Recreational Demand Model Overview
Core Stakeholder Workshop 11/8

Andrew (Lou) Carr-Harris
andrew.carr-harris@noaa.gov
Social Sciences Branch, Northeast Fisheries Science Center

Objectives of the summer flounder recreational demand model (RDM)

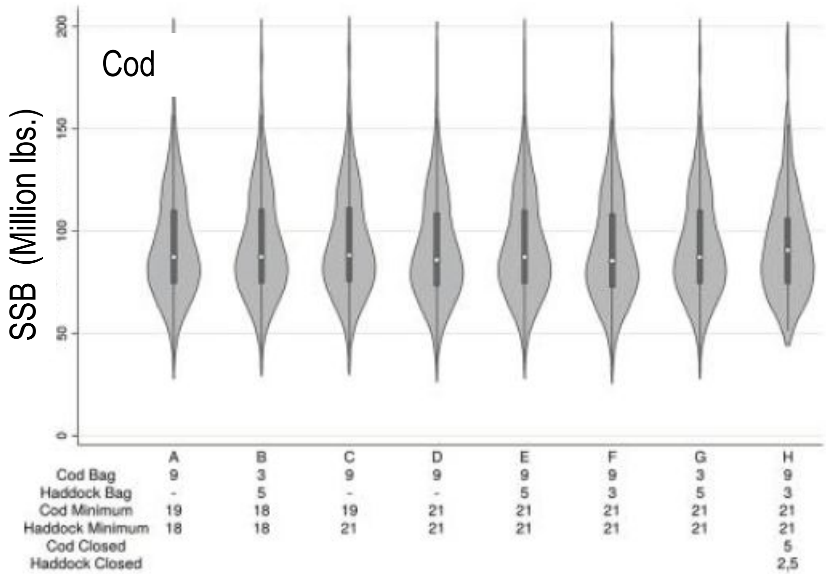
1. Predict the impact of management strategies on:
   - harvest;
   - discards;
   - angler welfare;
   - other metrics of fishing success?

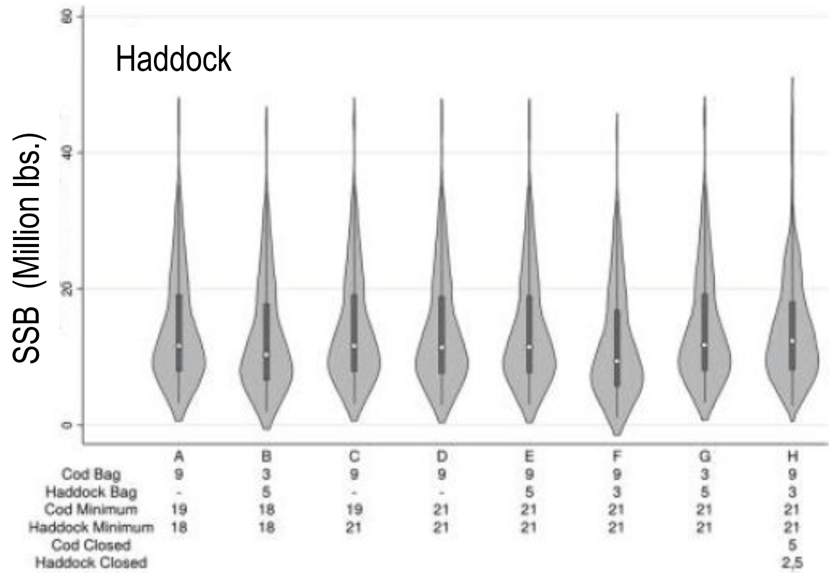
2. Evaluate economic and biological tradeoffs posed by alternative management strategies, such as:
   - +/- bag limits;
   - +/- minimum sizes, slots;
   - other types of mgt. strategies?

Literature

- Similar applications of recreational demand modeling in fishery settings:
  - Carr-Harris and Steinback 2020 – striped bass
  - Lee et. al 2017- GoM cod and haddock

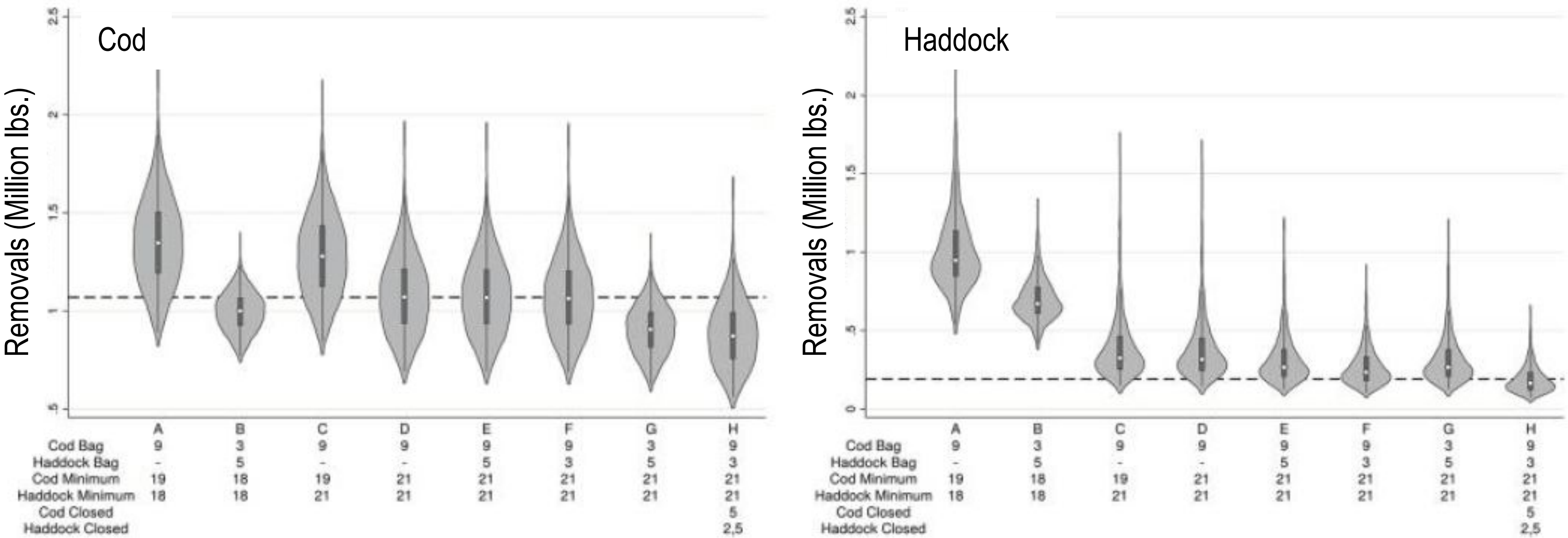
Lee et al. (2017)
Results - predicted spawning stock biomass 3 years out



