How to measure economic impacts with multiple interacting policies?

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Collaboration

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Motivation

How do changes in fishery policy (catch limits, bycatch caps) impact the fishery?

Motivation

Challenges:

- Fisheries are often constrained by multiple policies simultaneously.
- Individual vessels may be impacted differently.

Goals

Provide a tool to measure the impact of policy changes

Account for interactions between policies

Measure vessel-specific impacts

Hawaii's longline fishery

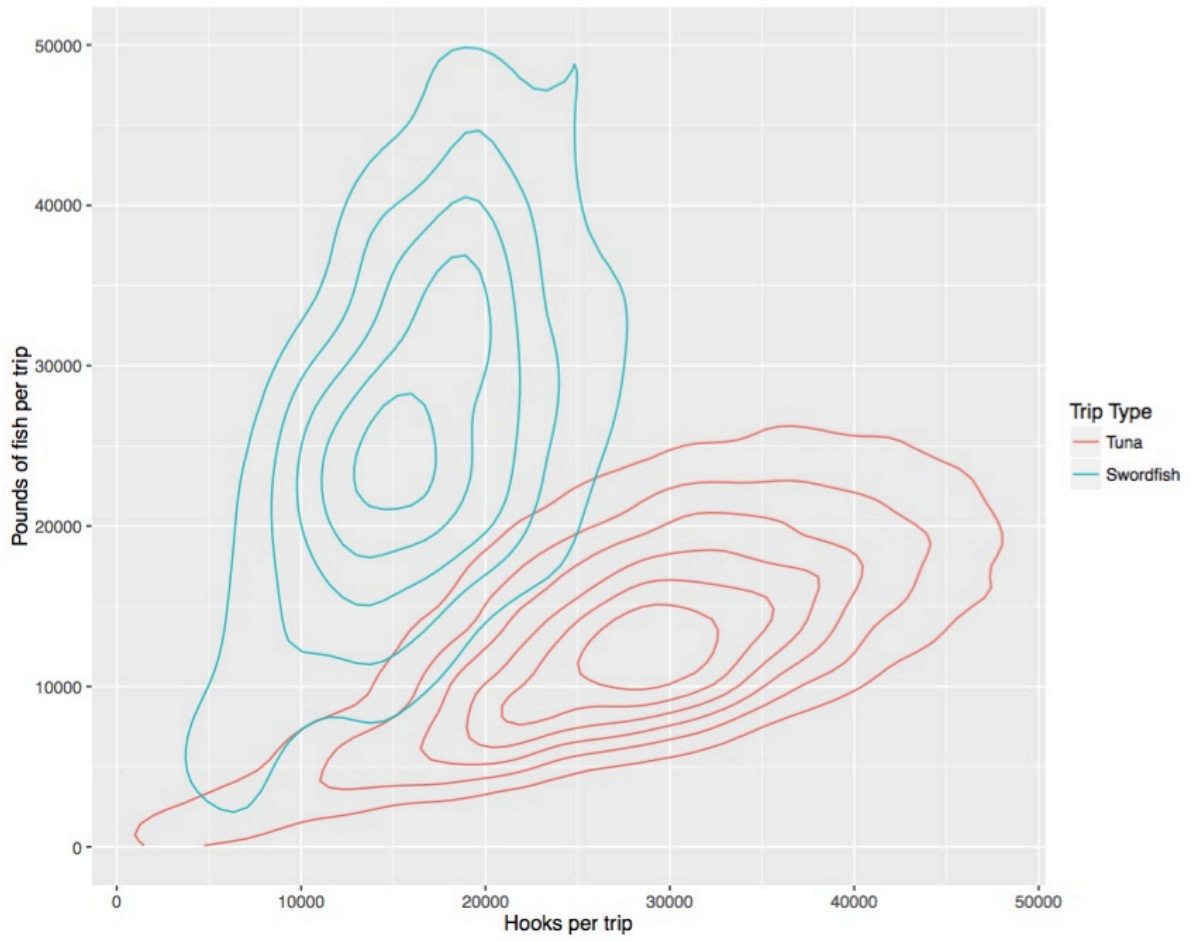
In 2012:

