Economic Impacts of Amendment 23 At-Sea Monitoring and Electronic Monitoring Options

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NOAA / NEFSC / READ / SSB
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Problem statement

The April 2019 SSC Peer Review report highlights that catch monitoring in New England groundfish may be a compliance problem. To date, we have treated it as an estimation problem.

Economic considerations .... are central to the long-run benefits derived from this fishery. There is a trade-off between the costs of monitoring catch and the potential for improving fishery performance through a robust and enforceable ACE lease market which, perhaps, will lead to improved stability for both allocations and catch.

Four inequities result from circumventing the ACE lease market:

1. Market is "incomplete": fisherman leasing in ACE do not pay the true cost, and fisherman leasing out ACE are insufficiently compensated;
2. Stock assessments are deprived of accurate data, perhaps leading to degraded assessment quality (*noting that inaccurate catch may not be the sole, or even a primary, cause of degraded assessments*);
3. To the extent that uncounted catch leads to degraded assessments and low fishery allocations, fish dealers and consumers are deprived of benefits from stable or increasing catch; and,
4. Where sector-level self-governance is at the core of the regulatory system, incentives that erode trust between fishermen, sectors, regulators and the public may create a negative feedback loop where circumventing regulations leads to loss of trust, inducing further circumvention of regulations.

ACE lease prices tell fisherman how and where to fish; high-grading and discarding mute these price signals....

- different incentives for lessors (who favor high lease prices) and lessees (who favor low lease prices); and,
- mis-allocating fishing effort, dulling the effect of ACE allocations as a constraint on fishing effort.

Benefits: **Improved catch accounting reduces effects of market failure in the ACE lease market, leading to a more equitable allocation of fishing effort and profits from the resource, while generating more accurate catch data.**

What is quantitatively analyzed?

1. Models and Methods
2. Describing the Status Quo and No Action
3. Stand-alone ASM Options (25, 50, 75, 100)
4. Blended ASM and EM Options (25/50/75/100 with Audit and Max Retention)
5. Removing the management uncertainty buffers
6. Summary
7. Dockside Monitoring

Two margins, **static costs** and dynamic impacts

Cost Efficiency Model - STATIC COSTS

What's changed?

- Applying models to FY 2018 data
  - 179 vessels making non-ELM exempt trips, vice 198 in FY 2017
- All vessels enroll in a technology for three years at a time
- For EM:
  - No "Census Model" considered
  - Three year horizon, not five
  - Review rates for Audit:
    - **Year 1 = 50%, Year 2 = 30%, Year 3 = 15%**
  - ...for Max Ret:
    - **Year 1 = 50%, Year 2 = 50%, Year 3 = 25%**
  - DSM incorporated into Max Retention cost estimates
  - Annual costs sequenced at vessel level (i.e. no shortcuts to a 15% review rate)
  - Two EM "flavors" considered: with, and without, a **"subsidy"**, a hypothetical where Year 1 equipment and installation are not industry obligations

- Estimated as "stand-alone" (where every vessel enrolls only in that technology)
- Four tables:
  - Days absent (six categories)
  - Home port (12 categories)
  - Vessel size class (three categories)
  - Sector (15 categories)
- High and Low estimates for the Fleet and per Vessel, Trip and Day
  - High and low are plus / minus one standard deviation from mean
  - Variability comes from two sources:
    1. vessel-level Monte Carlo sampling within the cost efficiency model; and,
    2. within-category variability for per vessel, trip and day estimates.

No Action at 22% Coverage, Days Absent Categories *(2018$, thousands)*

Cat	Fleet Low	Fleet High	Vessel Low	Vessel High	Trip Low	Trip High	Day Low	Day High
<=5	10.7	11.3	0.45	0.47	0.12	0.12	0.13	0.14
>5, <=20	68.8	72.6	2.22	2.34	0.12	0.13	0.13	0.14
>20, <=50	280.4	298.0	6.09	6.48	0.14	0.15	0.13	0.14
>50, <=80	170.8	182.7	12.20	13.05	0.17	0.18	0.13	0.14
>80, <=160	497.2	543.7	13.09	14.31	0.33	0.36	0.13	0.14
>160	419.1	461.1	20.96	23.06	0.55	0.61	0.13	0.14
TOTAL	1,447.0	1,569.4						

Home Port *(2018$, thousands)*

Home Port	Fleet Low	Fleet High	Vessel Low	Vessel High	Trip Low	Trip High	Day Low	Day High
OTHER MA PORTS	114.9	124	5.47	5.9	0.21	0.22	0.13	0.14
BOSTON	296.2	324.8	12.88	14.12	0.47	0.51	0.13	0.14
CHATHAM	82.6	86.6	3.75	3.93	0.1	0.1	0.13	0.14
GLOUCESTER	344	372.8	10.12	10.96	0.23	0.25	0.13	0.14
NEW BEDFORD	207.8	229	15.99	17.62	0.66	0.72	0.13	0.14
OTHER ME PORTS	70.9	75.7	5.46	5.83	0.15	0.16	0.13	0.14
PORTLAND	91.4	100.7	10.15	11.19	0.63	0.69	0.13	0.14
NH PORTS	99.8	107	8.32	8.92	0.17	0.18	0.13	0.14
NY PORTS	21.3	22.2	4.27	4.44	0.11	0.12	0.13	0.14
OTHER RI PORTS	8.8	9.8	2.95	3.25	0.55	0.61	0.13	0.14
POINT JUDITH	85.3	90.4	5.02	5.32	0.14	0.14	0.13	0.14
OTHER NORTHEAST PORTS	999	999	999	999	999	999	999	999