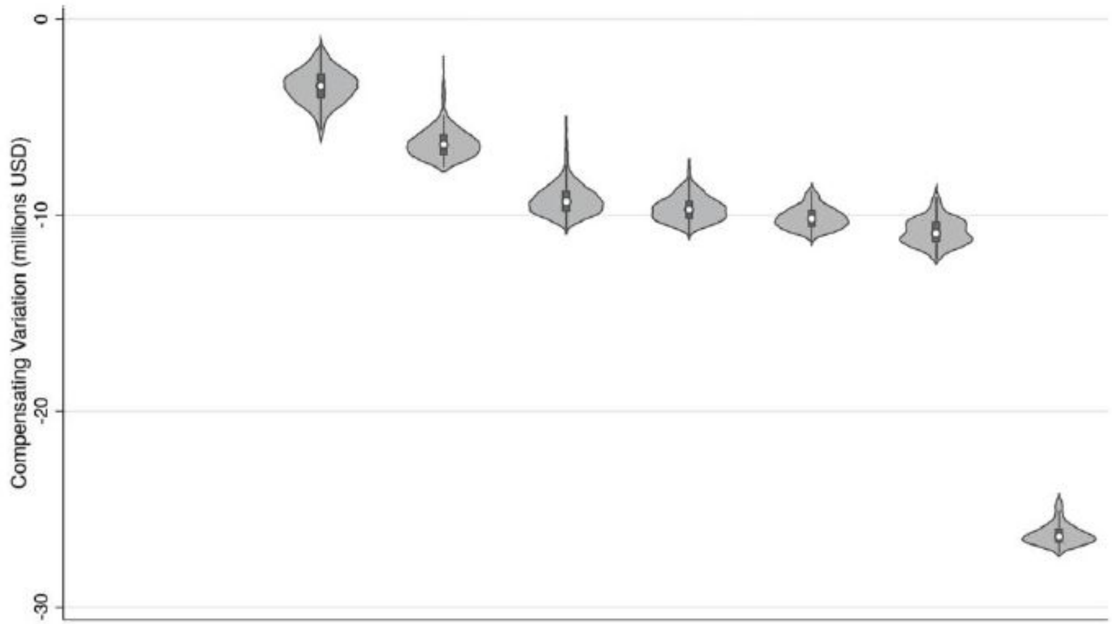


Lee et al. (2017)

Results - predicted removals next year



Lee et al. (2017)
Results – predicted angler welfare next year



	A	B	C	D	E	F	G	H
Cod Bag	9	3	9	9	9	9	3	9
Haddock Bag	-	5	-	-	5	3	5	3
Cod Minimum	19	18	19	21	21	21	21	21
Haddock Minimum	18	18	21	21	21	21	21	21
Cod Closed								5
Haddock Closed								2,5

Figure 4. Aggregate Angler CV in 2014 Evaluated Over Seven Alternative Fishing Policies
Note: Policy A is used as the baseline policy.

Approach to the summer flounder RDM

1. Behavioral model
   - Estimates angler preferences/drivers of fishing effort
   - Uses data from a 2010 choice experiment survey

2. Fishery simulation
   - Simulates the fishery using historical catch and effort data from MRIP
   - Incorporates the results of behavioral model
   - Measures the effect of mgt. strategies on anglers and fish

Estimate angler preferences
Angler behavior model

- Data from a 2010 choice experiment (CE) survey
  - Stated preference method for **non-market valuation**

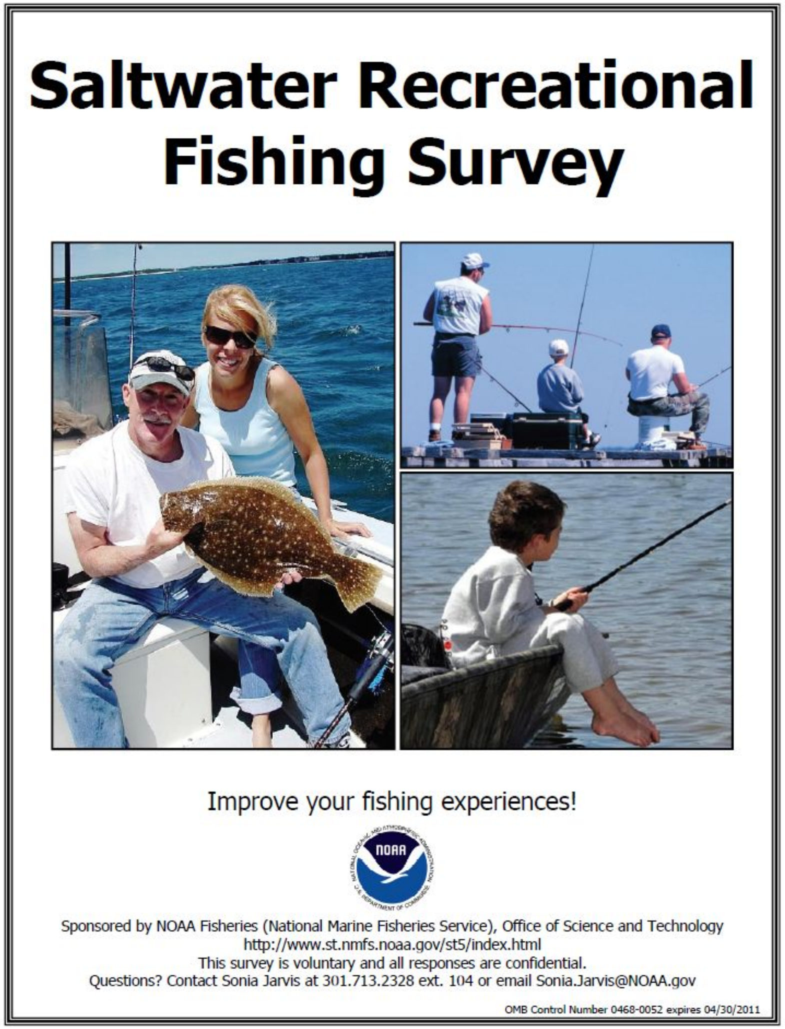
- Non-market goods or attributes do not have well-defined markets, necessitating the use of alternative methods of valuation

- CEs ask people a series of questions that can be used to infer economic values, such as willingness-to-pay (WTP)

- Allow for valuation of virtually any policy-relevant attributes of interest (e.g., harvest, regulations, environmental quality), including those for which observational data are nonexistent or do not vary

Choice experiment data

- 2010 saltwater fishing survey
- Administered in conjunction with MRIP intercepts
- Four regional sub-versions (ME-NY, NJ, DE/MD, VA/NC)
- 10,244 surveys distributed, 3,234 returned (RR=31.5%)



Saltwater Recreational Fishing Survey

Improve your fishing experiences!

