Predicting the effects of angler regulations off Washington and Oregon using discrete choice surveys and stock assessments

Josh Nowlis[1], Leif Anderson[2],

And Owen Hamel[2]

[1] ECS Federal; [2] Northwest Fisheries Science Center

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What role does economics play in fisheries?

- Cost-benefit analysis and optimal policy design

  but mostly

- Understanding incentives and predicting behavior
  - Even cost-benefit analysis is based on assumed future behavior

The big picture challenge

- Population biological objectives dominate in most modern management systems
- There is an imperfect mapping from potential regulations to population biology

$$\begin{matrix} Individual\ quotas \\ Trip\ limits \\ Gear\ restrictions \\ Bag\ limit \\ Size\ limit \\ Seasonal\ closures \\ Area\ closures \end{matrix} \longrightarrow \begin{matrix} Annual\ catch \\ limit\ based \\ on\ OY, MSY \end{matrix}$$

The role of models

- Commercial fisheries

Individual quotas	Models to address underutilization: Catch ≤ sum(IQs) = TAC → Catch ≤ TAC
Monthly trip limits	Models to estimate monthly allocations
Gear restrictions	Models to estimate effects on F and selectivity

- Recreational fisheries

Bag limit	Models can predict how these regulations translate into F. Models are more likely to be critical because: • Challenge in predicting participation: open access recreational vs. limited entry commercial • Lack of within-year monitoring; typically 2 yr lag
Size limit	
Closed season	
Closed area	

Principles for an effective angler effort model

- Predict changes in retained vs discarded catch
- Predict changes in number of trips taken
- Predict changes in type of trip taken

A bio-economic model of angler effort

- Inspired by Bio-economic Length Age Structured Tool (BLAST) by Scott Steinbeck and Min-Yang Lee
- As you will hear in the next talk, though imperfect, this model does an admirable job of estimating angler catches
- However, the Pacific Northwest recreational fishery has many more species (two salmon, many rockfish, lingcod, halibut…)
- BLAST coming soon to the Southeast
- If it works these places, it could work anywhere*

* with sufficient data

Economic sub-model

- Economic sub-model uses angler preferences and expected catches to estimate utility, then utility to predict effort and catch
  - Measure preferences, estimate utility weighting parameters
  - Estimate utility using parameters and expected catch composition on various fishing trips:
    - Bimonthly waves
    - Area (WA and OR ocean and estuarine)
    - BoatType (private or charter)
    - TripType (bottomfish or salmon)
  - Estimate effort and trip types based on expected utility

Choice experiment

- Surveys used to estimate preference coefficients for West Coast recreational fishing targets (Anderson and Lee 2013; Anderson, Lee, and Levin 2013)
- Fundamental trade-offs
  - Number of fish caught
  - Size of fish caught
  - Number of fish that can be kept
  - Cost

Choice experiment

- Built on data from a discrete choice experiment survey conducted in 2007 in Washington and Oregon
- Simplified discrete choice experiment question:

	Trip A	Trip B	Trip C	Other
Catch	1	1	2	---
Size	2 lb.	4 lb.	4 lb.	---
Cost	$15	$30	$30	---

  - Which trip do you prefer?
  - Would you prefer to take a trip or do something else (fishing from shore, in freshwater, out of State; not fishing)?

C1 Suppose that you have the choice between two boat fishing trips in the Ocean area (Choice A or Choice B) or not taking a boat fishing trip in the Ocean area (Choice C). Below the table, indicate which of these three choices you like best and second best.

		Choice A	Choice B	Choice C
Area	Boat boarding area	Ocean area	Ocean area	**Do one of the following** (other than boat fishing in the Ocean area): • Inside area fishing • Saltwater shore fishing • WA freshwater fishing • Non-WA fishing • Do some activity other than fishing
Salmon	Catch (weight per fish)	2 hatchery kings (20 lb.) 1 wild king (10 lb.) 2 wild kings (20 lb.)	3 wild kings (20 lb.)	
Salmon	Legal daily limit	4 salmon (combined), release all kings	2 salmon (combined), no more than 1 king, release wild kings	
Cost	Fishing cost (per person per day) + Transportation cost + Lodging cost	**Private:** $80 + auto fuel / air + motel / camp	**Private:** $80 + auto fuel / air + motel / camp	
Cost		**Charter:** $175 + auto fuel / air + motel / camp	**Charter:** $175 + auto fuel / air + motel / camp	

