Summer flounder simulation model overview

Core stakeholder group workshop 1b, July 14th

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Objectives

- MSE objective: “*Evaluate the biological and economic benefits of minimizing discards and converting discards into landings in the recreational sector. Identify management strategies to effectively realize these benefits.*"

- Model objective: Quantify the tradeoffs created by current and alternative management strategies.

Model objective

Types of tradeoffs to consider?

Economic/angler impacts	Biological impacts
• Angler satisfaction/welfare • Angler fishing success • # of fluke fishing trips • Economic impacts to related businesses (e.g., bait and tackle shops)	• Fluke SSB • Fluke fishing mortality • Fluke population size • Fluke population composition (age/sex distributions) • Effects on other stocks (e.g., black sea bass)

Approach

- Bio-economic simulation model
  - Predicts outcomes of individual fishing trips (harvest, release, satisfaction, etc.) under current and alternative management measures
  - Aggregates outcomes across trips to assess the fishery-wide impacts of a given management measure
  - Simulates the fishery for multiple years, using length-based stock projection model to capture growth and recruitment effects

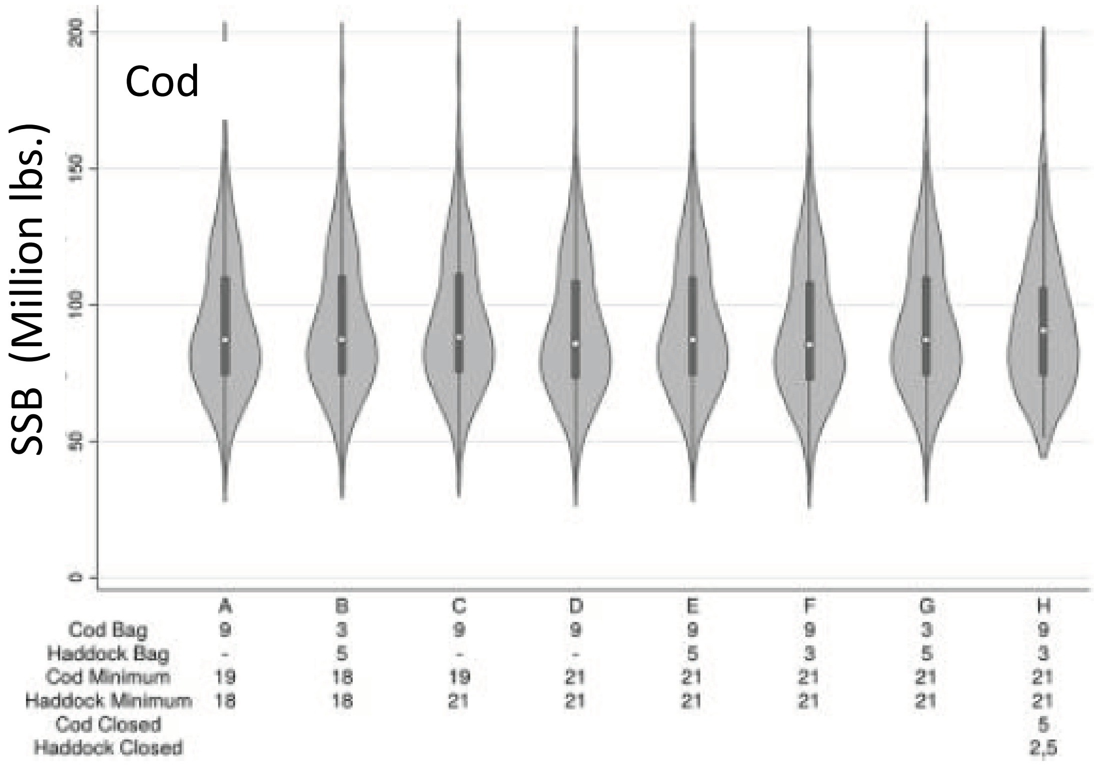
- Similar model currently used to determine recreational Gulf of Maine cod and haddock regulations (Lee et al. 2017)[1]

