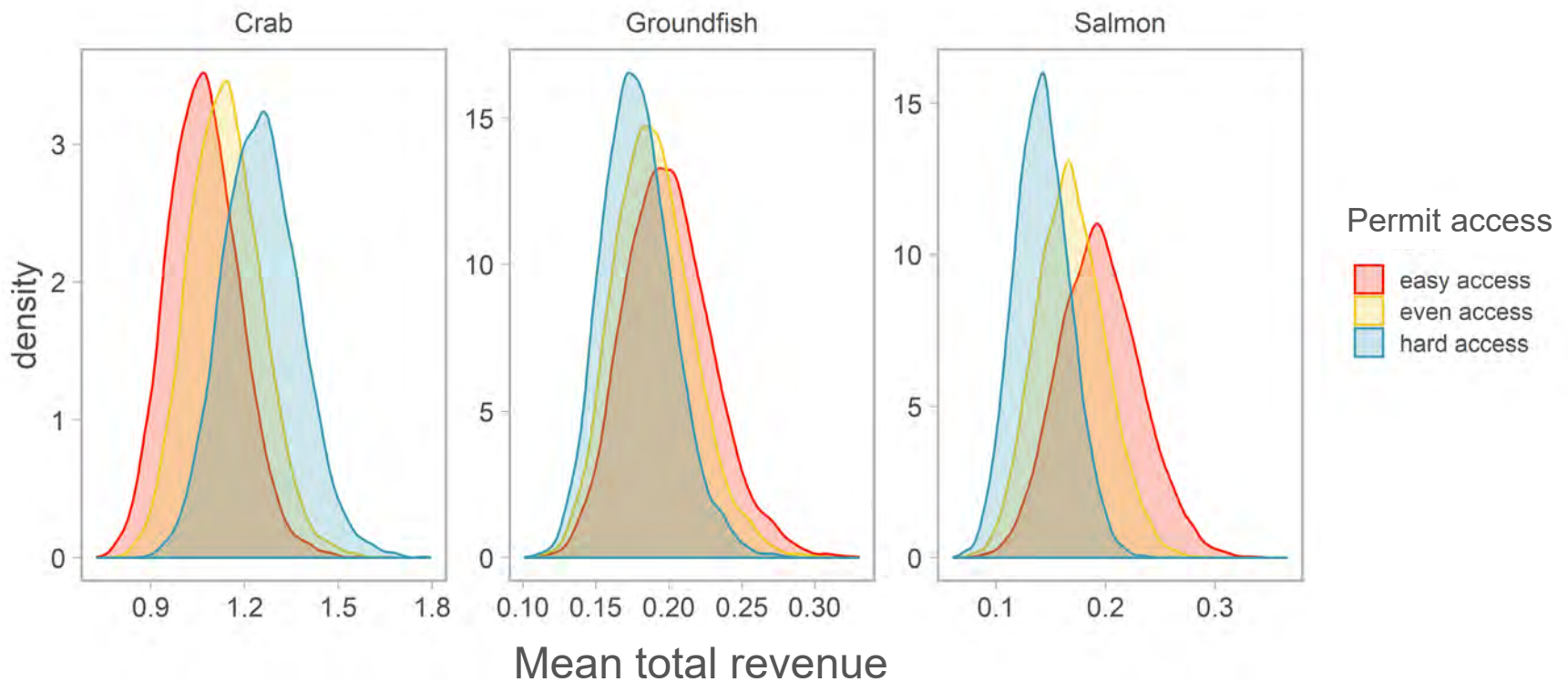


Permit access

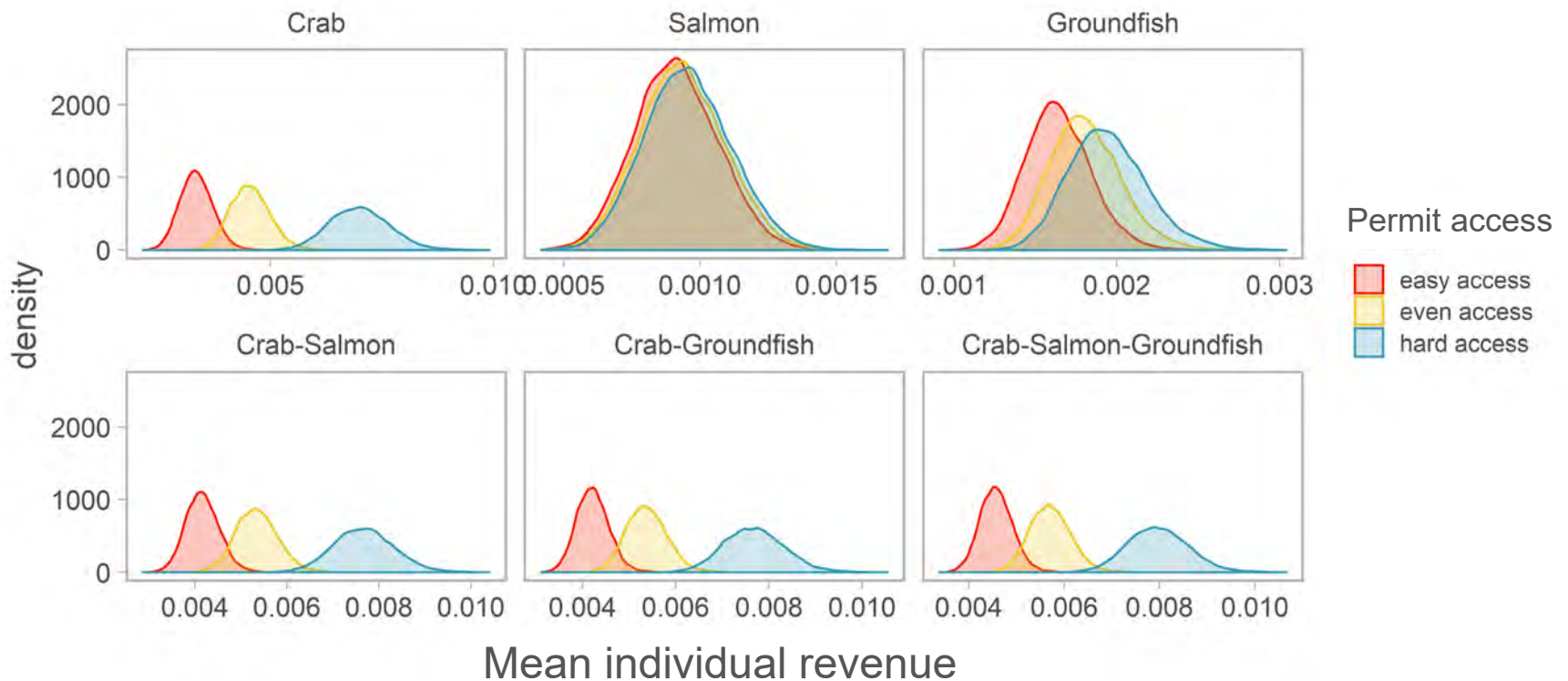
- easy access
- even access
- hard access