- 128 vessels
- Total ex-vessel revenue of $106 million

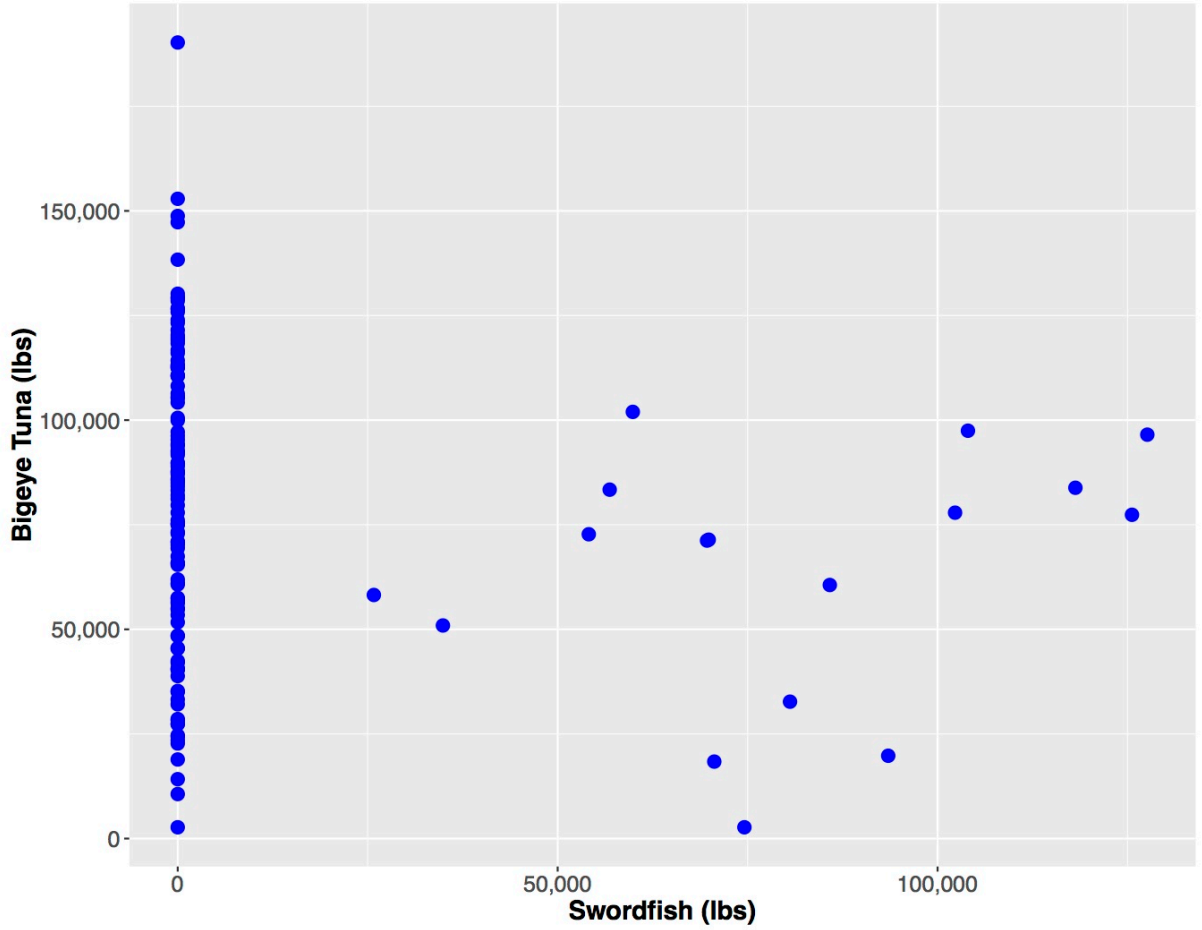
Targets: Bigeye tuna, Swordfish (Yellowfin tuna, Mahi mahi, Ono, +)