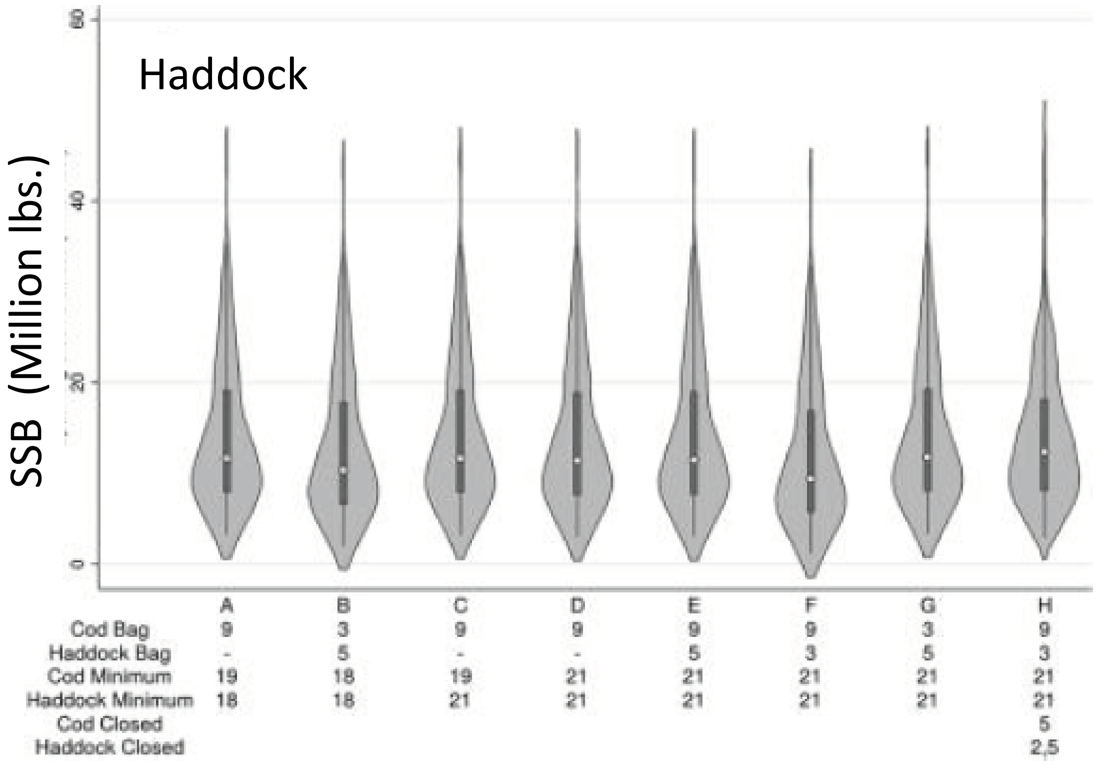
[1]Lee, M., S. Steinback, and K. Wallmo. 2017. "Applying a Bioeconomic Model to Recreational Fisheries Management: Groundfish in the Northeast United States." *Marine Resource Economics* 32 (2): 191–216.

Bio-economic model for recreational GoM cod and haddock (Lee et al. 2017)

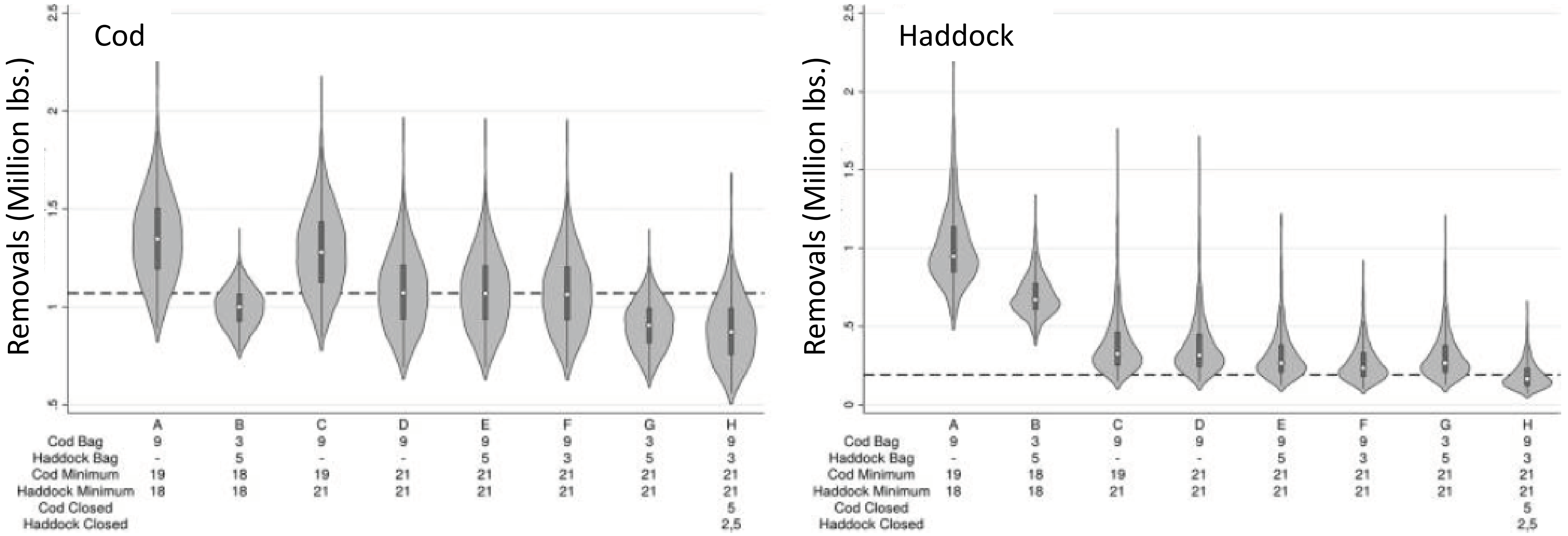
- Uses stock assessment data, MRIP data, angler survey data
- Angler satisfaction/recreational fishing effort responsive to policy-induced changes in harvest and releases
- Recreational catch-at-length function of population numbers-at-length
- Management options that have at least a 50% probability of keeping mortality of both species below their respective sub-ACLs are considered by the NEFMC and a preferred option is chosen