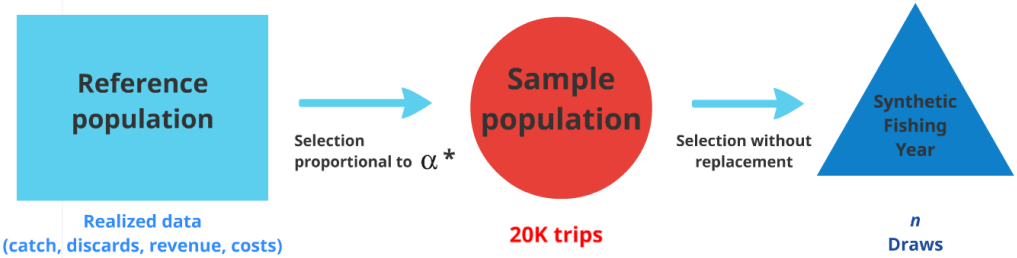
No Action at 22% Coverage, Vessel Size Class *(2018$, thousands)*

Size Class	Fleet Low	Fleet High	Vessel Low	Vessel High	Trip Low	Trip High	Day Low	Day High
30'to<50'	475.1	504.8	5.22	5.55	0.14	0.14	0.13	0.14
50'to<75'	474.2	516.0	8.78	9.55	0.28	0.30	0.13	0.14
75'+	497.7	548.6	17.77	19.59	0.71	0.78	0.13	0.14

Sector *(2018$, thousands)*

Sector	Fleet Low	Fleet High	Vessel Low	Vessel High	Trip Low	Trip High	Day Low	Day High
Sustainable Harvest Sector	379.1	417.7	15.8	17.4	0.66	0.72	0.13	0.14
Northeast Fishery Sector II	277.9	300.1	11.12	12	0.21	0.23	0.13	0.14
Northeast Fishery Sector XIII	120.9	132.8	8.06	8.85	0.49	0.54	0.13	0.14
Northeast Fishery Sector VI	106.5	117.4	15.22	16.78	0.74	0.82	0.13	0.14
Northeast Fishery Sector VIII	95.5	105.3	11.94	13.16	0.56	0.61	0.13	0.14
Northeast Fishery Sector XI	97.8	104.9	8.89	9.54	0.17	0.18	0.13	0.14
Georges Bank Cod Fixed Gear Sector	77.8	81.6	3.89	4.08	0.1	0.1	0.13	0.14
Northeast Fishery Sector V	76.7	80.3	5.12	5.35	0.11	0.12	0.13	0.14
Maine Coast Community Sector	67.7	73.3	4.51	4.89	0.2	0.22	0.13	0.14
Sustainable Harvest Sector - Inshore	51	55.1	6.38	6.89	0.19	0.21	0.13	0.14
Northeast Fishery Sector XII	48.3	50.9	6.9	7.27	0.12	0.13	0.13	0.14
Northeast Coastal Communities Sector	999	999	999	999	999	999	999	999
Northeast Fishery Sector III	18.1	19	2.26	2.38	0.11	0.11	0.13	0.14
Northeast Fishery Sector X	8.7	9.1	1.24	1.3	0.11	0.12	0.13	0.14
Northeast Fishery Sector VII	999	999	999	999	999	999	999	999

Quota Change Model - DYNAMIC IMPACTS



** Alpha weighs operational profit against quota consumed*

- Each ASM option as "stand-alone," plus "blended" with EM options
- MUB removal for ASM stand-alone and EM blended
- Four tables, as for static: Days absent, Home port, Vessel size class, Sector
- Reports gross revenues, ASM costs, Cost of Operations, Operational Profit, Profit as Percent of Gross and Profit relative to Status Quo are reported
- Mean estimates from 500 QCM runs, each with within-model ASM cost variability

No Action at 22% Coverage, Days Absent Categories *(2018$, thousands)*

Cat	Gross Rev	ASM Cost	Cost of Ops	Operational Profit	Profit (%)	Rel to SQ (%)
<=5	0.20	0.00	0.10	0.10	66.00	0.00
>5, <=20	1.80	0.10	0.50	1.20	69.10	-7.70
>20, <=50	7.80	0.30	2.20	5.30	67.80	-5.40
>50, <=80	6.20	0.20	2.10	3.90	62.80	-4.90
>80, <=160	27.50	0.50	7.30	19.70	71.60	-3.00
>160	27.80	0.40	7.30	20.00	72.10	0.50
TOTAL	71.30	1.50	19.50	50.20	70.40	-1.60

Home Port *(2018$, thousands)*

Home Port	Gross Rev	ASM Cost	Cost of Ops	Operational Profit	Profit (%)	Rel to SQ (%)
CT PORTS	0.20	0.00	0.00	0.10	76.60	0.00
OTHER MA PORTS	5.80	0.10	1.80	3.80	66.20	-2.60
BOSTON	16.60	0.30	4.70	11.60	70.10	-1.70
CHATHAM	4.80	0.10	0.80	3.90	81.50	-2.50
GLOUCESTER	16.40	0.40	4.40	11.70	71.20	-2.50
NEW BEDFORD	11.70	0.20	3.60	8.00	67.70	1.30
OTHER ME PORTS	2.10	0.10	0.70	1.30	63.70	-7.10
PORTLAND	5.30	0.10	1.50	3.70	69.60	-7.50
NH PORTS	2.20	0.10	0.70	1.40	64.60	-6.70
NY PORTS	0.60	0.00	0.10	0.50	85.50	0.00
OTHER RI PORTS	0.40	0.00	0.10	0.20	58.60	-33.30
POINT JUDITH	2.20	0.10	0.60	1.60	70.30	-11.10
OTHER NORTHEAST PORTS	999.00	999.00	999.00	999.00	999.00	0.00