Sponsored by NOAA Fisheries (National Marine Fisheries Service), Office of Science and Technology
http://www.st.nmfs.noaa.gov/st5/index.html
This survey is voluntary and all responses are confidential.
Questions? Contact Sonia Jarvis at 301.713.2328 ext. 104 or email Sonia.Jarvis@NOAA.gov

OMB Control Number 0468-0052 expires 04/30/2011

Example choice experiment question

SECTION B: SALTWATER FISHING TRIPS

The following questions help us understand tradeoffs made by anglers when they go fishing.
Compare Trip A, Trip B, and Trip C in the table below, then **answer** questions **2A** and **2B**.
Compare only the trips on this page. Do **not** compare these trips to trips on other pages in this survey.

Trip Features		Trip A	Trip B	Trip C
Summer Flounder (Fluke)	**Regulations**	2 Fluke, 20" or larger	5 Fluke, 21" or larger	
	Fish Caught	0 to 4 Fluke, 25" TL	8 Fluke, 12" TL	
	Fish Kept	0 to 2 Fluke	0 Fluke	
Black Sea Bass	**Regulations**	10 Bl. Sea Bass, 12.5" or larger	15 Bl. Sea Bass, 10" or larger	
	Fish Caught	15 Bl. Sea Bass, 9" TL	20 Bl. Sea Bass, 12" TL	Go fishing for striped bass or bluefish
	Fish Kept	0 Black Sea Bass	15 Black Sea Bass	
Scup (Porgy)	**Regulations**	15 Scup, 11.5" or larger	20 Scup, 11" or larger	
	Fish Caught	80 Scup, 13" TL	60 Scup, 10" TL	
	Fish Kept	15 Scup	0 Scup	
Total Trip Cost		$90	$105	$160

Definitions:

- **Regulations:** The legal minimum size restriction and bag limit for this trip.
- **Fish caught:** The number of fish caught on this trip and the total length (TL) of those fish.
- **Fish kept:** The number of fish you can legally keep on this trip.
- **Total trip cost:** ***Your portion*** of the costs associated with this trip, including bait, ice, fishing equipment purchase or rental, daily license fees, boat rental fees, boat fuel, trip fees, and round trip transportation costs associated with traveling to and from the fishing location. Travel costs may include vehicle fuel, car rental, tolls, airfare, and parking.

2A Choose your favorite trip. (Please mark only **one** trip with a ☑ or a ☒.)

- **Trip A** ☐
- **Trip B** ☐
- **Trip C** ☐
- **I would not go saltwater fishing** ☐

Behavioral model

- Random utility model framework
  - $U_i = V_i + e$
  - Select alternative with largest U

- Econometric model:

V_i = f($\sqrt{\text{\# SF kept}}$, $\sqrt{\text{\# SF released}}$, $\sqrt{\text{\# other fish kept}_s}$, $\sqrt{\text{\# other fish released}_s}$, Trip cost, Striper/bluefish alternative, No trip alternative)

Behavioral model results

Fluke parameters

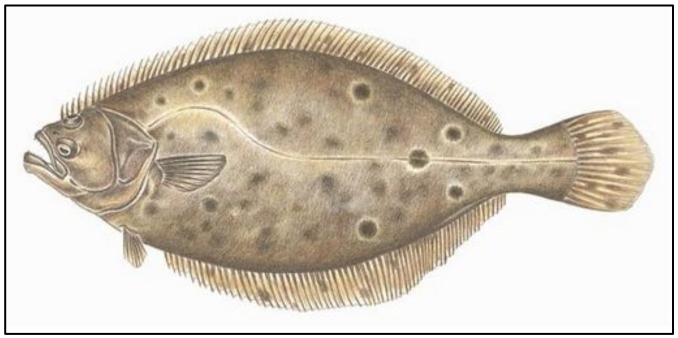
BSB parameters

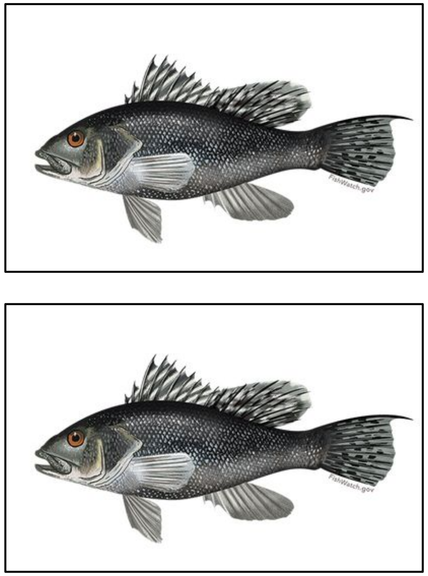
Table 2. Estimated utility parameters from panel mixed logit models.

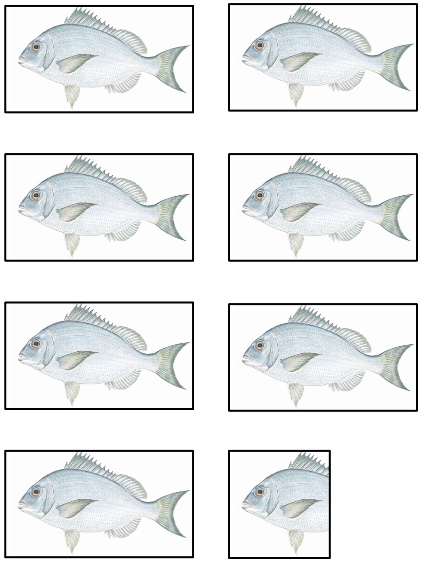
	ME-NY		NJ		DE/MD		VA/NC	
Mean parameters	*Estimate*	*St. Error*	*Estimate*	*St. Error*	*Estimate*	*St. Error*	*Estimate*	*St. Error*
trip cost	-0.012***	0.000	-0.009***	0.000	-0.009***	0.000	-0.008***	0.000
$\sqrt{\text{SF kept}}$	0.559***	0.063	0.762***	0.067	0.807***	0.051	0.521***	0.033
$\sqrt{\text{SF released}}$	-0.061	0.046	0.013	0.043	0.040	0.034	0.108***	0.022
$\sqrt{\text{BSB kept}}$	0.275***	0.034	0.174***	0.034	0.239***	0.027	0.192***	0.019
$\sqrt{\text{BSB released}}$	-0.021	0.024	0.015	0.025	-0.011	0.020	0.020	0.013
$\sqrt{\text{scup kept}}$	0.075***	0.021	0.097***	0.021				
$\sqrt{\text{scup released}}$	-0.010	0.015	-0.039**	0.016				
$\sqrt{\text{WF kept}}$			0.394***	0.056	0.379***	0.045	0.231***	0.032
$\sqrt{\text{WF released}}$			0.093**	0.044	0.064*	0.036	0.030	0.024
$\sqrt{\text{RD kept}}$							0.454***	0.040
$\sqrt{\text{RD released}}$							0.081***	0.025
do not fish	-2.641***	0.252	-2.095***	0.288	-2.963***	0.259	-3.908***	0.259
fish for other species	1.429***	0.181	1.139***	0.208	0.645***	0.159	0.454***	0.121
No. choices	3460		2768		4514		8340	
No. anglers	449		359		594		1072	
Pseudo R^2	0.332		0.274		0.323		0.307	
LL	-3203.6		-2785.2		-4236.5		-8010.3	
LL(0)	-4796.6		-3837.3		-6257.7		-11561.7	
AIC	6441.1		5612.3		8506.9		16062.6	
BIC	6569.2		5765.9		8639.6		16239.4	