Lee et al. (2017) model output – predicted spawning stock biomass 3 years out

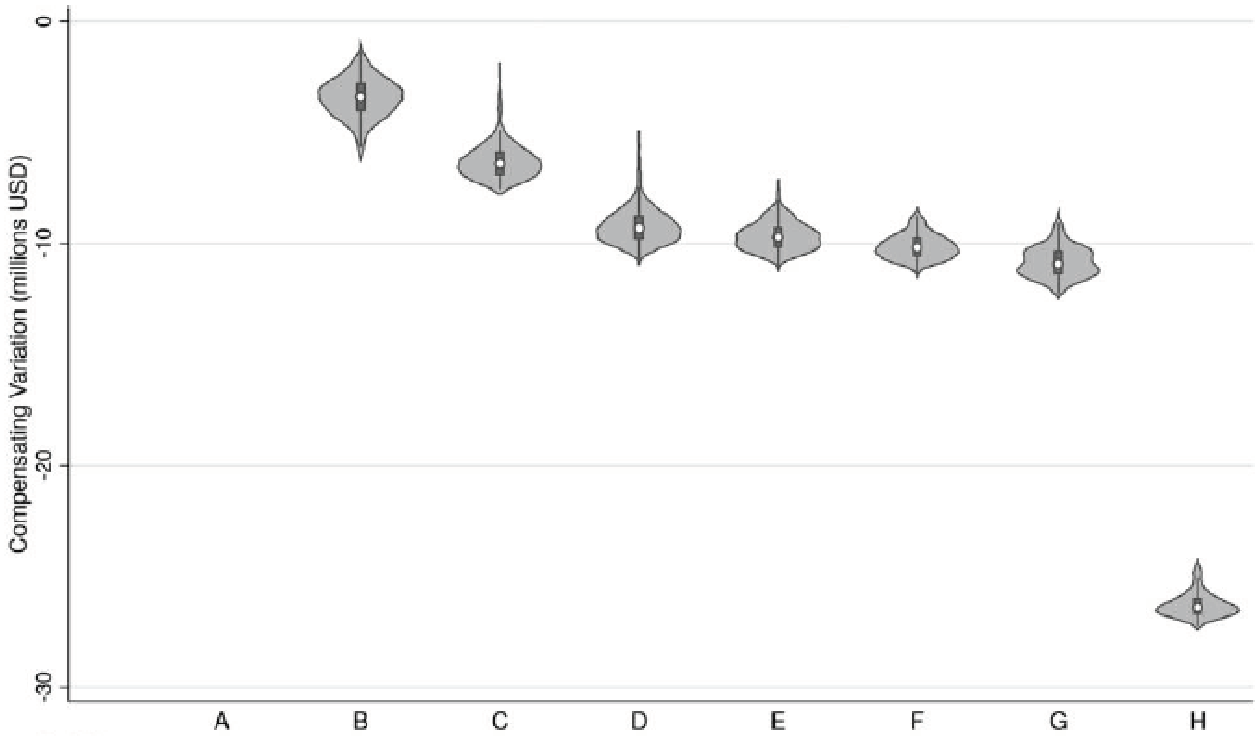




Lee et al. (2017) model output – predicted removals in 2014



Lee et al. (2017) model output – predicted angler welfare in 2014



	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.

The recreational fisheries system

Fish stock dynamics including growth and recruitment (1) – "operating model", length-structure stock projection model

- Metrics related to fish stock are common mgt. indicators (12) (e.g., SSB)