No Action at 22% Coverage, Vessel Size Class *(2018$, thousands)*

Size Class	Gross Rev	ASM Cost	Cost of Ops	Operational Profit	Profit (%)	Rel to SQ (%)
30'to<50'	14.60	0.50	3.70	10.50	71.60	-4.50
50'to<75'	23.60	0.50	5.90	17.20	72.80	-1.10
75'+	33.10	0.50	9.90	22.60	68.50	-1.30

Sector *(2018$, thousands)*

Sector	Gross Rev	ASM Cost	Cost of Ops	Operational Profit	Profit (%)	Rel to SQ (%)
Sustainable Harvest Sector	25.00	0.40	6.90	17.70	70.90	-0.60
Northeast Fishery Sector II	14.50	0.30	3.70	10.50	72.30	-1.90
Northeast Fishery Sector VI	5.50	0.10	1.50	3.80	70.40	-5.00
Northeast Fishery Sector XIII	5.30	0.10	1.90	3.40	62.90	-2.90
Northeast Fishery Sector VIII	5.30	0.10	1.60	3.70	68.90	2.80
Georges Bank Cod Fixed Gear Sector	4.80	0.10	0.80	3.90	82.20	-2.50
Maine Coast Community Sector	2.60	0.10	0.70	1.80	69.40	-5.30
Northeast Fishery Sector XI	2.20	0.10	0.70	1.40	65.00	-6.70
Sustainable Harvest Sector - Inshore	1.90	0.10	0.70	1.20	59.20	0.00
Northeast Fishery Sector V	1.80	0.10	0.40	1.30	74.90	-7.10
Northeast Fishery Sector XII	1.30	0.10	0.40	0.90	69.20	-10.00
Northeast Coastal Communities Sector	999.00	999.00	999.00	999.00	999.00	0.00
Northeast Fishery Sector III	0.50	0.00	0.20	0.30	63.00	0.00
Northeast Fishery Sector X	0.10	0.00	0.00	0.10	61.60	0.00
Northeast Fishery Sector VII	999.00	999.00	999.00	999.00	999.00	0.00

Estimating the Status Quo

Distinction between No Action (includes industry funded monitoring) and contemporary conditions (do not)

Evaluating change relative to No Action could underestimate true impacts Status Quo is

contemporary (FY18) conditions To distinguish between *effects driven by the model* and *effects driven by the regulatory changes*, QCM parameterized to replicate FY18, using FY18 sector sub-ACLs and trip data

Modeled SQ Nearly Replicates Realized FY18 Estimates *(2018$, thousands)*

Model	G Rev	Gfish Rev	Ops cost	Sect cost	ACE cost	ASM cost	Op prof
FY18 - Realized	70.90	49.40	12.30	2.00	5.40	0.00	51.30
FY18 - Prediction (SQ)	70.60	49.10	12.10	1.90	5.40	0.00	51.10

Model	Crew days	Days Absent	N trips
FY18 - Realized	39.14	10.57	7.17
FY18 - Prediction (SQ)	38.73	10.50	7.06

SQ Model Exhibits Most Uncertainty For Winter Fl and CC/GOM Ytf *(Catch in metric tons, revenue in 2018$, mil)*

Stockname	subACL	Real Catch	Pred Catch	Real Gross	Pred Gross	% Diff
GB Haddock West	28,857	4,590	4,353	7.75	7.44	-4%
GOM Haddock	8,643	2,843	2,908	6.26	6.43	2.7%
Redfish	10,696	5,369	5,189	5.92	5.70	-3.7%
Pollock	37,163	3,482	3,249	5.42	5.23	-3.5%
Plaice	1,550	1,071	1,125	4.84	5.08	5%
White Hake	2,713	2,096	2,162	4.36	4.52	3.7%
GB Cod West	1,083	726	735	3.13	3.16	1%
GB Winter Flounder	725	420	363	3.02	2.67	-11.6%
Witch Flounder	830	799	830	2.77	2.88	4%
GOM Cod	377	310	302	1.61	1.58	-1.9%
SNE Winter Flounder	456	229	224	1.38	1.39	0.7%
GB Haddock East	15,491	637	622	1.02	1.02	0%
GOM Winter Flounder	339	91	98	0.53	0.57	7.5%
GB Cod East	252	107	105	0.49	0.48	-2%
CC/GOM Yellowtail Flounder	381	165	179	0.37	0.40	8.1%
GB Yellowtail Flounder	167	28	20	0.10	0.08	-20%
SNE/MA Yellowtail Flounder	34	7	7	0.03	0.03	0%

No Action and Stand-alone ASM Options

No Action estimated *with industry funded monitoring* at both 13% and 22% coverage

- 13% represents average combined coverage target, less NEFOP
- 22% is average target with NEFOP
- Cost of 9% NEFOP (cost difference between 13% and 22%) is **~$600k**
- EM options not analyzed together with No Action

Stand-alone ASM options analyzed at target rates **without NEFOP**, except 100% coverage (analyzed at 91%)

EM Options

Audit and Max Retention models are analyzed separately as "stand-alone" options (static costs) and together as "blended" options (dynamic impacts)

Notes:

- EM considered voluntary substitute for human observers;
- has costs that decrease between year 1 and 3 due to equipment purchase, installation and a declining review rate;
- for blended (EM and ASM) model, costs are based on 3-yr average;
- analyzed in two flavors, with subsidy and without.