If you were presented these three choices (A, B, C), which one would you choose to do?
(mark only one)

OCEAN Choice A ☐	OCEAN Choice B ☐	NO OCEAN Fishing Trip Choice C ☐

If your first choice was not available, what would be your second choice?
(mark only one)

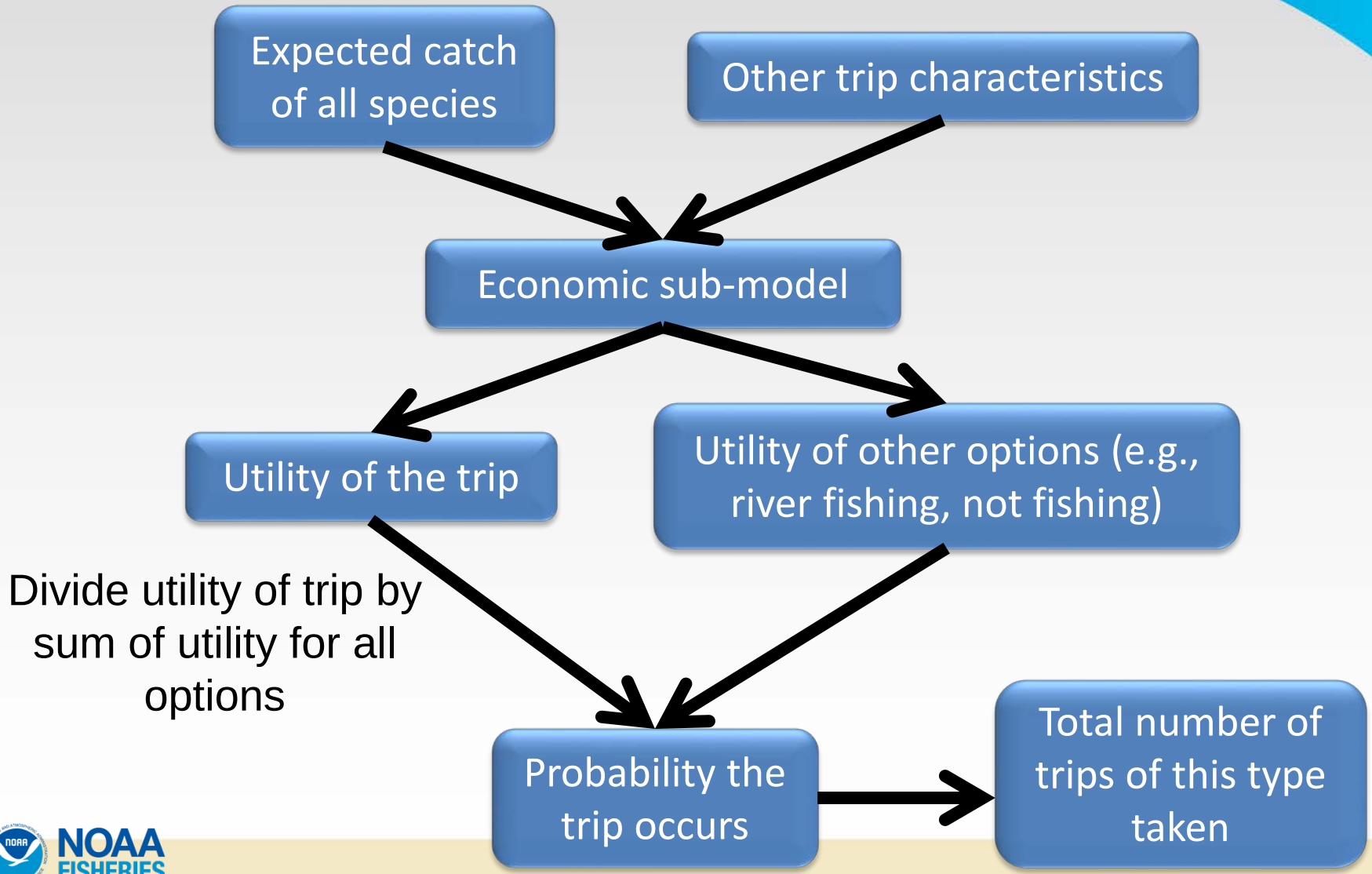
OCEAN Choice A ☐	OCEAN Choice B ☐	NO OCEAN Fishing Trip Choice C ☐