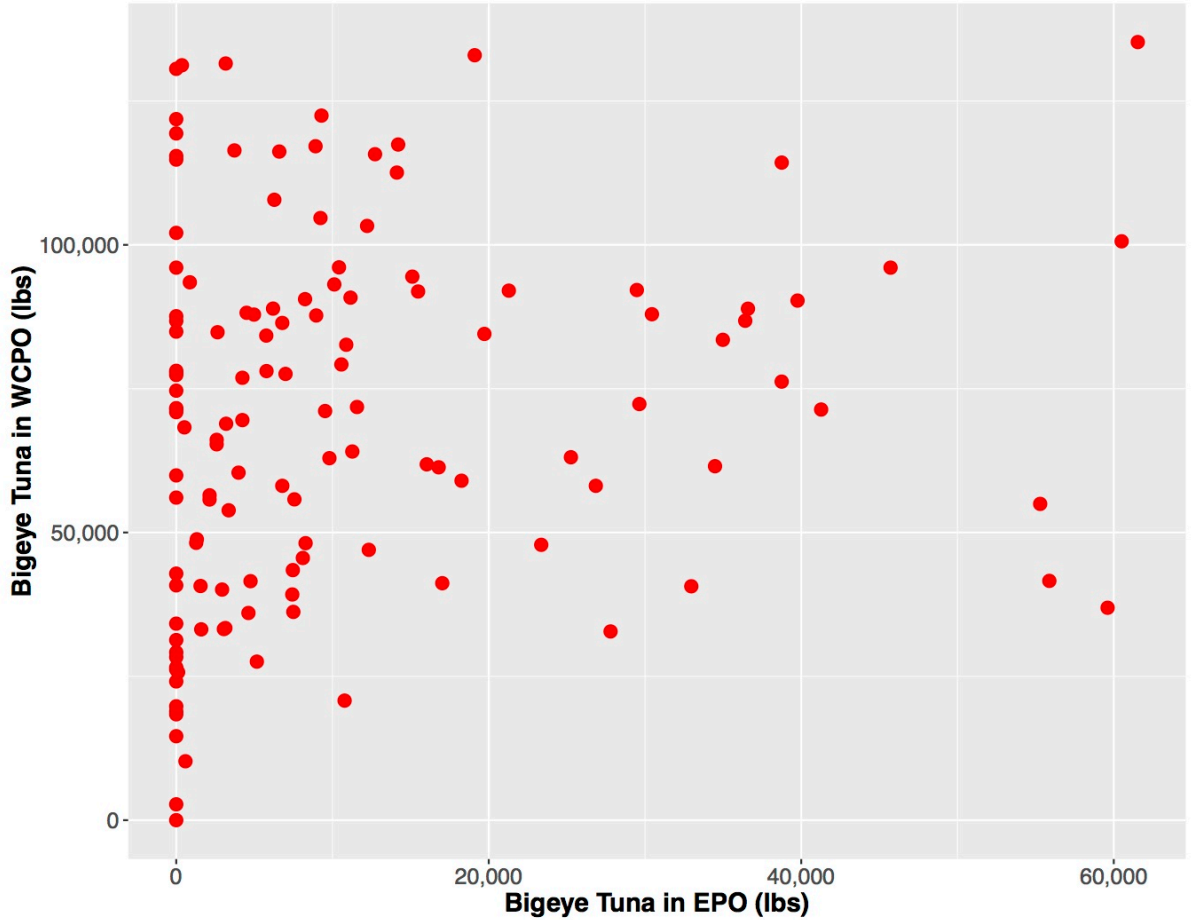
Operates in both Eastern (EPO) and Western Central Pacific Oceans (WCPO)

Hawaii's longline fishery



Hawaii's longline fishery





Hawaii's longline fishery

Policy constraints:

- Annual bigeye catch limit in WCPO (3763 mt)
- Annual bigeye catch limit in EPO (500 mt for vessels over 24 meters)
- Turtle bycatch cap for swordfish (26 leatherback, 34 loggerhead)

Modeling approach

Positive mathematical programming (PMP)

- Used extensively in agriculture economic policy analysis (SWAP, Howitt et al. 2010)
- Combines programming constraints with “positive” observations

Model

For a given vessel using a given technology,

$$\pi = (p + \mu_j)\alpha\left(\sum_j \beta_j (x_j)^{\rho}\right)^{\frac{\delta}{\rho}} - \sum_j c_j x_j$$

$$j = [fuel, captain\ pay, crew\ pay, bait, other, hooks]$$

Fishery model

$$\max_{x_{i,j,r}} \sum_i \pi_{WCPO}\left(x_{i,j,WCPO}\right)+\pi_{SF}\left(x_{i,j,sf}\right) + \pi_{EPO}\left(x_{i,j,EPO}\right)$$