For Static Costs, EM Savings Come In Years 2-3 (without subsidy); With Subsidy, EM Lower Cost Than All But 25% ASM *($2018, mil)*

Option	Stand-alone Cost
ASM, 13% (NA)	0.90
ASM, 22% (NA)	1.51
ASM, 25%	1.72
ASM, 50%	3.39
ASM, 75%	4.89
ASM, 100%	5.72
Audit, Yr1	5.72
Audit, Yr1-Subsidy	2.68
Audit, Yr2	2.01
Audit, Yr3	1.23
MaxRet, Yr1	5.19
MaxRet, Yr1-Subsidy	2.15
MaxRet, Yr2	2.15
MaxRet, Yr3	1.82

Costs Matter: Year 1 EM Costs Much Higher Than 3-year Average; EM Subsidy Saves About 35%; Audit and MaxRet Roughly Similar In Cost *($2018, mil)*

Cost Type	ASM Option	ASM Cost	Audit Cost	Audit Cost, Subsidy	MaxRet Cost	MaxRet Cost, Subsidy
Year 1	ASM, 100%	5.72	5.72	2.68	5.19	2.15
Year 1	ASM, 75%	4.89	5.72	2.68	5.19	2.15
Year 1	ASM, 50%	3.39	5.72	2.68	5.19	2.15
Year 1	ASM, 25%	1.72	5.72	2.68	5.19	2.15
3-Yr Avg	ASM, 100%	5.72	2.99	1.97	3.05	2.04
3-Yr Avg	ASM, 75%	4.89	2.99	1.97	3.05	2.04
3-Yr Avg	ASM, 50%	3.39	2.99	1.97	3.05	2.04
3-Yr Avg	ASM, 25%	1.72	2.99	1.97	3.05	2.04

Blending EM and ASM

Three factors drive which vessels chose which programs:

1. The cost of the ASM alternative (varies by coverage option);
2. EM costs for the Audit and MaxRet models; and,
3. Preferences of the owner, captain and crew.

Predictions of how many and which vessels may opt into each monitoring technology are based on cost, but cost will not be the sole driver

We analyze (a) the lowest possible cost and, using a different model, (b) an "expected value" estimate that is substantially higher than the "low-cost frontier"

"Expected value" model uses weighted sampling to pick ASM, Audit or MaxRet randomly for each vessel in a Monte Carlo model with 10k replications, where weights determined by the cost difference between ASM and the two EM options

If an EM option is half the cost of ASM, it will be picked twice as often

"Low-cost Frontier" About 35% Less Expensive Than "Expected Value" *($2018, mil)*

Subsidy	ASM Option	Low-cost Frontier	Expected Value
0	ASM 25	1.67	1.89
	ASM 50	2.19	2.78
	ASM 75	2.30	3.03
	ASM 100	2.33	3.17
1	ASM 25	1.42	1.51
	ASM 50	1.54	2.10
	ASM 75	1.56	2.28
	ASM 100	1.57	2.31

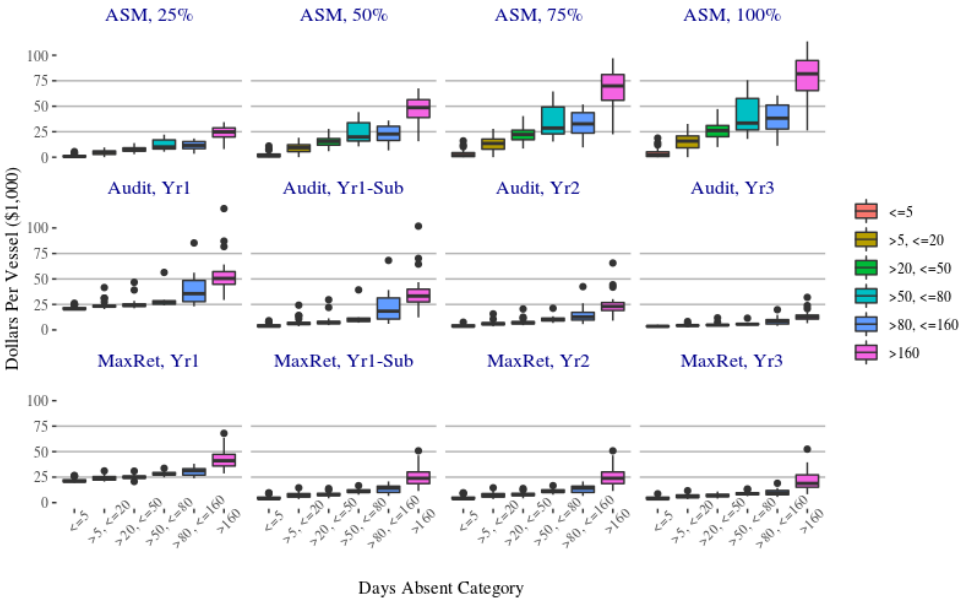
The Expected Value model is intended as a proxy for unknowable individual preferences, and **is the basis for blended EM and ASM impact estimates**