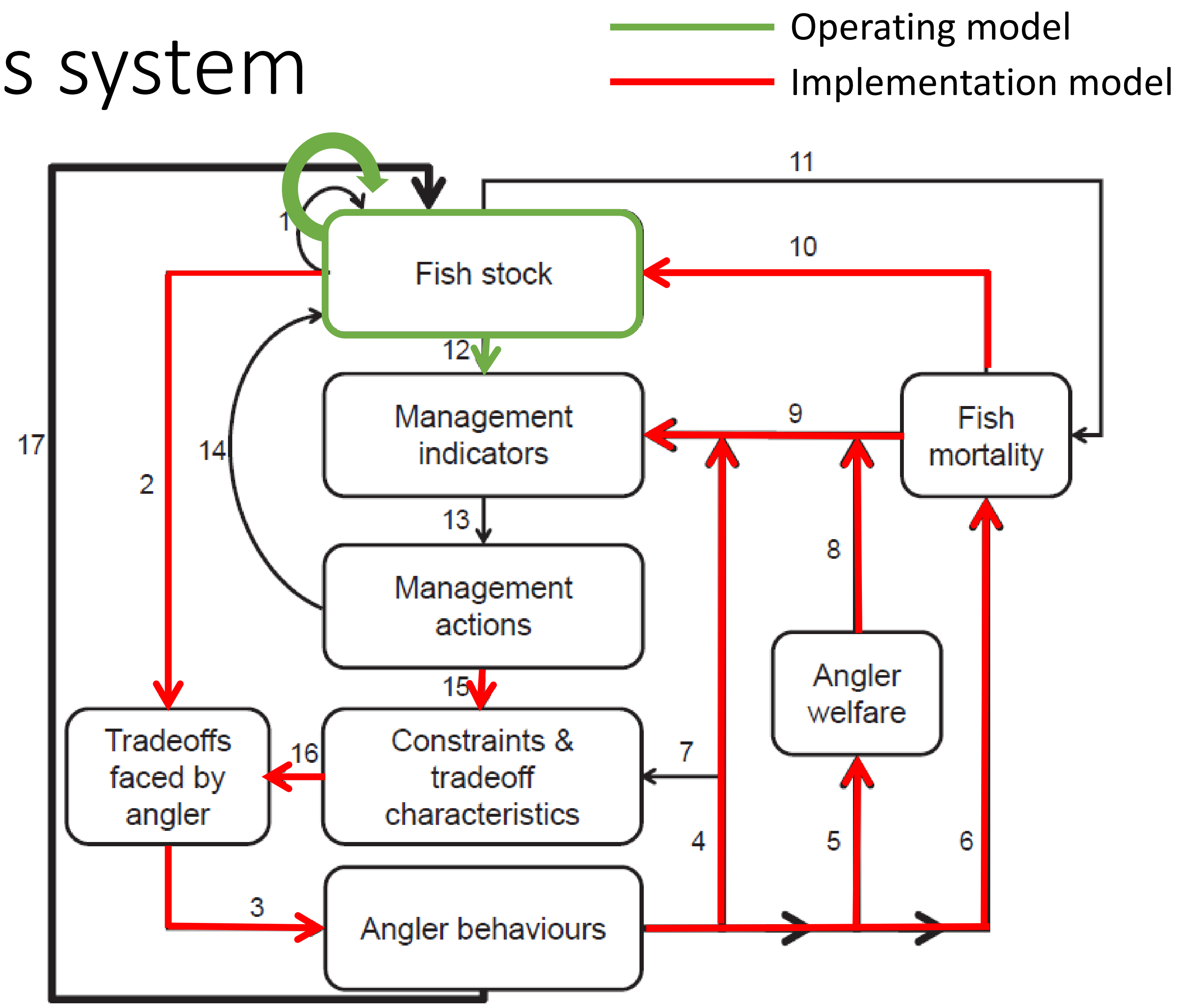
Changes in fish populations (2; e.g. size distribution of catch) and management measures (15 and 16) affect the tradeoffs anglers face

Anglers act on those tradeoffs (3)

Anglers' actions lead to realized angler effort, well-being or satisfaction (5), and rec. fishing mortality (6)

- All can be mgt. indicators (4, 8, and 9)

Fish mortality affects the fish stock (10)



Fenichel et al. 2013. "Modelling angler behaviour as a part of the management system: synthesizing a multi-disciplinary literature". Fish and Fisheries 14 (2): 137-157

Implementation model

- Evaluates changes in angler satisfaction/welfare, fishing trips, and fishing mortality conditional on management measures and fish stock
  - Can capture other metrics of angler success (e.g., % trips that catch a keeper)

- Two components:
  1. Estimation of angler behavior and preferences
     - Data from a 2010 choice experiment (CE) survey

  2. Fishery simulation
     - Historical catch and effort data from MRIP
     - Parameterized with results of angler behavioral model

Implementation model

1. Estimation of angler behavior and preferences
   - Data from a 2010 choice experiment (CE) survey

Angler behavioral model

- Data from a 2010 discrete choice experiment (DCE) 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. Examples:
  - Clean air/water
  - Household proximity to public parks/wind turbines/landfills
  - Quality of public beaches
  - Keeping and releasing fish on a recreational fishing trip