$$s.t.$$

$$\sum_i cth_{EPO,i} \leq ACL_{EPO}$$

$$\sum_i cth_{WCPO,i} \leq ACL_{WCPO}$$

$$\sum_i turt_{SF,i} \leq Cap$$

Data

2012 Cost and Earnings Survey of Hawaii's longline fleet

2012 Observer data of turtle bycatch

Impute missing data for complete vessel sample

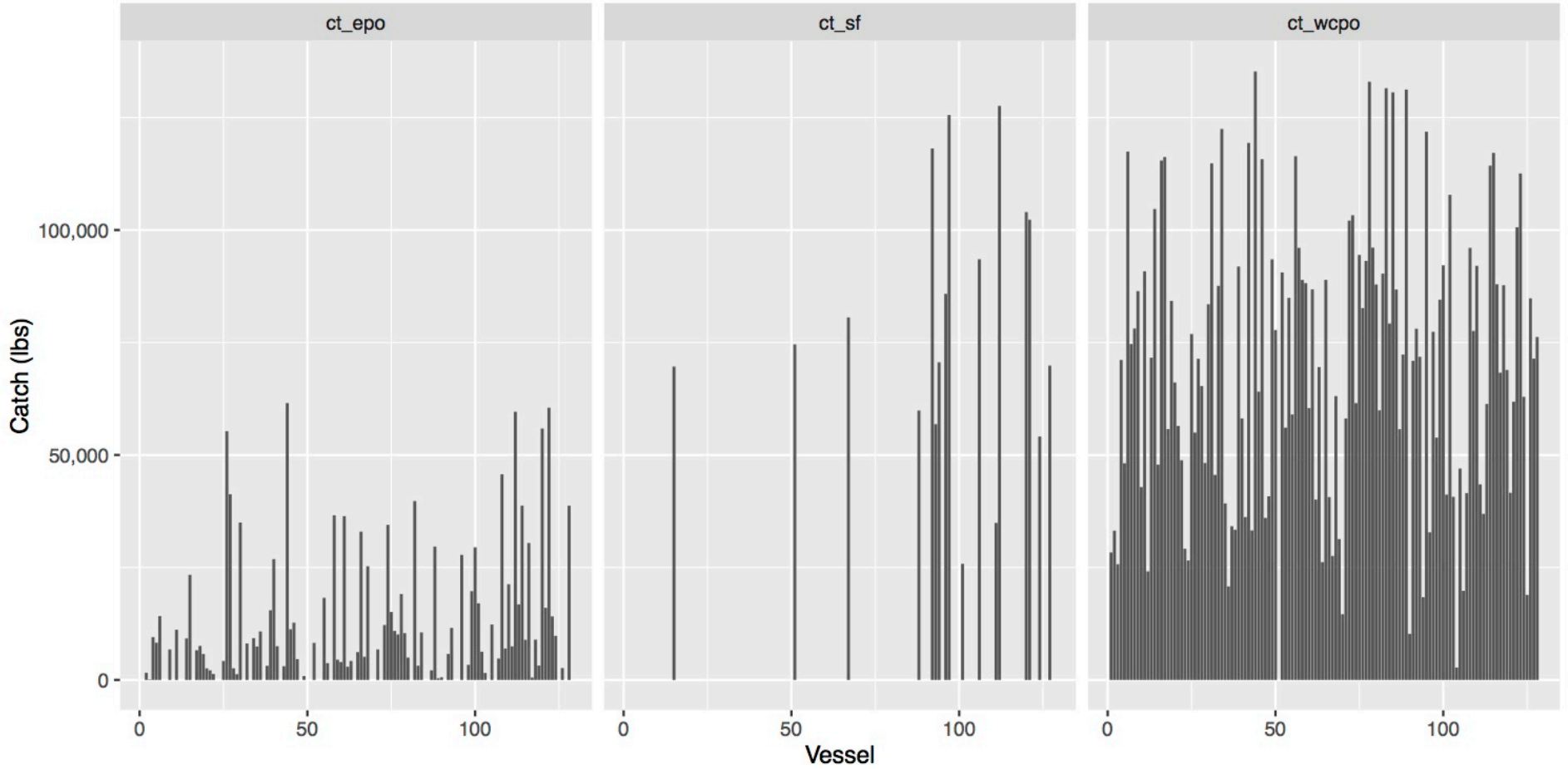
Simulations

1) Base year verification

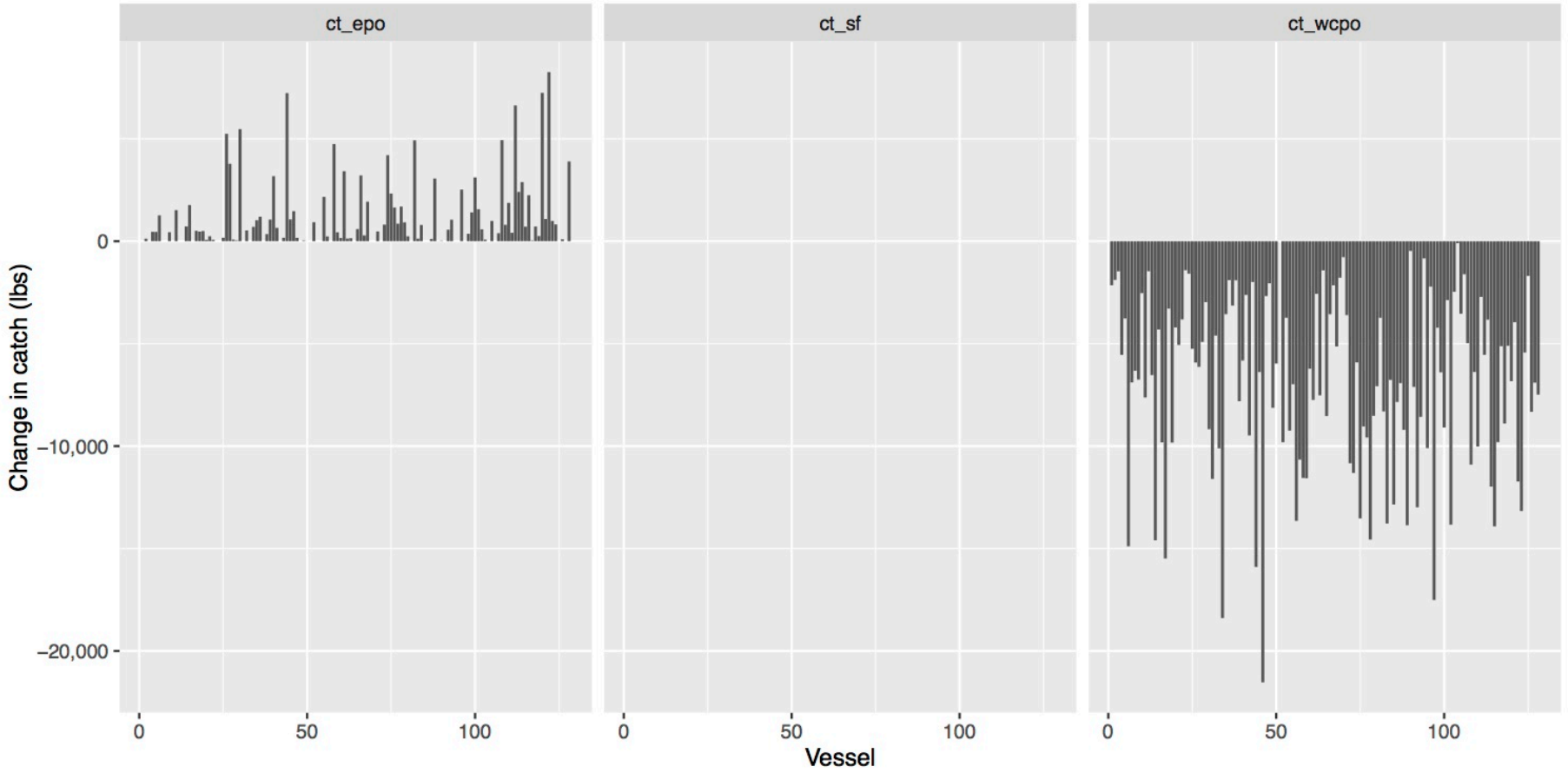
2) Decrease ACL_{WCPO} by 10%, relaxing ACL_{EPO}

3) Decrease ACL_{WCPO} by 10%, relaxing ACL_{EPO} , plus decrease turtle cap to 10