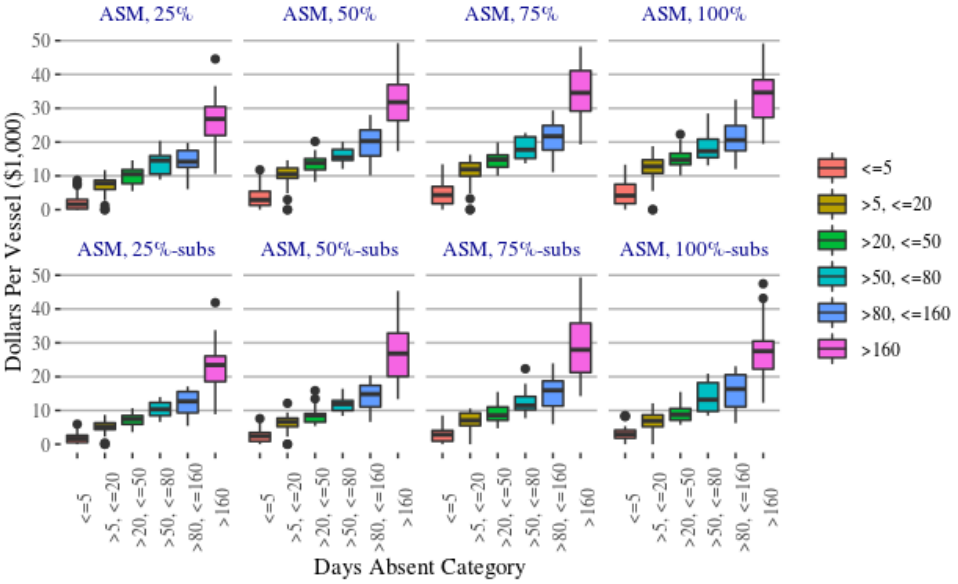
Most Vessels Predicted to Opt Into Audit Program

Subsidy	ASM Option	nVsls ASM	nVsls Aud	nVsls MaxR
0	ASM 25	169	7	3
	ASM 50	92	72	15
	ASM 75	65	96	18
	ASM 100	58	104	17
1	ASM 25	117	49	13
	ASM 50	54	105	20
	ASM 75	36	120	23
	ASM 100	33	125	21

EM Options Significantly Less Costly Than ASM Alone *($2018, mil)*

Subsidy	Option	Blend	ASM	$ Saved	% Saved	Yr1	Yr2	Yr3
0	ASM 25	1.89	1.72	-0.17	-10%	1.94	1.73	1.67
	ASM 50	2.78	3.39	0.61	18%	4.34	2.17	1.58
	ASM 75	3.03	4.89	1.86	38%	5.00	2.19	1.50
	ASM 100	3.17	5.72	2.55	45%	5.27	2.23	1.51
1	ASM 25	1.51	1.72	0.21	12%	1.72	1.58	1.29
	ASM 50	2.10	3.39	1.29	38%	2.59	2.15	1.41
	ASM 75	2.28	4.89	2.61	53%	2.75	2.26	1.46
	ASM 100	2.31	5.72	3.42	60%	2.99	2.43	1.57


ASM, 25%
ASM, 50%
ASM, 75%
ASM, 100%
Audit, Yr1
Audit, Yr1-Sub
Audit, Yr2
Audit, Yr3
MaxRet, Yr1
MaxRet, Yr1-Sub
MaxRet, Yr2
MaxRet, Yr3
Dollars Per Vessel ($1,000)
100
75
50
25
0
<=5
>5, <=20
>20, <=50
>50, <=80
>80, <=160
>160
Days Absent Category


ASM, 25%
ASM, 50%
ASM, 75%
ASM, 100%
ASM, 25%-subs
ASM, 50%-subs
ASM, 75%-subs
ASM, 100%-subs
Dollars Per Vessel ($1,000)
0
10
20
30
40
50
<=5
>5, <=20
>20, <=50
>50, <=80
>80, <=160
>160
Days Absent Category

Removal of Management Uncertainty Buffers

Buffers are 5% for most allocated stocks and 3% for stocks with no state waters sub-component

Only applies if Council selects 100% coverage option

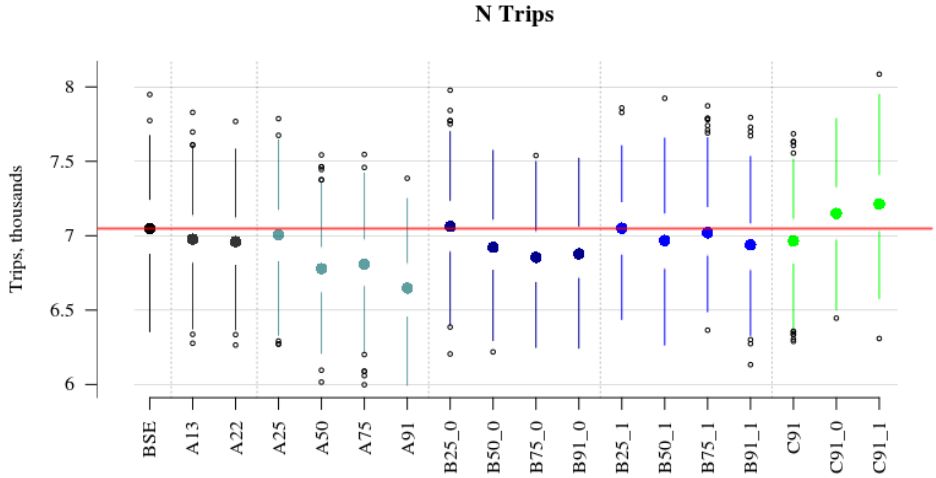
Three scenarios:

- Stand-alone ASM at 100% (91% industry);
- Blended EM and ASM without subsidy; and,
- Blended with subsidy.

