Quota Change Model Prediction for 2020 Groundfish Fishing Year

Methods

The Quota Change Model (QCM) is used to analyze the impacts of each combination of measures on the sector portion of the groundfish fishery, which comprised 99% of commercial groundfish landings and revenues during the 2018 groundfish fishing year (FY2018). The QCM is a Monte Carlo simulation model that selects from existing records the trips most likely to take place under new regulatory conditions. To do this, a large pool of actual trips is created from a reference data set. The composition of this pool is conditioned on each trip's utilization of allocated ACE, under the assumption that the most likely trips to take place in the FY being analyzed are those fishing efficiently under the new sector sub-ACLs. The more efficiently a trip uses its ACE, the more likely that trip is to be drawn into the sample pool. ACE efficiency is determined by the ratio of ACE expended to net revenues on a trip, iterated over each of the 17 allocated stocks. Operating profits are calculated as gross revenues minus trip costs minus the opportunity cost of quota, where trip costs are estimated using observer data and quota opportunity costs are estimated from a model of inter-sector lease price and quantity data (details on the methods can be found in Murphy et al. 2018).

After the sample pool has been constructed, trips are pulled from the pool at random, summing the ACE expended for the 17 allocated stocks as each trip is drawn. When one stock's ACE reaches the sector sub-ACL limit, no further trips from that broad stock area are selected. The model continues selecting trips until sector sub-ACLs are achieved in all three broad stock areas or, alternatively, if sub-ACLs are reached for one of the unit stocks, the trip selection process ends for all broad stock areas at once[1]. This selection process forms a "synthetic fishing year" and a number of years, typically 500, are drawn to form a model. Median values and confidence intervals for all draws in a model are reported.

By running simulations based on actual fishing trips, the model implicitly assumes that:

- stock conditions, fishing practices and harvest technologies existing during the data period are representative;
- trips are repeatable;
- demand for groundfish is constant, noting that fish prices do vary between the reference population and the sample population, but this variability is consistent with the underlying price/quantity relationship observed during the reference period;
- quota opportunity costs and operating costs are both constant; and,
- no transaction costs and perfect information. ACE flows seamlessly from lesser to lessee such that fishery-wide caps can be met without leaving ACE for constraining stocks stranded.

Because the fishery is modeled as a whole, allocations to individual sectors are not considered.

[1] The model does not currently incorporate sector's ability to convert cod and haddock quota from the "east" (US/CA area) to the "west" allocations. Instead, it assumes that initial east and west allocations are fixed with no conversion.

These assumptions will surely not hold—fishermen will continue to develop their technology and fishing practices to increase their efficiency, market conditions will induce additional behavioral changes, and fishery stock conditions are highly dynamic. Fuel prices and other operating costs may change due to larger economic shifts or shore-side industry consolidation.

The net effect of the constraints imposed by these assumptions is unclear. The selection algorithm draws mainly from efficient trips[2]—if fishermen make relatively less efficient trips the model estimates will be biased high. Fishermen, however, are generally good at their job, and through a combination of technological improvement (gear rigging, equipment upgrades, etc.) or behavioral modifications, they are likely to improve on their ability to avoid constraining stocks. If fishermen are able to make these adjustments, the model predictions will be biased low. Furthermore, the model will under-predict true landings and/or revenues if stock conditions for non-constraining stocks improve, if demand for groundfish rises, or if fishing practices change and fishermen become more efficient at maximizing the value of their ACE. Conversely, the model will over-predict true landings and/or revenues if stock conditions of non-constraining stocks decline, markets deteriorate, or fishing costs increase. Importantly, the model will over-predict landings and revenues if stock conditions for constraining stocks improve substantially and/or fishermen are unable to avoid the stock—in this circumstance, better than expected stock conditions will lead to worse than anticipated fishery performance. The opposite is also true—if a stock predicted to be constraining to the fishery becomes easier to avoid due to technological or behavioral improvements in targeting, or due to declining stock conditions, the model will under-predict revenues.

The model is intended to capture fishery-wide behavioral changes with respect to groundfish sub-ACL changes, and groundfish catch is maximized by the constrained optimization algorithm. Catch of non-groundfish stocks on groundfish trips are captured in the model, but not explicitly modeled, such that constraints on other fisheries are not incorporated. Groundfish vessels on groundfish trips form the unit of measurement for this analysis. Many groundfish fishermen are involved in other fisheries and groundfish trip revenues may represent anywhere from 100% to a small fraction of total revenues for individual fishing businesses impacted by these regulations.

Each year the QCM is updated to reflect regulations and on-the-water conditions. In FW47, FW51, and FW53 the QCM drew from the most recent fishing year for which a full year of data was available. To better capture contemporary stock conditions, operating costs and fishing practices, trips from two fishing years were used in FW55 (FY2014 through November FY2015) and FW56 (FY2015 through November FY2016). The model for FY2015 and FY2016 over-predicted groundfish revenues and this may have been due to the additional partial-year of trips included in the sample pool—the model was able to draw in more efficient trips than the fishery was able to realize. For FW57 and FW58, trips were drawn from a sample pool constructed from one FY of data, in this case FY2016 for FW57 and FY2017 for FW58.