- Choice experiments 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

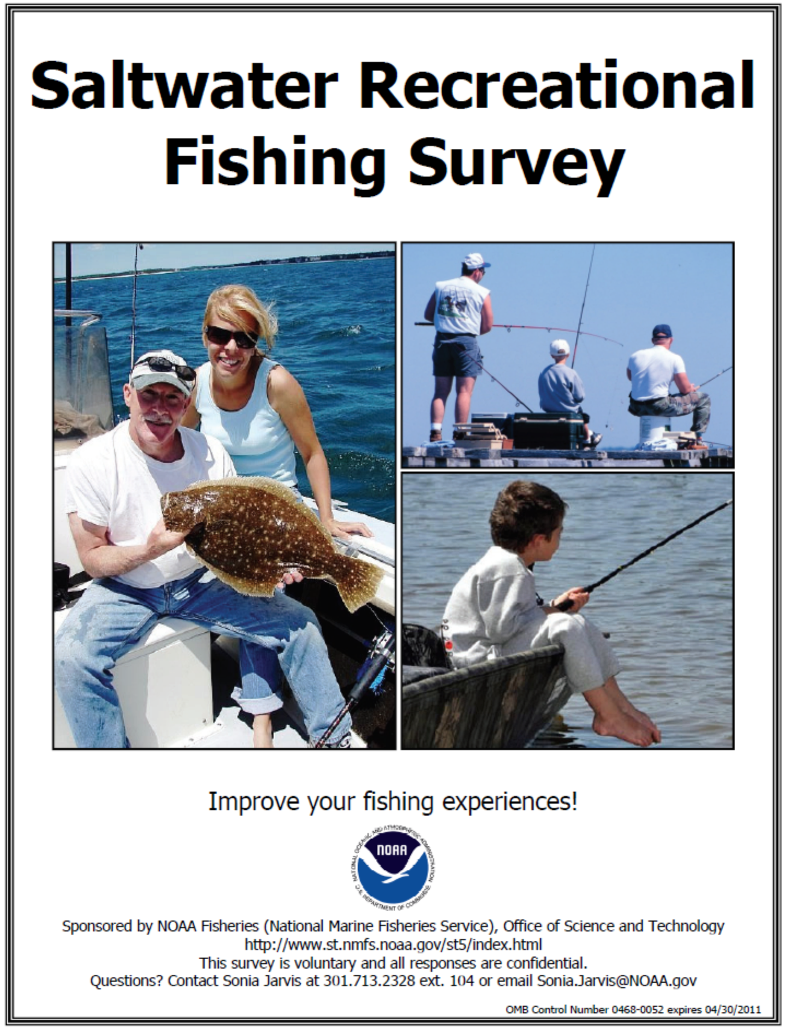
DCEs and recreational fishing

DCEs have been used extensively in recreational fishing contexts, providing a variety of information that can be used for management:

- Value of a fishing trip
- Value of keeping or releasing an additional fish
- Value of other trip factors (e.g., gear restrictions)
- Tradeoffs between factors (e.g., value of keeping cod relative to haddock)
- Effect of changes in factors on the probability of participation (effort shifts)

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 DCE question from 2010 survey

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	Go fishing for striped bass or bluefish
	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	
	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

<u>Definitions</u>:

- **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** ☐

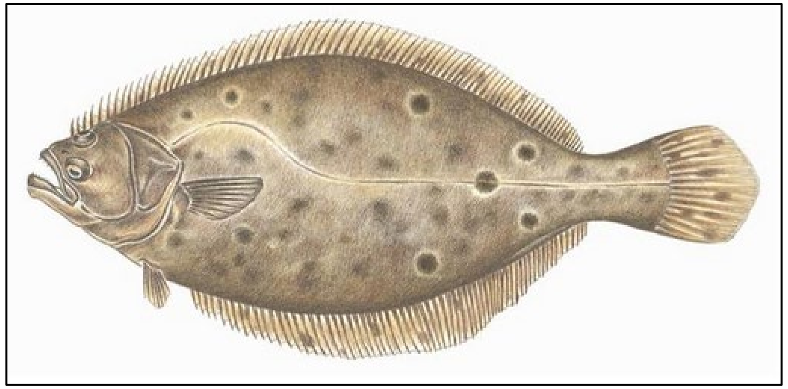
Key behavioral model output

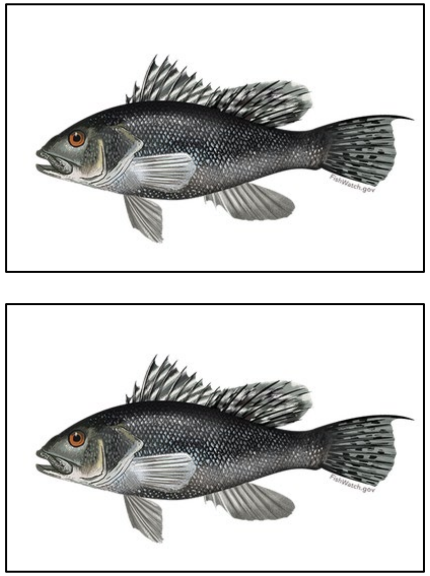
1. Satisfaction an angler receives from each trip attribute, particularly the number of fluke kept and released on a trip