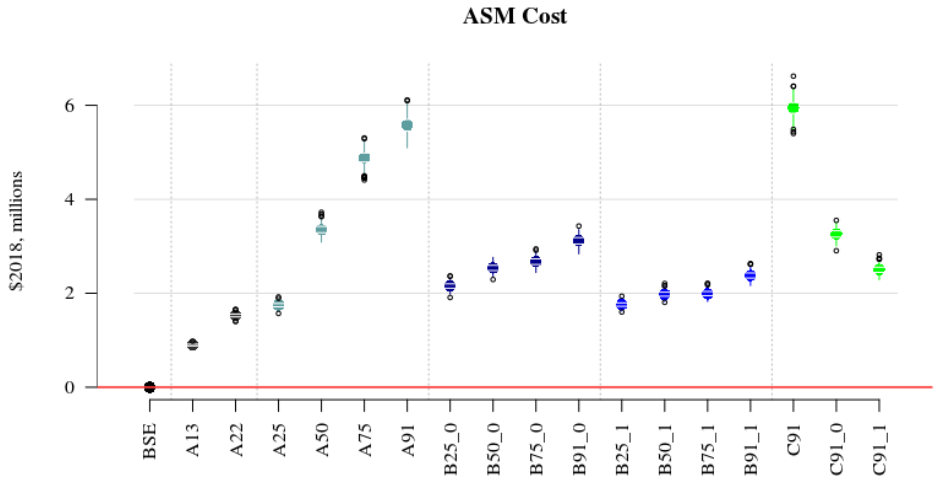
With EM, Removing Management Uncertainty Buffer Increases Catch and Raises Profits Relative to SQ *($2018, mil)*

Option	Gross	ASM	Ops Cost	Op Profit	Prof (%)	Rel SQ (%)
No Action	71.0	5.5	19.1	46.2	65.1	-9.4
ASM only	75.1	5.9	20.5	48.7	64.8	-4.5
Blended, 0	75.6	3.3	20.5	51.7	68.4	1.4
Blended, 1	75.7	2.5	20.6	52.9	69.9	3.7

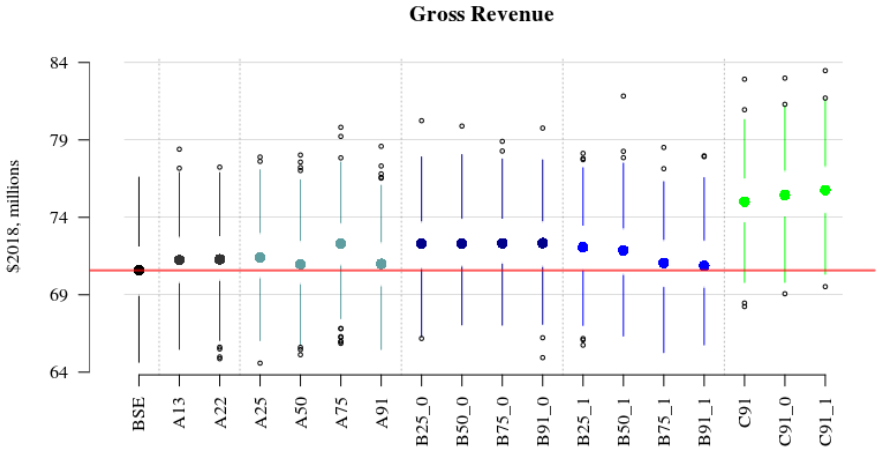
Number of Trips Declines As Costs Rise, Except When More Fish Is Available



EM Options Reduce Costs Substantially

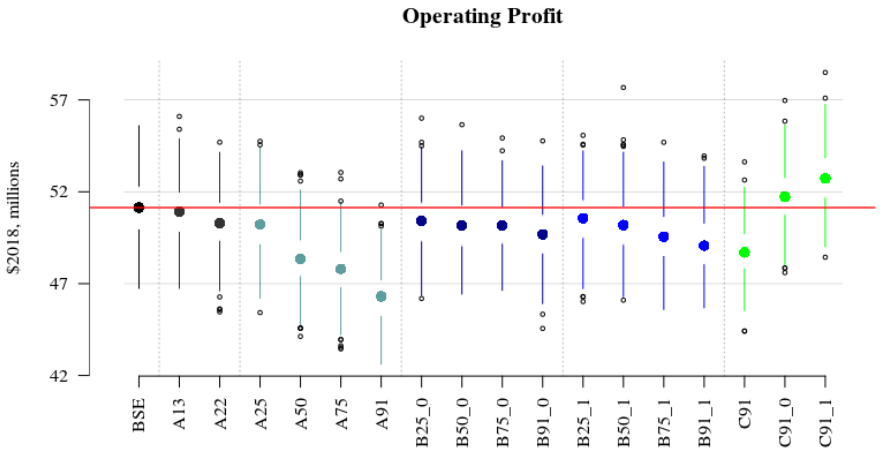


Cost Increases May Increase Revenue; More Fish Will Generate More Revenue, and 5% More Fish May Generate >5% More Revenue

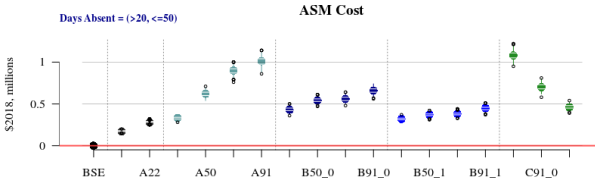


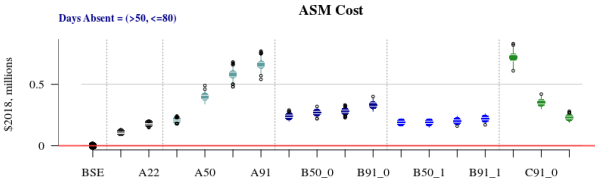
Profits Decline As Costs Increase*; Declines Are Much Less for Blended EM; More Fish + EM May Raise Profits Above SQ