Preference parameters

$$U_{nij} = \delta Price_{nij} + \sum_t \alpha_t Opt_{tnij} + \sum_s \sum_l \beta_{ls} Catch_{lsij} + \sum_s \rho_s Catch_{sij}^2 + \sum_s \gamma_s LbsRelease_{sij} + \sum_k \theta_k Type_{kij} + \varepsilon_{nij}$$

Catch (β_{ls})	Halibut	
	Small	1.25866***
	Medium	1.50204***
	Large	1.77075***
	Rockfish	
	Small	0.106269***
	Medium	0.131425***
	Large	0.130522***
Catch^2 (ρ_s)	Halibut	–0.22859***
	Rockfish	–0.00334***
LbsRelease(γ_s)	Halibut	–0.0178***
	Rockfish	–0.00674

Estimating recreational fishing effort



Biological sub-model

- The catch is fed into a biological model based on the most recent stock assessments to predict changes in population size, which for key species affects estimates of future catch

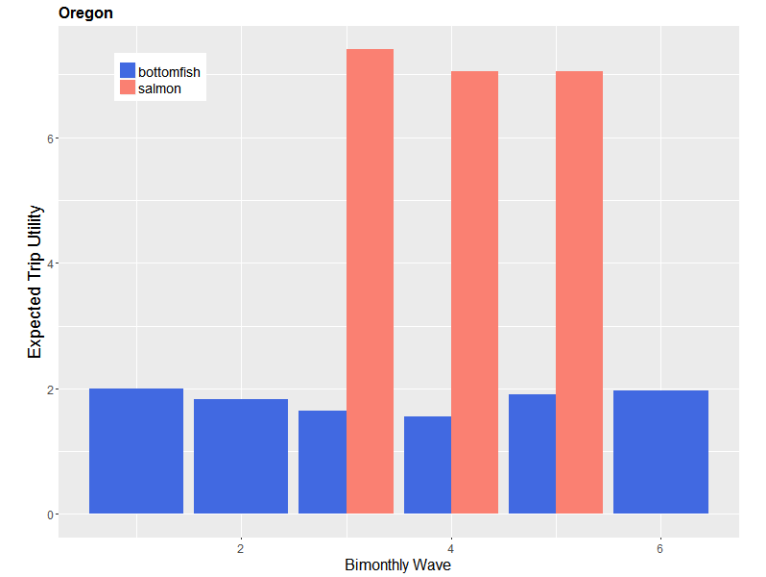
- Lingcod
- Black rockfish
- Canary rockfish
- Yelloweye rockfish
- Other rockfish

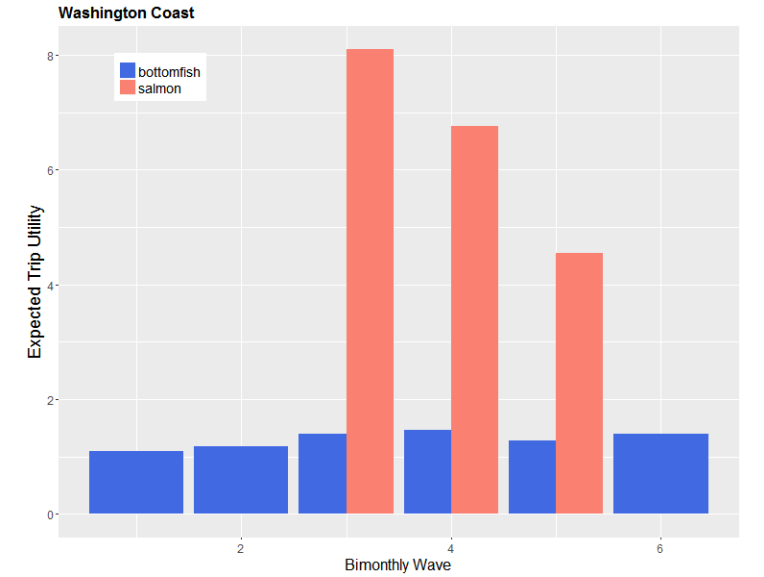
- Halibut
- Hatchery coho salmon
- Wild coho salmon
- Hatchery chinook salmon
- Wild chinook salmon