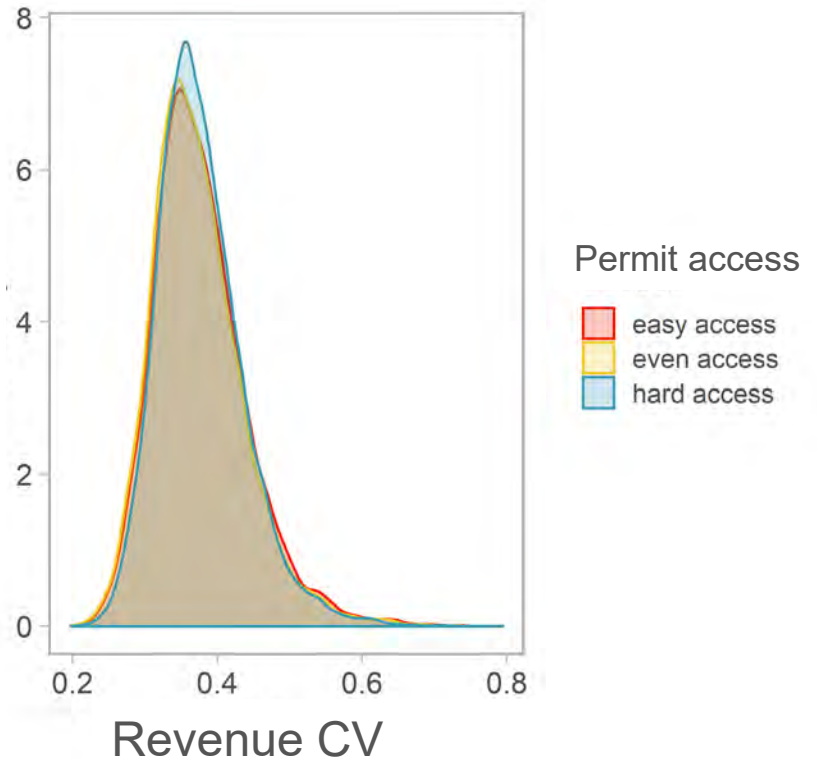
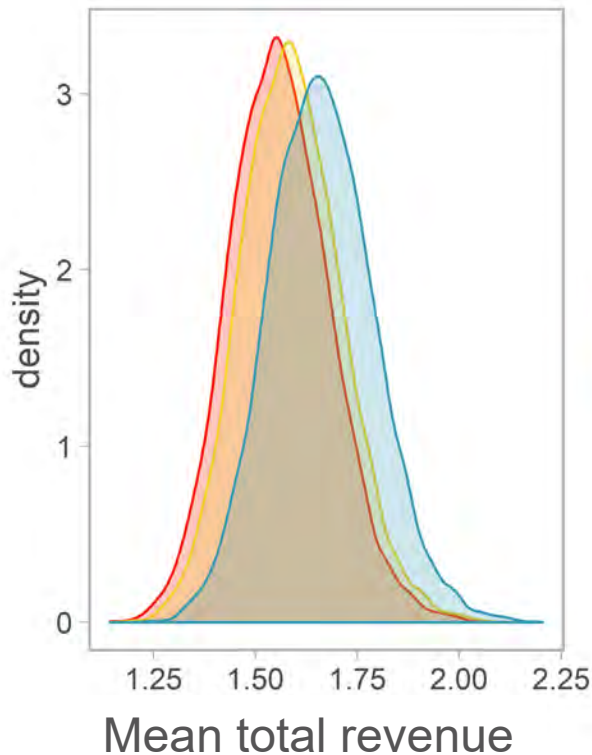
Aggregation masks different trends among stocks