[2] Since the prediction for FY2015 (FW55), a parameter has been added to the QCM to select a small number of inefficient (often negative net revenue) groundfish trips. In general, model predictions of effort (trips and days absent) have been closer to realized effort since the addition of this parameter.

Likewise, for FW59, the sample pool was constructed using data from one FY (2018). As the anticipated groundfish closed areas for FY2020 are the same as those which occurred during FY2018, there was no need to filter out trips to certain areas from the selection pool. At-sea monitoring (ASM) was assumed to be fully subsidized for FY2020. That is, the condition of a trip being observed/unobserved has no explicit effect on its ability to be chosen into the selection pool.[3]

To understand the QCM's ability to predict groundfish fishery catch and revenues, we offer a retrospective of the models' performance. The model was developed during FY2011 to make predictions for FW47 (FY2012) and has been used in analyzing the impacts of all subsequent groundfish management actions that included ACL changes for the groundfish fishery. Table 1 summarizes the performance of the QCM in predicting revenues and costs on sector groundfish trips since FY2015. Information on the performance of the QCM during earlier years (FY2011-FY2014) can be found in Groundfish FW58. Groundfish revenues were slightly over predicted for FY2015 (+4.8%), FY2016 (8.9%), and FY2017[4] (+7.4%). For FY2018, the over-prediction was more substantial (+19.2%), driven in part by a decrease in groundfish ex-vessel prices for FY2018. Total revenues were under-predicted for FY2015 (-6.8%) and FY2016 (-5.1%), followed by over-predictions for FY2017 (+6.5%) and FY2018 (+16.3%). Cost predictions, in percentage terms, have generally been less accurate than revenue predictions. Operating costs were only slightly over-predicted for FY2017 (+7.0%), but predicted operating costs were over 25% more than realized operating costs for FY2015, FY2016, and FY2018. Quota costs were under-predicted for FY2015 (-32.0%), FY2016 (-40.4%), and over-predicted for FY2017 (27.8%) and FY2018 (121.7%).

[3] In the reference year (FY2018) unobserved trips were found to be slightly more quota efficient than observed trips, meaning the synthetic fishing years produced by the QCM for FY2020 would have lower observer coverage rates than was realized in FY2018. In prior years (FY2014-2017), this phenomenon of unobserved trips being more quota efficient than unobserved trips was not realized.

[4] Predictions made in FW56 for FY2017 were affected by the suspension of operations for the Northeast Fisheries Sector (NEFS) 9 on November 20, 2017. Under the terms of this suspension, NEFS 9 was not permitted to utilize or lease out their remaining quota, leaving a portion of the total available sector sub-ACL stranded (i.e., unable to be leased or caught because the sector could not operate).

Table 1- QCM predictions, FY2015-2019, 2018 dollars (millions)

	FY2015		FY2016		FY2017		FY2018		FY2019
	Predicted[5]	Realized	Predicted[6]	Realized	Predicted[7]	Realized	Predicted[8]	Realized	Predicted[9]
Groundfish Revenue	60.2	57.5	56.4	51.8	50.9	46.7	58.9	49.4	54.7
Total Revenue	77.7	83.3	74.3	78.3	73.5	70.1	83.9	72.1	78.0
Operating Cost	23.9	16.6	17.9	14.1	13.5	13.0	15.6	12.5	14.6
Sector Cost	1.7	2.0	2.0	1.7	1.7	1.8	1.7	2.0	1.9
Quota Cost	6.4	9.4	6.1	10.2	7.1	9.4	12.0	5.4	7.5
Operating Profit	45.7	55.3	48.4	52.4	51.2	46.0	54.5	52.2	53.9

[5] FW53, reference pool=FY2013

[6] FW55, reference pool=FY2014-15 (full year FY2014, FY2015 through Oct. 2015)

[7] FW56, reference pool=FY2015-16 (full year FY2015, FY2016 through Nov. 2016) ; FY2017 prediction incorporating Sector NEFS IX stranded quota

[8] FW57, reference pool=FY2016

[9] FW58, reference pool=FY2017

Results- Alternative 1/No Action ACLs for FY2020

Predicted groundfish revenue for FY2020 is $46.0M, representing an $8.7M decrease from the FY2019 prediction in FW58, and a $3.4M decrease from the FY2018 realized value of $49.4M (Table 2). Total gross revenues from groundfish trips for FY2020 is $65.2M. This represents a $12.8M decrease from the FY2019 prediction of $78.0M, and a $6.9 decrease from the FY2018 realized value of $72.1M.

At the stock-level (Table 3), witch flounder is predicted to be a constraining stock under No Action ACLs. Other stocks with high utilization rates include plaice, white hake, GOM cod, and GB cod east. The four stocks with highest predicted ex-vessel value (GB haddock west, GOM haddock, plaice, and redfish) are not predicted to have high rates of utilization in FY2020.