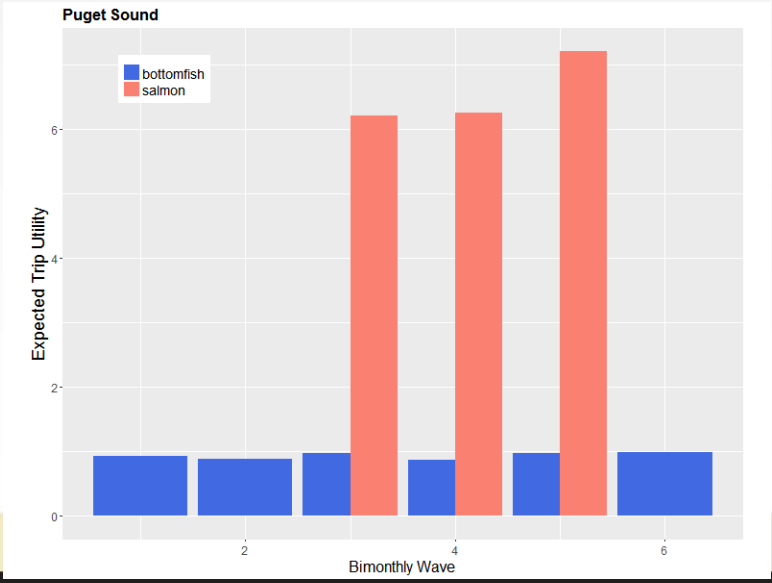
Example of results

Run	Wave	Year	BoatType	TripType	Subarea	Area	Trips
	1	1	1Private	bottomfish	WA.Coast	WA	23
	1	2	1Private	bottomfish	WA.Coast	WA	24
	1	3	1Private	bottomfish	WA.Coast	WA	5
	1	4	1Private	bottomfish	WA.Coast	WA	9
	1	5	1Private	bottomfish	WA.Coast	WA	7
	1	6	1Private	bottomfish	WA.Coast	WA	26
	1	1	2Private	bottomfish	WA.Coast	WA	18
	1	2	2Private	bottomfish	WA.Coast	WA	24
	1	3	2Private	bottomfish	WA.Coast	WA	8
	1	4	2Private	bottomfish	WA.Coast	WA	7
	1	5	2Private	bottomfish	WA.Coast	WA	7
	1	6	2Private	bottomfish	WA.Coast	WA	25
	1	1	3Private	bottomfish	WA.Coast	WA	21
	1	2	3Private	bottomfish	WA.Coast	WA	22
	1	3	3Private	bottomfish	WA.Coast	WA	8
	1	4	3Private	bottomfish	WA.Coast	WA	5
	1	5	3Private	bottomfish	WA.Coast	WA	5
	1	6	3Private	bottomfish	WA.Coast	WA	22
	1	1	1Charter	bottomfish	WA.Coast	WA	10