Base year verification



Decrease ACL_{WCPO} by 10%, relaxing ACL_{EPO}



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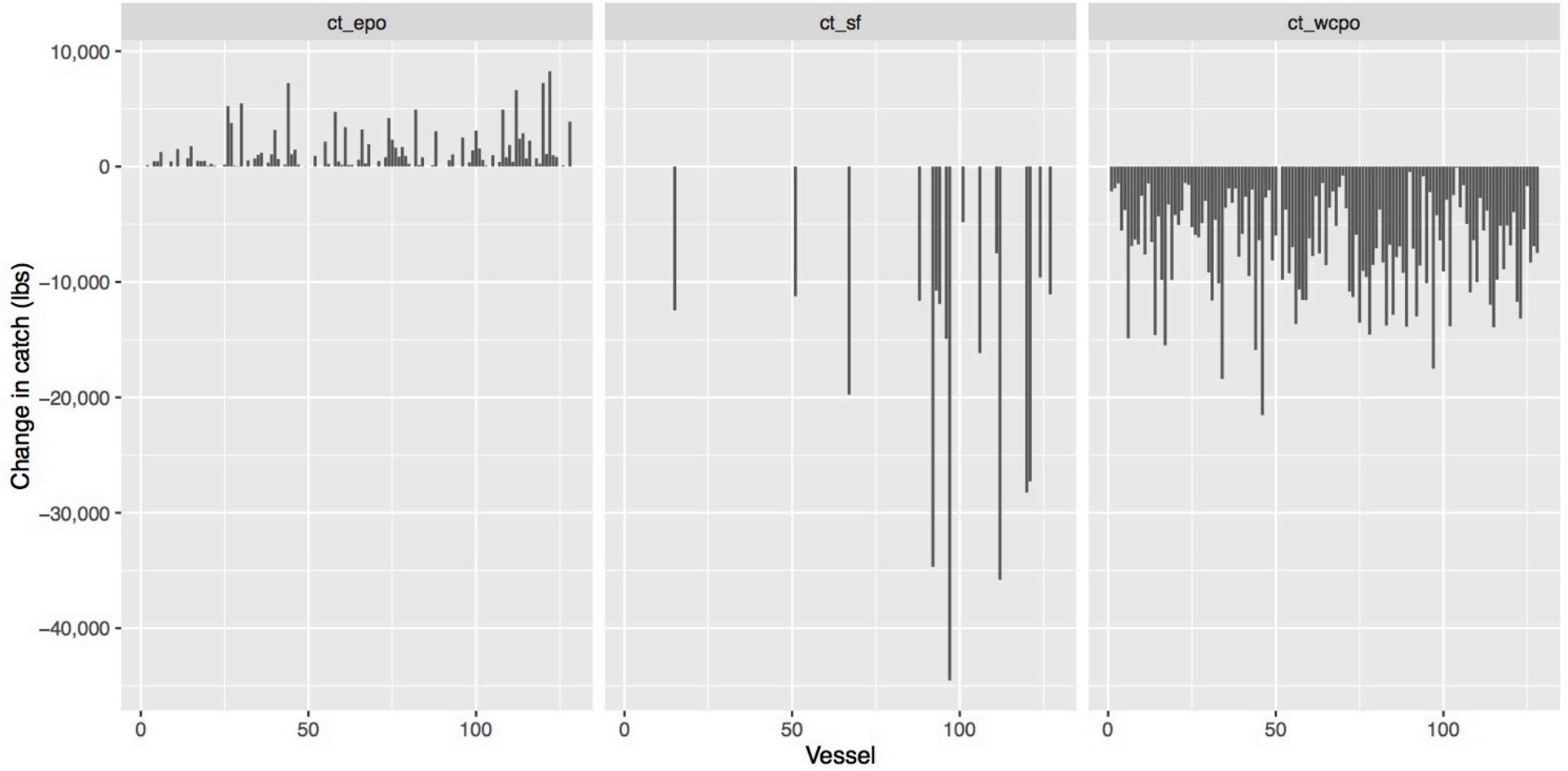

Conclusions

Individual vessels will be impacted differently.

Cumulative impacts will depend on vessel-specific switching behavior.

The impact of a new policy depends on flexibility in other constraints.

Limitations

We don’t explicitly model switching (static model)

There may be more capacity to switch than observed

Thank you.