Notes: *,**, and *** represent significance at the 10%, 5%, and 1% level of significance, respectively. SF = summer flounder, BSB = black sea bass, WF = weakfish, RD = red drum.

Estimated willingness-to-pay for keeping fish (ME-NY)







keeping 1 summer flounder = keeping ~ 2 black sea bass = keeping ~ 7.5 scup

<u>Willingness-to-pay for the first fish kept:</u>

$23.29	$11.45	$3.13

Fishery simulation overview

- Historical MRIP catch and effort data is used to simulate individual fishing trips under baseline and alternative mgt. strategies.

- Under the two scenarios, calculate:
  - expected utility;
  - probability of taking a trip;
  - angler welfare;
  - other metrics of fishing success?

Based on behavioral model parameters

Example choice occasion

Trip outcomes from a change in attributes based on 100 utility parameter draws.

Trip attributes	Baseline scenario (s^0)	Alternative scenario (s^1)
# summer flounder kept	1	3
# summer flounder released	4	1
# black sea bass keep	1	4
# black sea bass released	3	0
# scup kept	0	0
# scup kept	0	0
Trip cost	$55.85	$55.85
Trip outcomes		
Trip probability	0.51 (0.44, 0.58)	0.69 (0.62, 0.75)
Expected BSB harvest (prob. × BSB keep)	0.50 (0.43, 0.57)	2.75 (2.49, 3.00)
Expected BSB releases (prob. × BSB release)	1.52 (1.31, 1.73)	0
Expected BSB mortality (harvest + 0.1×releases)	0.66 (0.58, 0.74)	2.75 (2.49, 3.00)
CV $s^0 \rightarrow s^1$	-$64.90 ($52.45, $77.35)	

Fishery simulation method

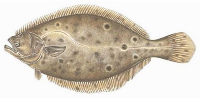
1. Simulate fishing trips, with each assigned:
   - #'s fish kept/released
   - sizes of fish kept/released
   - trip cost

2. Calibrate the model to baseline year (2019) MRIP effort estimates

3. Re-run under alternative conditions, calculate changes in metrics of interest

Fishery simulation data

- Catch-per-trip: MRIP aggregated across 3 regions (MA-NY, NJ, DE-NC)
- Catch-at-length: MRIP aggregated across 3 regions in baseline year, adjusts to the size distribution of the population in prediction years
- Regulations: state level
- Behavioral parameters: 4 regions (MA-NY, NJ, DE/MD, VA/NC)
- Trip cost data: state level by mode from 2017 expenditure survey data



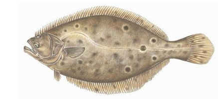
Fishery simulation
Data

2019 actual regulations

State	Period	Dates	Fluke regs.	BSB regs.	Scup regs.	Weakfish Regs.	Red drum regs.	Estimated # directed fluke trips
MA	1	Jan 1. - May 17	closed	closed	30 fish, 9"	N/A	N/A	0
MA	2	May 18 - Sep. 8	5 fish, 17"	5 fish, 15"	50 fish, 9"	N/A	N/A	92,813
MA	3	Sep. 9 - Oct. 9	5 fish, 17"	closed	30 fish, 9"	N/A	N/A	9,978
MA	4	Oct. 10 - Dec 31	closed	closed	30 fish, 9"	N/A	N/A	1,460
NJ	1	Jan. 1 - May 14	closed	closed	50 fish, 9"	1 fish, 13"	N/A	2,463
NJ	2	May 15 - June 30	3 fish, 18"	10 fish, 12.5"	50 fish, 9"	1 fish, 13"	N/A	960,362
NJ	3	July 1 - Aug. 31	3 fish, 18"	2 fish, 12.5"	50 fish, 9"	1 fish, 13"	N/A	2,763,076
NJ	4	Sep. 1 - Sep. 30	3 fish, 18"	closed	50 fish, 9"	1 fish, 13"	N/A	810,316
NJ	5	Oct. 1 - Oct. 31	closed	10 fish, 12.5"	50 fish, 9"	1 fish, 13"	N/A	41,088
NJ	6	Nov. 1 - Dec. 31	closed	15 fish, 13"	50 fish, 9"	1 fish, 13"	N/A	1,891