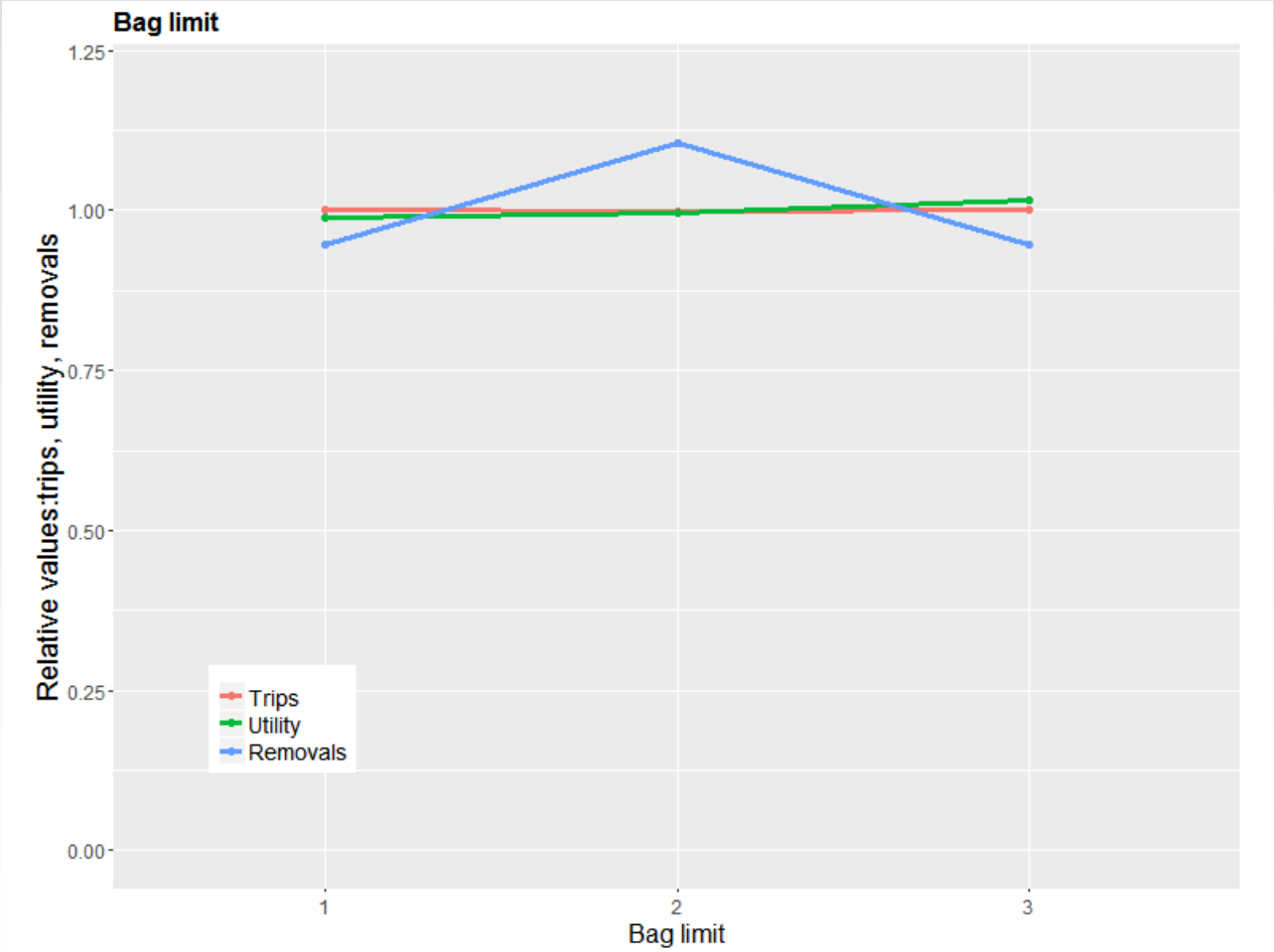
Trip Utility







Response to regulation



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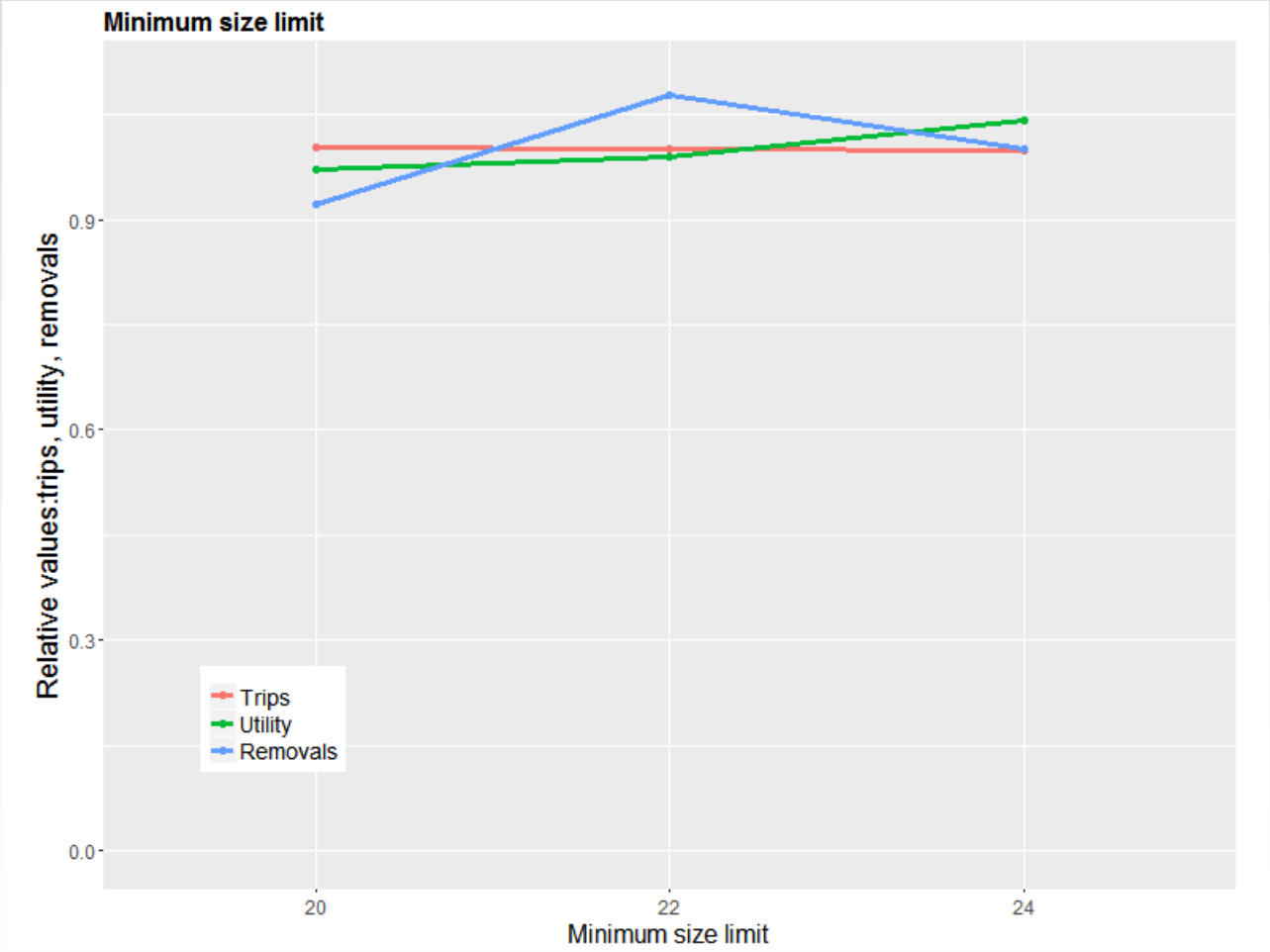

Future work

- Future research will focus on being able to attribute utility to fishing trips, and the bioeconomic integration and its implications
- Future operationalization will develop abilities to provide estimates of catches as a function of regulation change, and identification of regulation “baskets” that would achieve desired catch allocations
- Southeast model

Related research

- Bio-economic model of recreational cod and haddock fisheries in the Northeast U.S. (Steinback et al.)
- Bio-economic model looked at how changes in water quality may affect the Atlantic Coast summer flounder recreational fishery (Massey et al., 2006)
- Theoretical recreational bio-economic modeling work on the influence of fish life history, angler behavior, discard mortality, and non-compliance on optimal recreational fishery management (Johnston et al., 2010, 2013, and 2015)

Catch per trip parameters: WA bottomfish lingcod

Variable	Est.	S.E.
Zero-inflation model coefficients		
(Intercept)	1.672	0.146***
log(LingcodAvailable)	-0.502	0.021***
BoatTypePrivate	0.974	0.031***
Negative binomial model coefficients		
(Intercept)	-2.053	0.061***
log(LingcodAvailable)	0.312	0.008***
Wave3	-0.414	0.026***
Wave4	-0.712	0.028***
Wave5	-0.923	0.039***
BoatTypePrivate	0.179	0.030***
Wave3:BoatTypePrivate	-0.185	0.032***
Wave4:BoatTypePrivate	-0.187	0.035***
Wave5:BoatTypePrivate	0.073	0.050
Log(theta)	-0.157	0.013***