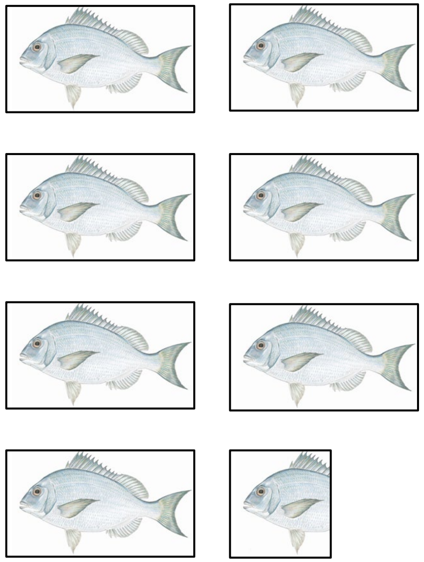
2. Satisfaction in dollar terms for these attributes (willingness-to-pay)

3. Changes in the probability of participation from changes in these attributes (effort shifts)

Estimated values of 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

Implementation model

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Implementation model

2. Fishery simulation
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Fishery simulation - method

- Simulate individual fishing trips using catch-per-trip data from MRIP and trip cost data from 2017 survey
- Catch-at-length is a function of population numbers-at-length
- Trips are assigned
    - #’s of fish caught for each species (SF and BSB, other species vary by region)
    - size of each fish caught
    - trip cost
- Impose bag and size limits at the state level, calculate numbers of fish kept and released
- Angler behavioral model results are used to calculate:
    - Probability-weighted numbers of fish kept and released
    - measures of success (e.g., angler welfare)
    - probability of participation (e.g., fishing demand responds as regulations make fishing more or less attractive)
- Aggregate output across region, simulate for multiple years and under different management measures

Implementation model – calibration statistics

	SF harvest in 2019 (#'s fish)			
Region	Model	MRIP	% error	Abs. error
MA-NY	953,868	919,994	3.68	33,874
NJ	1,038,184	1,108,158	-6.31	-69,974
DE-NC	240,562	355,076	-32.25	-114,514
Coast-wide total	2,232,615	2,383,228	-6.32	-150,613

	SF releases in 2019 (#'s fish)			
Region	Model	MRIP	% error	Abs. error
MA-NY	11,017,793	11,610,978	-5.11	-593,185
NJ	12,615,577	13,068,170	-3.46	-452,593
DE-NC	2,899,656	3,680,415*	-21.21	-780,759
Coast-wide total	26,533,025	28,359,563	-6.44	-1,826,538

*Two intercepted trips in VA, reportedly rec. fishing while actively tagging as part of tagging program, each released 100 fish which translates to 932,196 fish released

Implementation model – calibration statistics

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NJ	12,615,577	13,068,170	-3.46	-452,593
DE-NC	2,899,656	**2,748,219**	**5.51**	**151,437**
Coast-wide total	26,533,025	**27,427,367**	**-3.26**	**-894,341**

Combining implementation and operating model

- Implementation model output (rec. fishing mortality-at-length) will feed into the operating model, allowing for growth and recruitment effects over a given time horizon

- Can impose and predict the outcome of a variety of management measures (slot, minimum size limits, bag limits)

- Currently working on integrating the implementation with the operating model

Thank you!

Questions?