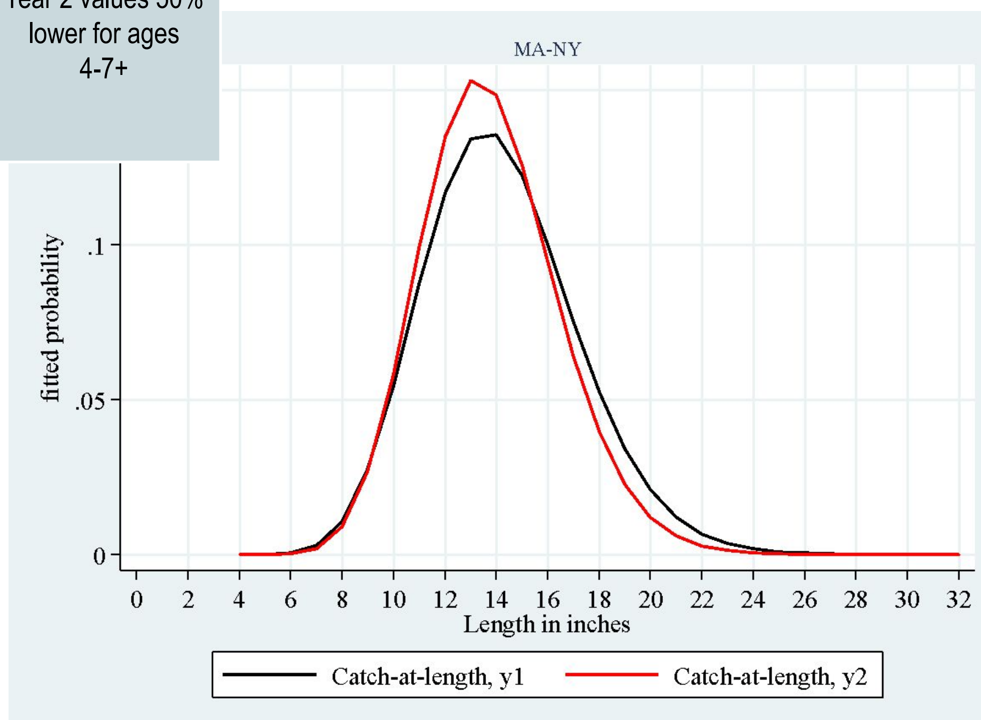
Fishery simulation - data

- Catch-at-length
  - In baseline year, use distribution fitted (gamma) to recent MRIP data
  - In prediction year, calculate and fit based on population abundance-at-length



Abundance-based catch-at-length example (fluke)

Age	Numbers at age y1	Numbers at age y2	
0	50361.35	75542.03	Year 2 values 50% higher for ages 0-3
1	32063.45	48095.18	
2	19979.2	29968.8	
3	11473.4	17210.1	
4	10145.7	5072.85	Year 2 values 50% lower for ages 4-7+
5	4716.905	2358.453	
6	2377.51	1188.755	
7+	4155.28	2077.64	



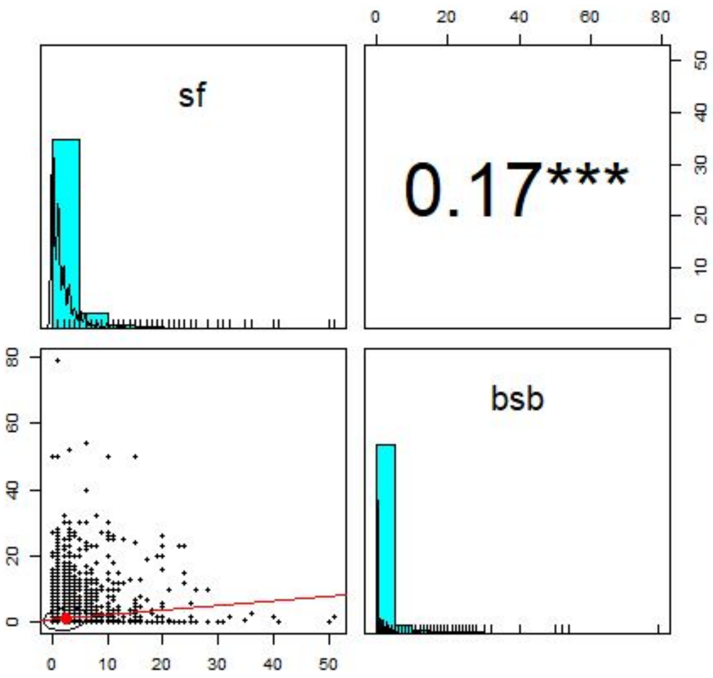
Fishery simulation
Data

- Catch-per-trip based on recent MRIP data

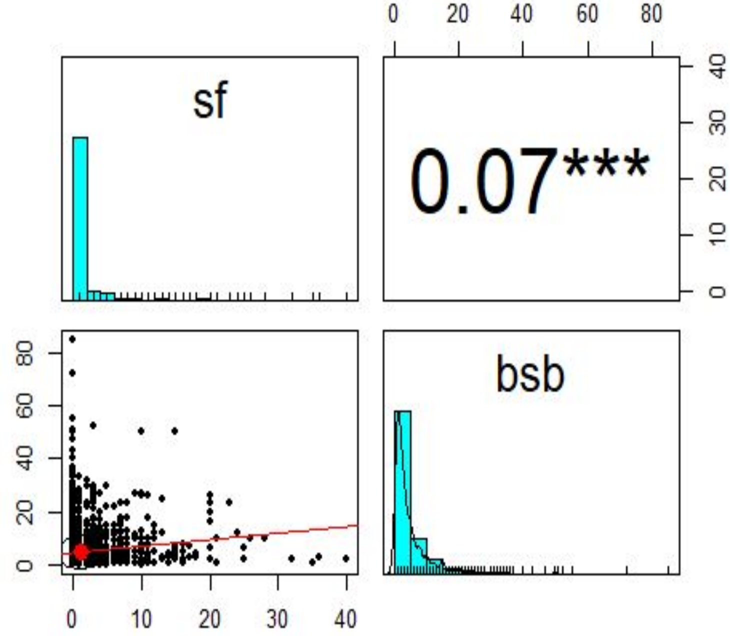
- Account for correlation in fluke and BSB catch through the use of copulas
  - Specify marginal distributions for each series, select copula function that generates data with similar correlation structure
- Catch-per-trip of other species assumed independent

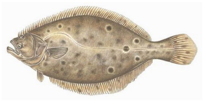
Correlation between fluke and BSB

Observed catch on directed fluke trips, MA-NY 2019



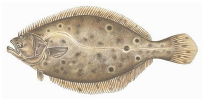
Observed catch on directed BSB trips, MA-NY 2019





Fishery simulation
Calibration

- Calibrate the model to baseline year (2019)
  - Select *N* simulated trips so that $\sum_{n=1}^{N} p$ = actual # of trips

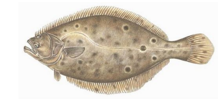


Calibration results for summer flounder

Harvest

Table 1. Simulated vs. estimated 2019 fluke harvest (#'s fish)

state	Simulation (95% CI)	MRIP (95% CI)	Difference	% difference
MA	57,627 (56,938 58,316)	55,386 (26,630 84,142)	2,241	4.0
RI	104,350 (103,250 105,449)	213,592 (59,161 368,022)	-109,242	-51.1
CT	91,145 (90,136 92,153)	89,843 (56,326 123,360)	1,302	1.4
NY	709,441 (701,566 717,316)	561,173 (321,106 801,240)	148,268	26.4
NJ	1,058,311 (1,047,499 1,069,124)	1,108,158 (740,721 1,475,595)	-49,847	-4.5
DE	55,132 (54,733 55,532)	91,025 (58,913 123,137)	-35,893	-39.4
MD	75,912 (75,395 76,429)	79,371 (66,857 91,885)	-3,459	-4.4
VA	106426 (105,963 106,889)	149,785 (72,911 226,659)	-43,359	-28.9
NC	8,660 (8,604 8,716)	34,895 (23,833 45,956)	-26,235	-75.2
Total	2,267,008 (2244221 2289795)	2,383,228 (1,908,190 2,858,266)	-116,223	-4.9