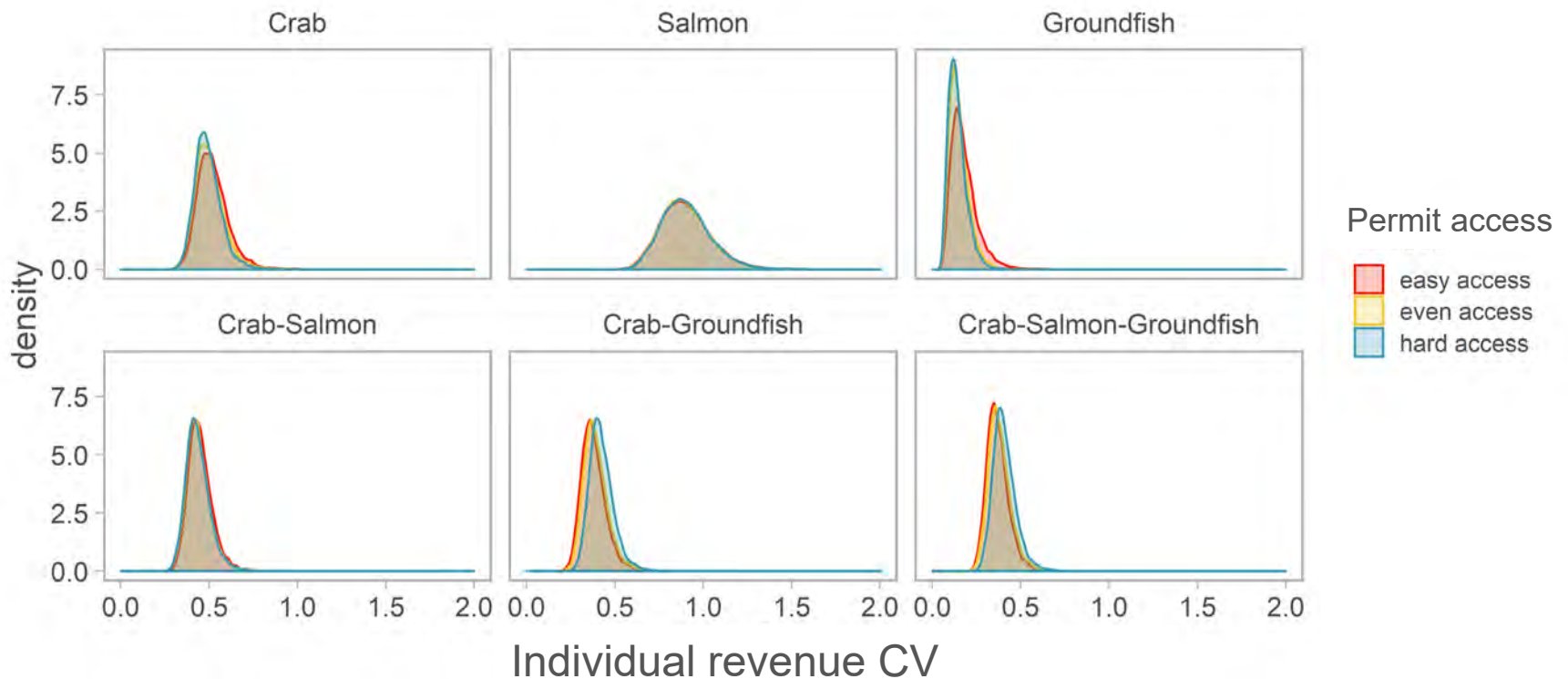
Individuals with different permit portfolios experience different trends than the aggregated fisheries