Fishery simulation - data

- Catch-per-trip distributions based on MRIP data

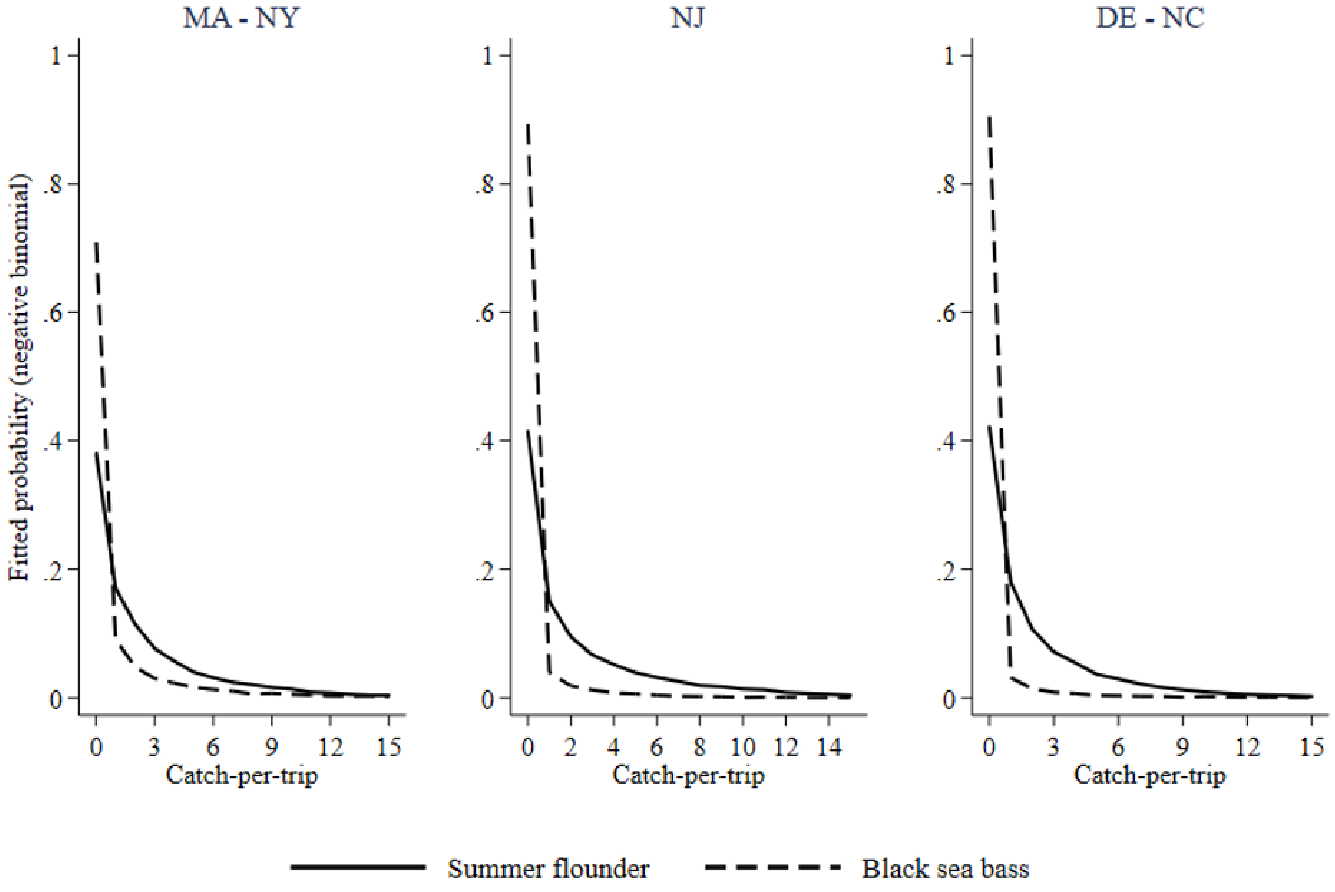

Figure 3. Detail of lower tail of 2019 catch-per-trip probability distributions. Distributions for scup, weakfish, and red drum not shown.