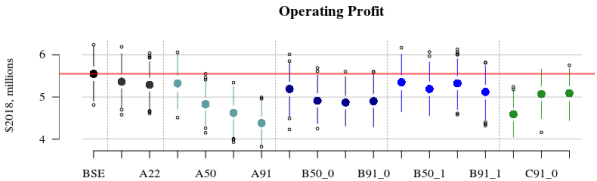
*Duh

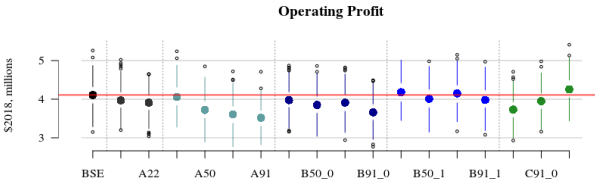


Addition of Buffers + EM May Not Compensate for Costs Until Vessels Fish >50 Days

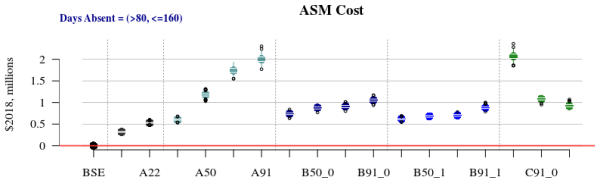


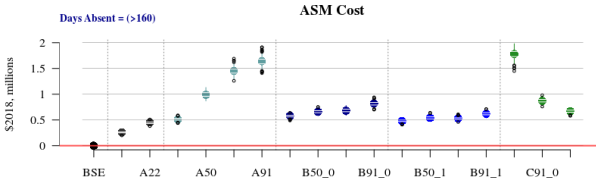


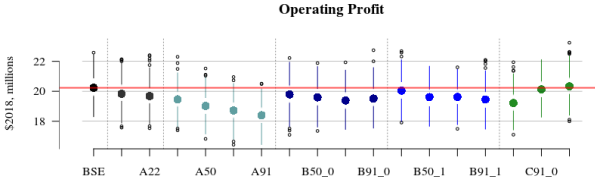


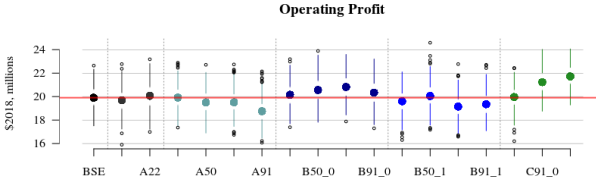


Vessels Fishing >160 Days May Benefit More From Buffers + EM

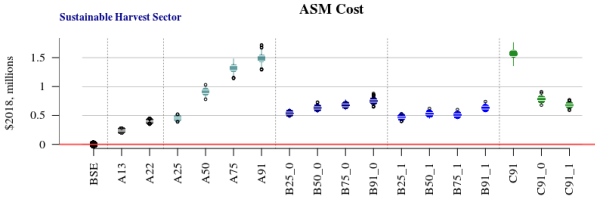


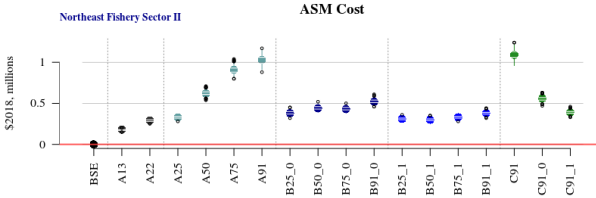


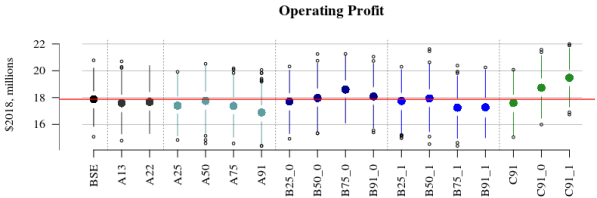


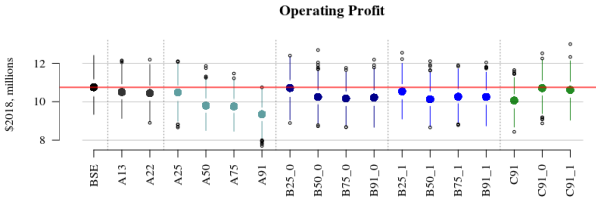


SHS May Be Less Affected By Costs (ASM and EM), Benefit More From Buffers, Relative to NEFS 2