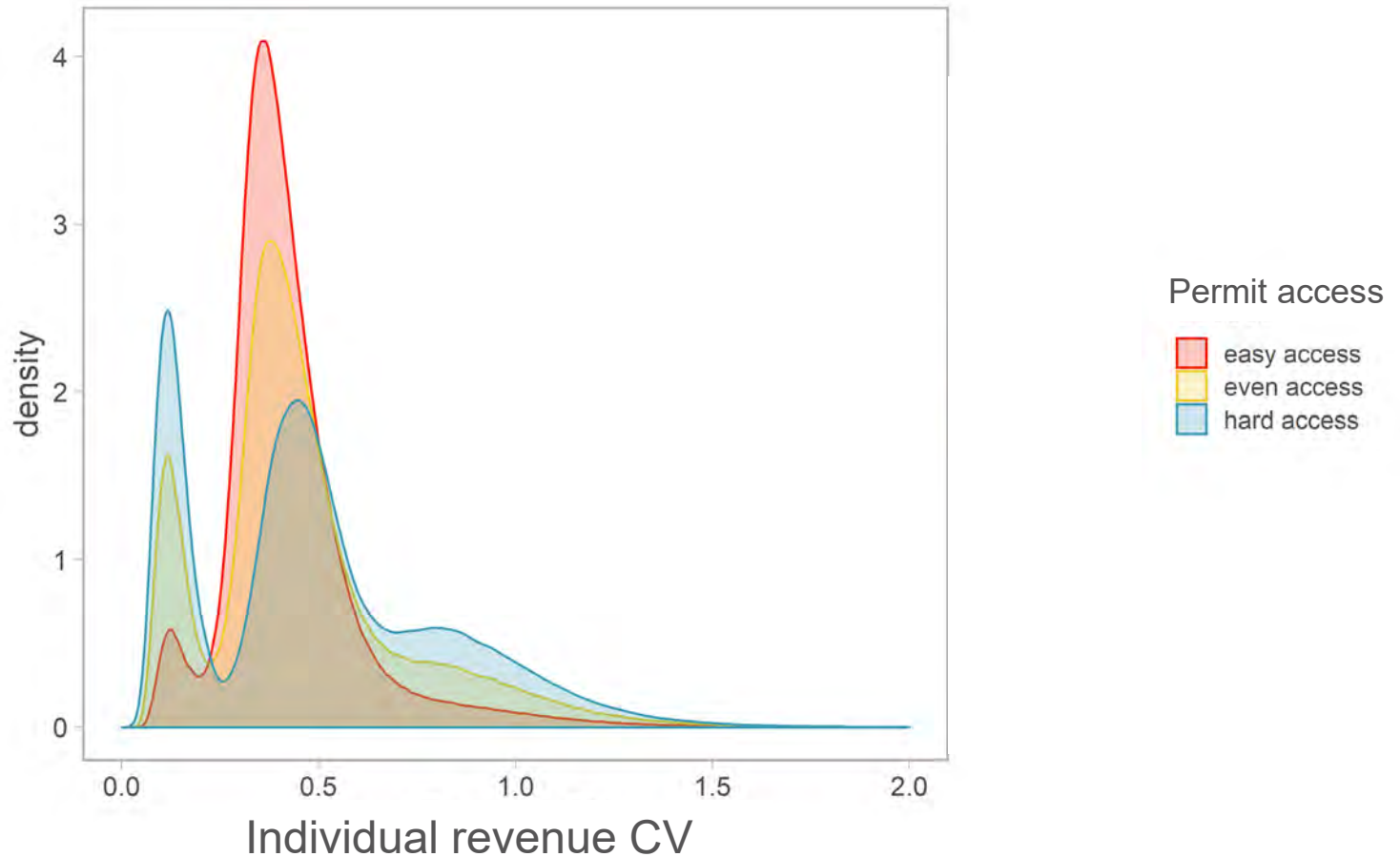
Access does not influence variability of total revenue much