Fishery simulation - data

- Catch-at-length distributions (used for calibration) based on MRIP data

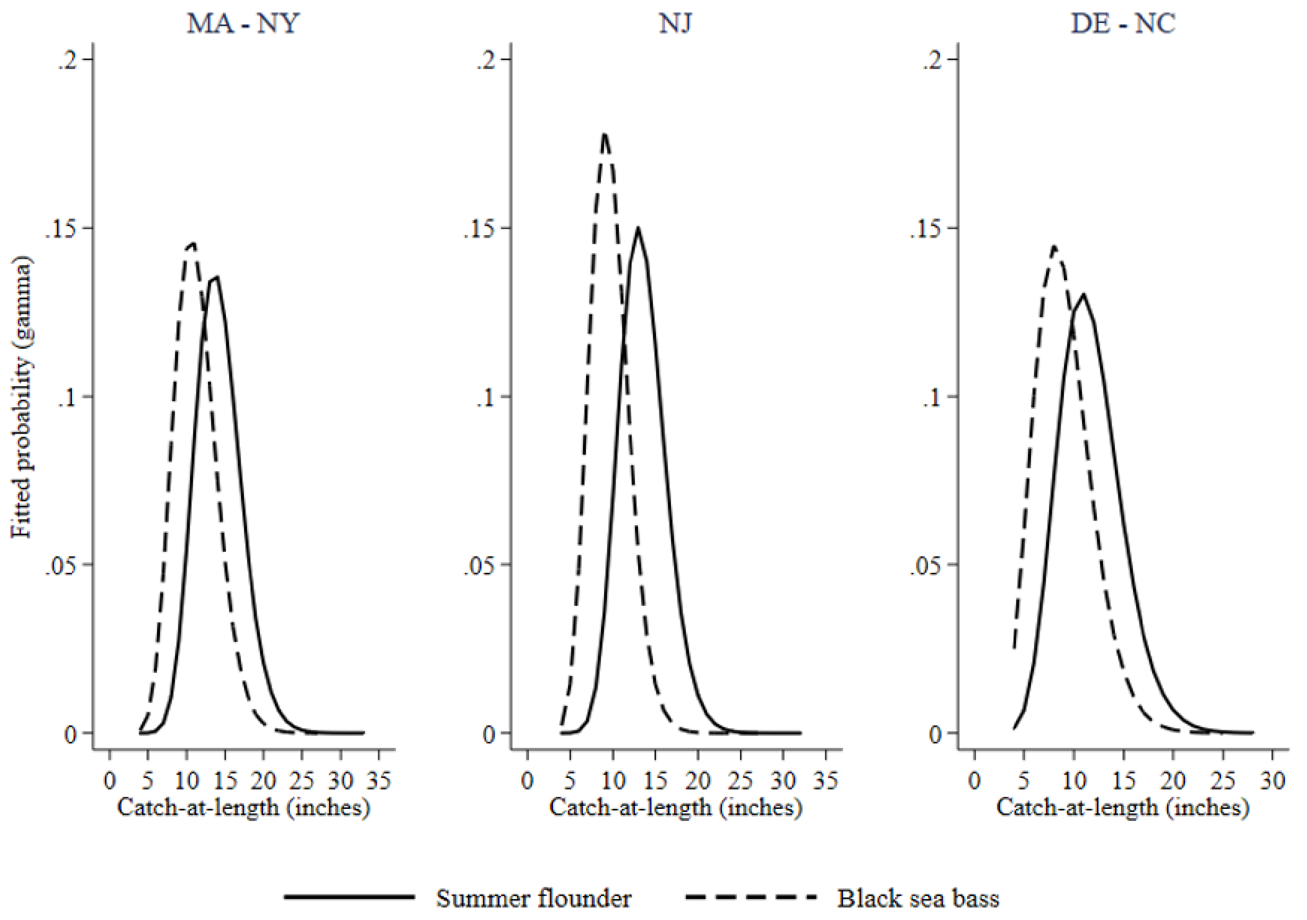

Figure 4. 2019 catch-at-length probability distributions. Distributions for scup, weakfish, and red drum not shown.

	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
St. dev. parameters								
$\sqrt{\text{SF kept}}$	0.678***	0.081	0.677***	0.081	0.599***	0.065	0.464***	0.044
$\sqrt{\text{SF released}}$	0.336***	0.064	0.181**	0.088	0.317***	0.049	0.221***	0.036
$\sqrt{\text{BSB kept}}$	0.261***	0.043	0.334***	0.045	0.287***	0.039	0.200***	0.032
$\sqrt{\text{BSB released}}$	0.087	0.063	0.012	0.080	0.160***	0.027	0.131***	0.023
$\sqrt{\text{scup kept}}$	0.143***	0.039	0.113**	0.045				
$\sqrt{\text{scup released}}$	0.014	0.067	0.117***	0.022				
$\sqrt{\text{WF kept}}$			0.199*	0.114	0.381***	0.066	0.393***	0.048
$\sqrt{\text{WF released}}$			0.278***	0.062	0.227***	0.067	0.146**	0.057
$\sqrt{\text{RD kept}}$							0.601***	0.059
$\sqrt{\text{RD released}}$							0.356***	0.035
do not fish	2.554***	0.221	2.394***	0.214	2.448***	0.214	2.918***	0.206
fish for other species	1.920***	0.135	1.832***	0.142	1.900***	0.127	1.991***	0.096
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	

	ME-NY	
Mean parameters	*Estimate*	*St. Error*
trip cost	-0.012***	0.000
$\sqrt{\text{SF kept}}$	0.559***	0.063
$\sqrt{\text{SF released}}$	-0.061	0.046
$\sqrt{\text{BSB kept}}$	0.275***	0.034
$\sqrt{\text{BSB released}}$	-0.021	0.024
$\sqrt{\text{scup kept}}$	0.075***	0.021
$\sqrt{\text{scup released}}$	-0.010	0.015
do not fish	-2.641***	0.252
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$\sqrt{\text{WF kept}}$		
$\sqrt{\text{WF released}}$		
$\sqrt{\text{RD kept}}$		
$\sqrt{\text{RD released}}$		
do not fish	2.554***	0.221
fish for other species	1.920***	0.135
No. choices	3460	
No. anglers	449	
Pseudo R^2	0.332	
LL	-3203.6	
LL(0)	-4796.6	
AIC	6441.1	
BIC	6569.2	

Regulations for 2019 (baseline year)

State	Period	Dates	Fluke regs.	BSB regs.	Scup regs.	Weakfish Regs.	Red drum regs.
MA	1	Jan 1. - May 17	closed	closed	30 fish, 9"	N/A	N/A
MA	2	May 18 - Sep. 8	5 fish, 17"	5 fish, 15"	50 fish, 9"	N/A	N/A
MA	3	Sep. 9 - Oct. 9	5 fish, 17"	closed	30 fish, 9"	N/A	N/A
MA	4	Oct. 10 - Dec 31	closed	closed	30 fish, 9"	N/A	N/A
NJ	1	Jan. 1 - May 14	closed	closed	50 fish, 9"	1 fish, 13"	N/A
NJ	2	May 15 - June 30	3 fish, 18"	10 fish, 12.5"	50 fish, 9"	1 fish, 13"	N/A
NJ	3	July 1 - Aug. 31	3 fish, 18"	2 fish, 12.5"	50 fish, 9"	1 fish, 13"	N/A
NJ	4	Sep. 1 - Sep. 30	3 fish, 18"	closed	50 fish, 9"	1 fish, 13"	N/A
NJ	5	Oct. 1 - Oct. 31	closed	10 fish, 12.5"	50 fish, 9"	1 fish, 13"	N/A
NJ	6	Nov. 1 - Dec. 31	closed	15 fish, 13"	50 fish, 9"	1 fish, 13"	N/A