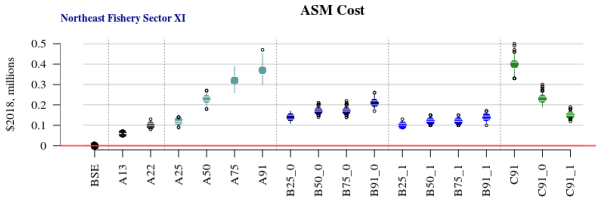


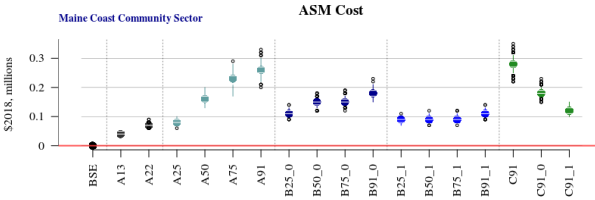


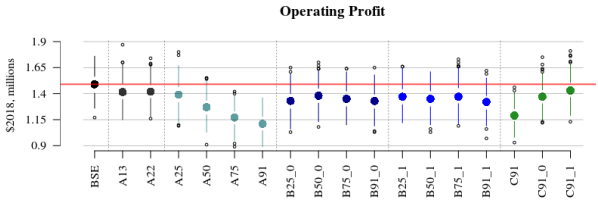


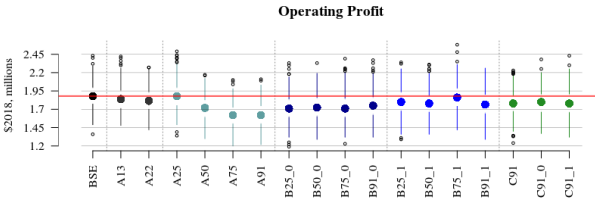


Even Within GOM, Some Sectors May Be Affected More Than Others

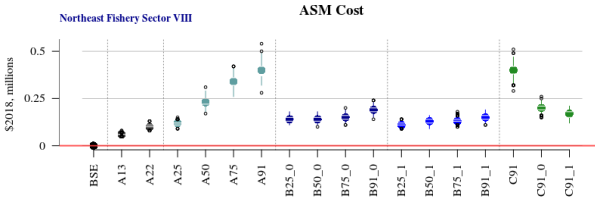


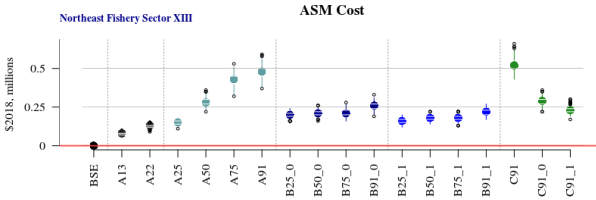


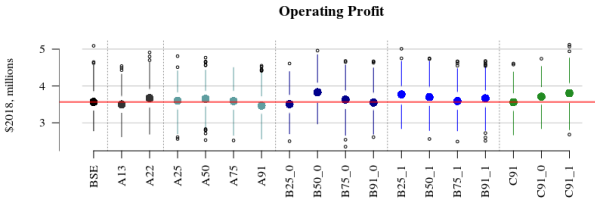


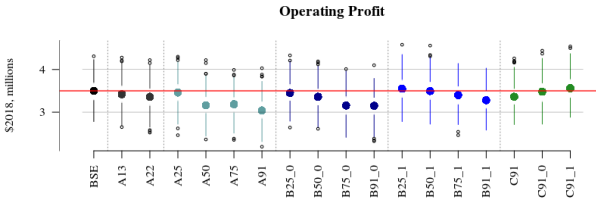


Southern GB and SNE Sectors Also See Different Responses to Higher Costs

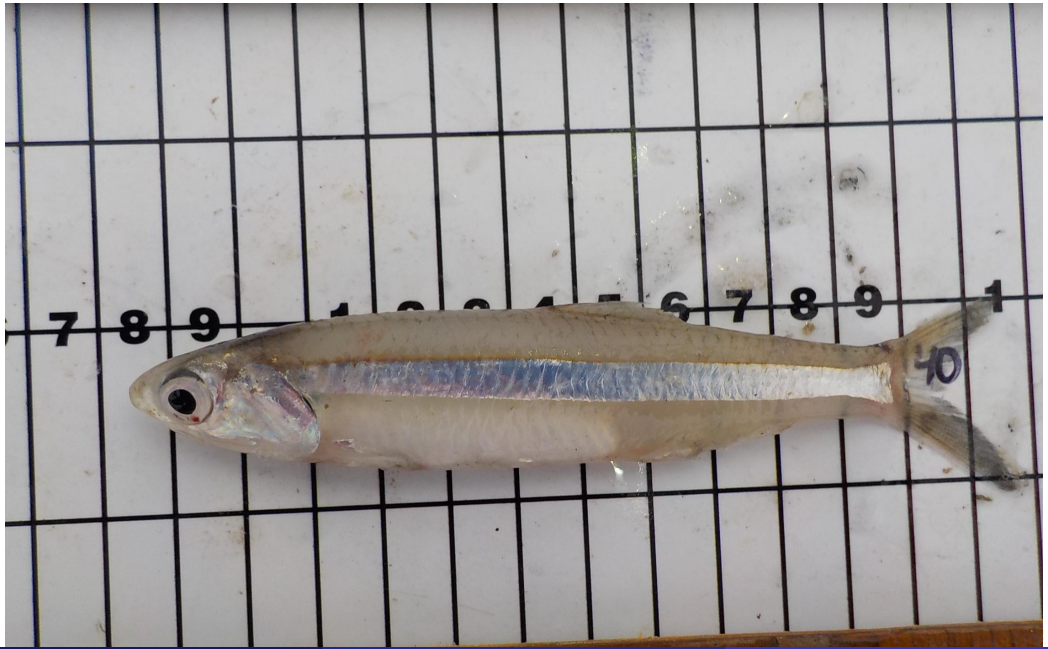








- Relationship between static cost and dynamic operating profit is not linear because quota are tradeable;
- **EM is substantially less costly than ASM** for all vessels fishing in the (non-FW55 exempt) groundfish fishery more than 20 days per year;
- The ability to select into EM **reduces cost by 44% - 60%** when costs are averaged over three years, noting that even this cost reduction is based on an estimate that is not optimized (ASM alone could be roughly 70% more expensive to industry than the low-cost frontier when equipment and installation are subsidized);
- Subsidizing equipment and installation in year 1 brings the three-year average cost of comprehensive monitoring below the cost of partial monitoring as they were initially analyzed in A16; and,
- **Gross revenues and operating profits are all higher for comprehensive (100%) monitoring** than they are estimated to be under the Status Quo (no industry funded monitoring) scenario, when the option to remove management uncertainty buffers is selected, noting that these increased profits are not uniformly distributed across the fishing fleet.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