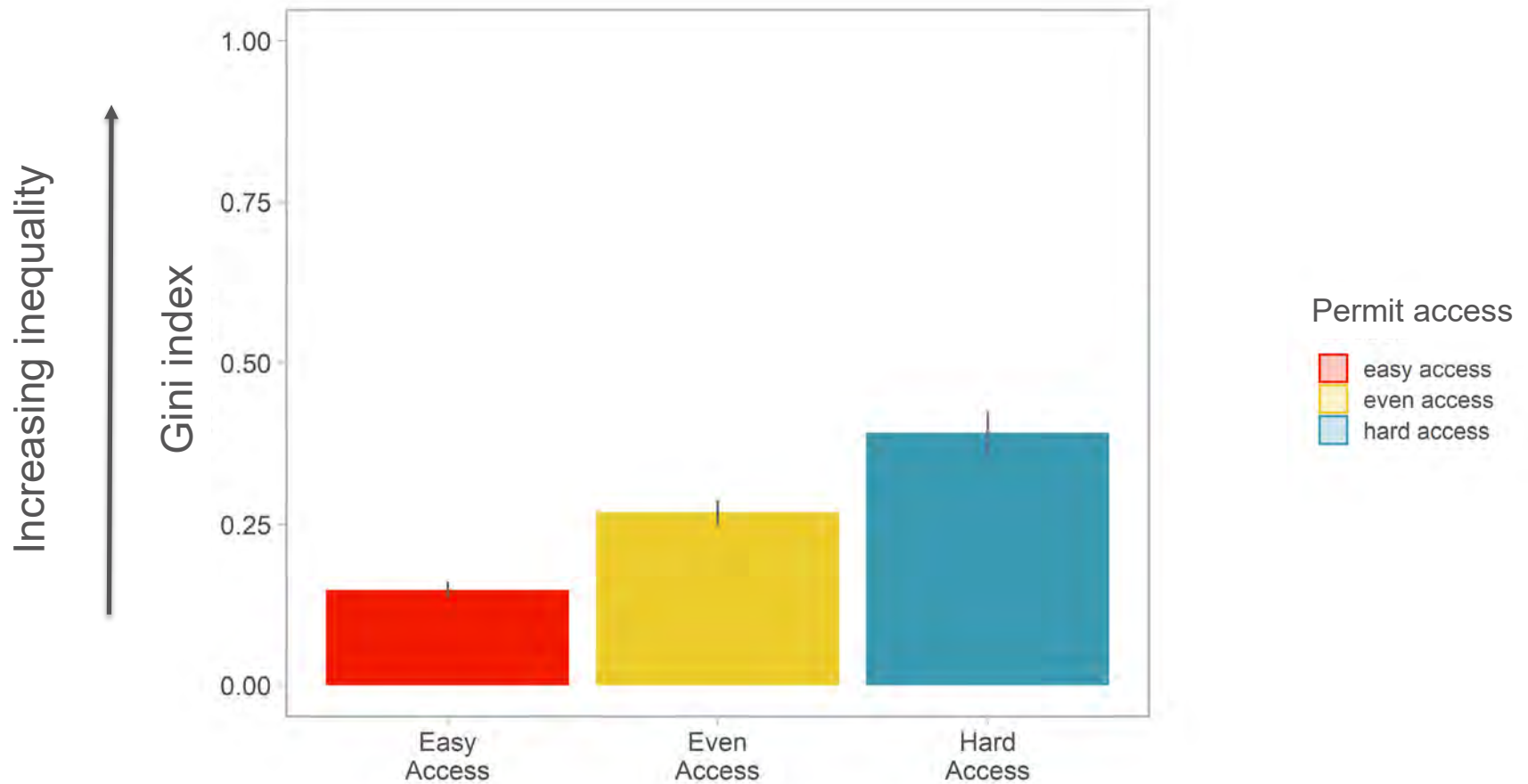
Individual revenue shows minimal change in variability within a diversification strategy



But - easy access decreases individual variability across all permit portfolios because more fishers are in diversified portfolios



Easy access reduces inequality / Stricter access increases inequality



So what's a manager to do?

- Embrace the tradeoff between higher revenue vs. lower individual variability and reduced inequality
- **Synchronous productivity**: fishermen can rely on the long-lived populations for stability. Provide access, keep abundance steady.
- **Asynchronous productivity**: policies that permit portfolio diversification among any life history type can benefit revenue stability.