Calibration results for summer flounder

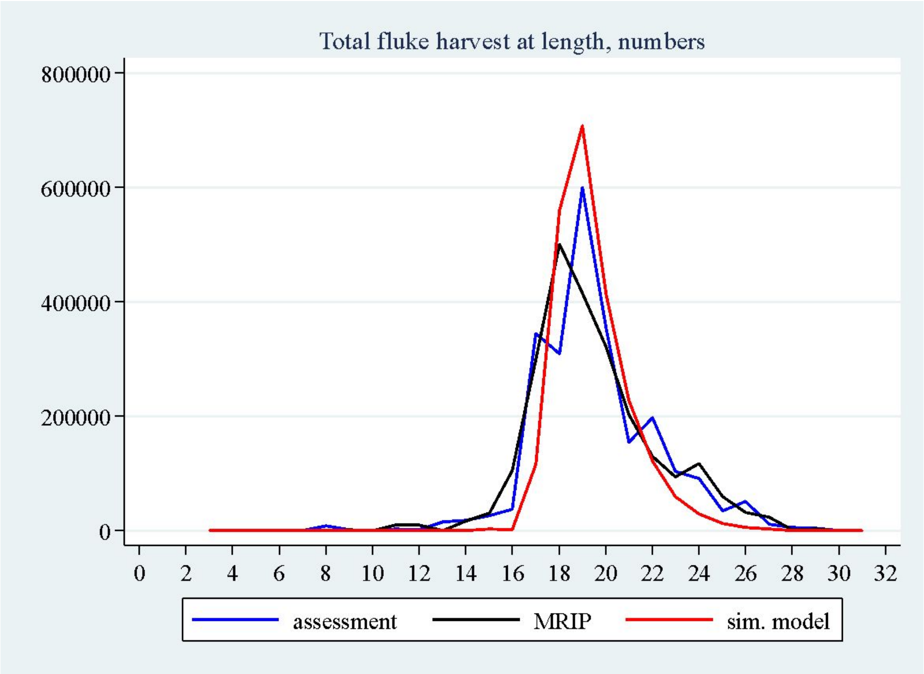
Discards

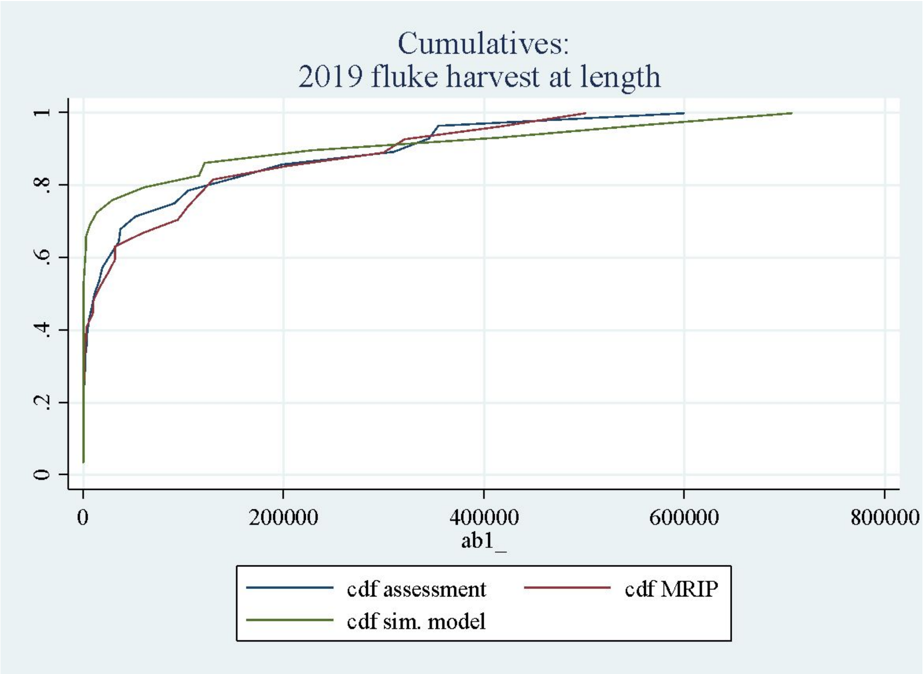
Table 2. Simulated vs. estimated 2019 fluke discards (#'s fish)

state	Simulation (95% CI)	MRIP (95% CI)	Difference	% error
MA	226,302 (224,099 224,099)	224,421 (83,344 365,498)	1,881	0.84
RI	1,168,887 (1,159,973 1,177,801)	1,319,352 (400,194 2,238,510)	-150,465	-11.40
CT	1,025,365 (1,017,481 1,033,250)	1,065,404 (674,356 1,456,452)	-40,039	-3.76
NY	8,620,060 (8,551,801 8,688,317)	9,001,801 (6,144,099 11,859,503)	-381,741	-4.24
NJ	12,703,465 (12,607,124 12,799,806)	13,068,170 (8,729,440 17,406,900)	-364,705	-2.79
DE	663,235 (660,637 665,833)	441,178 (302,647 579,708)	222,057	50.33
MD	902,174 (898,782 905,567)	938,193 (781,958 1,094,428)	-36,019	-3.84
VA	1,307,589 (1,304,510 1,310,668)	1,367,380* (761,049 1,973,711)	-61,986	-4.53
NC	39,621 (39,442 39,801)	1,469 (-1,410 4,348)	38,152	2,597.14
Total	26,656,701 (26,465,040 26,848,362)	28,359,562 (22,868,977 33,850,147)	-772,865	-2.82

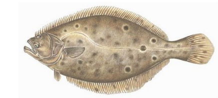
*estimate exclude two anomalous observations that account for 933k discarded fish

Calibration results for summer flounder
Harvest-at-length

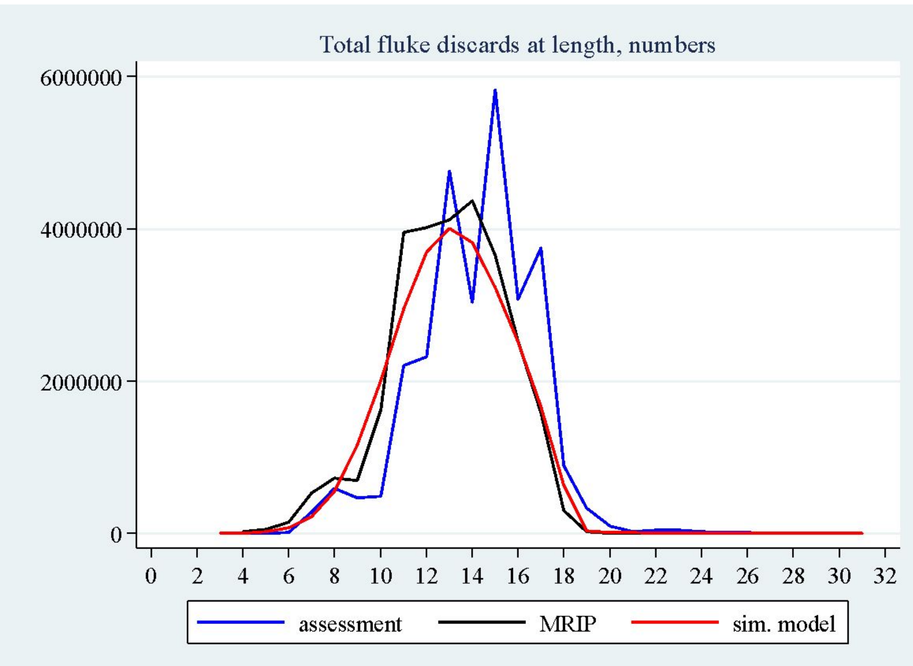


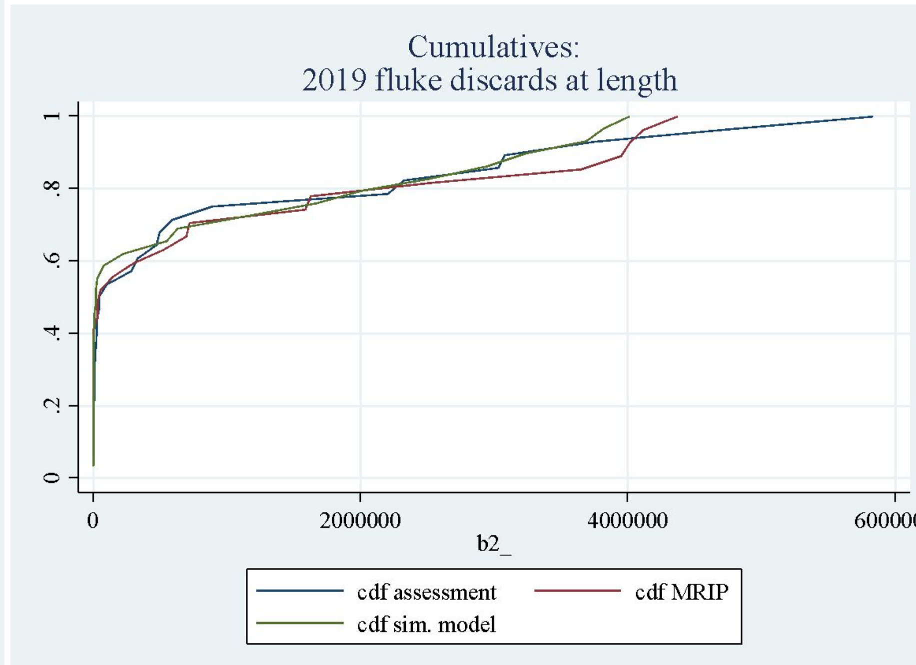


Kolmogorov-Smirnov test for equality of distribution functions:
Sim. model vs. assessment p-value =0.084
Sim. model vs. MRIP p-value =.175



Calibration results for summer flounder
Discards-at-length





Kolmogorov-Smirnov test for equality of distribution functions:
Sim. model vs. assessment p-value =0.390
Sim. model vs. MRIP p-value =0.043

Calibration results for black sea bass

Harvest

Table 1. Simulated vs. estimated 2019 black sea bass harvest (#'s fish)

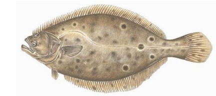
state	Simulation (95% CI)	MRIP (95% CI)	Difference	% difference
MA	327,511 (326,810 328,211)	526,593 (321,668 731,519)	-199,083	-37.8
RI	456,037 (455,216 456,856)	517,032 (337,340 696,724)	-60,996	-11.8
CT	668,207 (666,873 669,540)	515,601 (276,600 754,602)	152,606	29.6
NY	1,575,259 (1,571,983 1,578,534)	157,7042 (1,069,013 2,085,070)	-1,783	-0.1
NJ	599,326 (597,729 600,922)	831,241 (539,811 1,122,671)	-231,915	-27.9
DE	51,861 (51,758 51,962)	43,434 (19,184 67,684)	8,426	19.4
MD	139,200 (138,939 139,460)	129,431 (58,667 200,196)	9,768	7.5
VA	198,073 (197,808 198,336)	230,843 (-33,141 494,828)	-32,771	-14.2
NC	221,275 (220,980 221,570)	151,998 (-17,270 321,268)	69,276	45.6
Total	4,236,748 (4,228,184 4,245,311)	4,523,220 (3,762,717 5,283,723)	-286,472	-6.3

Calibration results for black sea bass

Discards

Table 2. Simulated vs. estimated 2019 black sea bass discards (#'s fish)

state	Simulation (95% CI)	MRIP (95% CI)	Difference	% difference
MA	2,392,956 (2,388,455 2,397,456)	2,728,800 (1,734,077 3,723,522)	-335,844	-12.31
RI	3,263,576 (3,258,043 3,269,109)	8,646,693 (6,471,292 10,821,676)	-172,647	-5.02
CT	3,239,776 (3,234,031 3,245,519)	2,624,762 (1,673,134 3,576,389)	615,014	23.43
NY	8,596,060 (8,580,162 8,611,958)	9,725,431 (7,401,427 12,048,987)	-1,129,371	-11.61
NJ	5,367,557 (5,352,499 5,382,613)	5,352,818 (4,002,933 6,702,703)	14,739	0.28
DE	463,846 (463,116 464,575)	378,300 (203,933 552,667)	85,545	22.61
MD	1,240,920 (1,238,929 1,242,909)	1,635,747 (4,005 3,267,489)	-394,827	-24.14
VA	1,950,094 (1,948,118 1,952,068)	1,903,352 (1,045,363 2,761,340)	46,742	2.46
NC	2,708,943 (2,706,037 2,711,847)	2,802,990 (1,756,042 3,849,9370)	-94,047	-3.36
Total	29,223,726 (29,169,744 29,277,708)	30,588,422 (26,593,505 34,583,339)	-1,364,696	-4.46

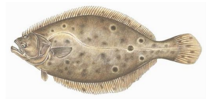


Simulation example

- Implemented a variety of regulations across states, holding everything else constant
- Assumed 100% compliance
- Measured expected changes in angler welfare, harvest, discards, and effort

Actual and hypothetical regulations used in summer flounder simulation.

State	2019 actual regulations	2019 alternative regulations	Change actual → alternative
MA	5 fish, 17”	5 fish, 19”	Min. size +2
RI	6 fish, 19”	6 fish, 21”	Min. size +2
CT	4 fish, 19”	4 fish, 17”	Min. size -2
NY	4 fish, 19”	4 fish, 16”-19”	Slot limit
NJ	3 fish, 18”	3 fish, 18”	No change
DE	4 fish, 16.5”	4 fish, 16.5”	No change
MD	4 fish, 16.5”	No harvest	Harvest moratorium
VA	4 fish, 16.5”	No harvest	Harvest moratorium
NC	4 fish, 16.5”	No harvest	Harvest moratorium

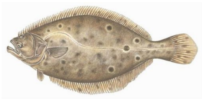


Simulation results – angler welfare

Expected welfare responses to alternative regulations

state	Regulation change	CV ($) (95% CI)
RI	19” → 21” min	5,807,945 (4,288,726 7,327,164)
CT	19” → 17” min	-9,434,245 (-11,909,176 -6,959,314)
NY	19” → 16”-19” slot	-103,299,312 (-130,189,418 -76,409,206)
NJ	No change	-60,721 (-151,228 29,786)
DE	No change	61,426 (44,612 78,239)
MD	4 fish, 16.5”→ Harvest moratorium	12,329,541 (10,463,853 14,195,228)
VA	4 fish, 16.5”→ Harvest moratorium	12,359,496 (10,378,030 14,340,962)
NC	4 fish, 16.5”→ Harvest moratorium	996,390 (834,756 1,158,025)
Total		-79,747,696 (-10,3296,553 -5,6198,839)

Expected changes are in relation to actual regulations in 2019

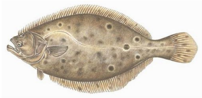


Simulation results – harvest

Expected harvest responses to alternative regulations

state	Regulation change	Change in harvest (# fish) (95% CI)	% change in harvest (# fish) (95% CI)
RI	19” → 21” min	-72,528 (-73,527 -71,528)	-69.5 (-69.78 -69.2)
CT	19” → 17” min	149,119 (143,972 154,266)	163.6 (159.3 167.9)
NY	19” → 16”-19” slot	1,652,488 (1,589,013 1,715,964)	232.9 (225.9 225.9)
NJ	No change	1,440 (725 2,156)	0.14 (0.069 0.20)
DE	No change	-215 (-235 -196)	-0.39 (-0.42 -0.35)
MD	4 fish, 16.5”→ Harvest moratorium	-75,912 (-76,429 -75,395)	-100 ( )
VA	4 fish, 16.5”→ Harvest moratorium	-106,426 (-106,889 -105,963)	-100 ( )
NC	4 fish, 16.5”→ Harvest moratorium	-8,660 (-8,716 -8,604)	-100 ( )
Total		1,494,583 (1,428,199 1,560,966)	65.9 (63.52 68.31)

Expected changes are in relation to actual regulations in 2019

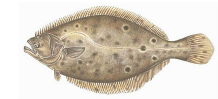


Simulation results – discards

Expected discard responses to alternative regulations

state	Regulation change	Change in discards (# fish) (95% CI)	% change in discards (# fish) (95% CI)
RI	19” → 21” min	14,058 (872 27,245)	1.20 (0.071 2.33)
CT	19” → 17” min	-68,641 (-85,964 -51,317)	-6.69 (-8.39 -4.99)
NY	19” → 16”-19” slot	-729,826 (-903,398 -556,255)	-8.46 (-10.49 -6.43)
NJ	No change	12,545 (7,817 17,273)	0.09 (0.06 0.13)
DE	No change	493 (405 580)	0.07 (0.06 0.08)
MD	4 fish, 16.5”→ Harvest moratorium	20,475 (12,424 28,527)	2.26 (1.37 3.16)
VA	4 fish, 16.5”→ Harvest moratorium	55,728 (48,546 62,911)	4.26 (3.70 4.81)
NC	4 fish, 16.5”→ Harvest moratorium	4,956 (4,309 5,603)	12.51 (10.84 14.17)
Total		-771,019 (-932,499 -609,538)	-2.89 (-3.50 -2.27)

Expected changes are in relation to actual regulations in 2019



Simulation results – effort

Expected demand responses to alternative regulations

state	Regulation change	Change in expected # trips (95% CI)	% change in expected # trips (95% CI)
RI	19” → 21” min	-16,396 (-20,797 -11,994)	-3.47 (-4.4 -2.54)
CT	19” → 17” min	26,625 (19,399 33,851)	6.4 (4.69 8.19)
NY	19” → 16”-19” slot	287,612 (209,778 365,445)	8.28 (6.037 10.51)
NJ	No change	261 (-321 844)	0.01 (-0.01 0.02)
DE	No change	-142 (-178 -106)	-0.04 (-0.04 -0.03)
MD	4 fish, 16.5”→ Harvest moratorium	-27,129 (-31,274 -22,983)	-4.98 (-5.74 -4.21)
VA	4 fish, 16.5”→ Harvest moratorium	-22,807 (-26,424 -19,191)	-2.90 (-3.36 -2.44)
NC	4 fish, 16.5”→ Harvest moratorium	-1,686 (-1,972 -1,399)	-6.32 (-7.39 -5.25)
Total		(200,870) (128,216 273,523)	1.85 (1.18 2.51)

Expected changes are in relation to actual regulations in 2019

Other model outputs

- Total summer flounder catch-, harvest-, discards-at-length

- Harvest and discards of other species caught on summer flounder trips

Goals of this workshop

- Define other types of model outputs that may be important to capture.

- Decide what types of management scenarios are important to model.

Advantages compared to current process

- Model accounts for:
  - changes in availability
  - changes in angler behavior/welfare
  - species interactions

- Can be used to model the effect of slight to extreme changes in regulations

- With population projections, can be used to model regulations for multiple years

Feedback from SSC peer review

- SSC peer review comments focused mainly on two concerns
  1. Sample selection
  2. Out-of-sample predictive power

Thank you!