At the port-level (Table 4), many of the major groundfish ports have lower predicted values for FY2020 than were predicted for FY2018 or FY2019. Gloucester is predicted to be the top groundfish port ($11.7M), with ~25% of ex-vessel value in the sector groundfish fishery. Boston is predicted to be the second highest grossing port ($11.3M), followed by Portland ($7.4M), and New Bedford ($6.8M).

By vessel length (Table 5), vessels >75'+ are predicted to generate ~50% of sector groundfish revenue in FY2020. Vessels in the 50 to <75' category are predicted to generate ~35% of sector groundfish revenue, and vessels in the 30' to <50' category are predicted to generate ~15%.

Table 2- Summary of realized FY2018 and predicted FY2019 and FY2020 revenues and costs for the sector portion of the commercial groundfish fishery, real dollars (millions, 2018)

Option	Groundfish Gross Revenues	Total Gross Revenues	Operating Cost	Sector Cost	Quota Cost	Operating Profit	Days Absent
FY2018 Realized	49.4	72.1	12.5	2.0	5.4	52.2	10,952
FY2018 Prediction (FW57)	58.9	83.9	15.6	1.7	12.0	54.5	14,762
FY2019 Prediction (FW58)	54.7	78.0	14.6	1.9	7.5	53.9	13,900
FY2020 Prediction (Alt 1/No Action)	46.0	65.2	11.7	1.8	5.2	46.5	10,209
FY2020 Prediction (Alt 2)	48.9	69.9	12.5	1.9	5.4	50.2	10,907
FY2020 Prediction - FY2018 Realized	*-0.5*	*-2.2*	*0.0*	*-0.1*	*0.0*	*-2.0*	*-45*

Table 3-Alternative 1/No Action stock-level catch and revenue predictions with 5% and 95% confidence intervals, nominal dollars (millions). Stocks are presented in order of FY2020 predicted ex-vessel value.

Stock	Sub-ACL (mt)	Predicted Catch (mt)	Predicted Utilization	FY20 Prediction	p(5%) Revenue	p(95% Revenue)	FY19 Predicted Revenue	FY18 Predicted Revenue	FY18 Realized Revenue
GB Haddock West	61,815	3,892	6.3%	6.7	5.8	7.7	7.1	7.7	7.3
GOM Haddock	6,700	2,767	41.3%	6.2	5.7	6.6	6.8	6.3	5.7
Plaice	1,337	1,105	82.6%	5.0	4.7	5.3	7.3	4.8	7.9
Redfish	11,060	4,477	40.5%	4.9	4.3	5.5	5.9	5.9	6.0
Pollock	37,152	2,742	7.4%	4.5	4.2	4.9	6.0	5.4	6.4
White Hake	2,714	2,085	76.8%	4.3	4.1	4.7	5.9	4.4	5.8
GB Cod West	1,832	731	39.9%	3.1	2.9	3.3	2.5	3.1	3.0
Witch Flounder	831	831	100.0%	2.9	2.8	2.9	2.9	2.8	2.7
GB Winter Flounder	742	390	52.6%	2.8	2.3	3.4	3.5	3.0	4.6
GOM Cod	378	300	79.2%	1.6	1.4	1.7	1.8	1.6	2.0
SNE Winter Flounder	444	248	55.8%	1.4	1.1	1.6	2.7	1.4	2.6
GB Haddock East	5,213	579	11.1%	1.0	0.7	1.4	0.7	1.0	1.3
GOM Winter Flounder	337	98	29.1%	0.6	0.5	0.6	0.9	0.5	1.0
CC/GOM Yellowtail Flounder	377	183	48.5%	0.4	0.4	0.4	0.8	0.4	1.3
GB Cod East	65	52	80.0%	0.2	0.2	0.3	0.3	0.5	0.4
GB Yellowtail Flounder	125	22	17.3%	0.1	0.0	0.1	0.1	0.1	0.2
SNE/MA Yellowtail Flounder	25	9	35.0%	0.0	0.0	0.0	0.1	0.0	0.1

Table 4- Alternative 1/No Action groundfish species revenue prediction by port, with 5% and 95% confidence intervals and average fish prices on groundfish trips, nominal dollars (millions).

State/Port	FY20 Prediction	p(5%) Revenue	p(95% Revenue)	Avg. Price	FY19 Prediction	FY18 Prediction
Massachusetts						
Gloucester	11.7	10.7	12.8	0.8	14.6	14.0
Boston	11.3	10.3	12.3	1.1	13.5	13.2
New Bedford	6.8	5.9	7.8	1.3	8.1	13.2
Chatham	0.4	0.3	0.4	1.65	0.6	0.4
Other MA ports	3.7	3.1	4.3	1.28	4.3	3.4
Maine						
Portland	7.4	6.4	8.6	0.8	9.2	8.3
Other ME ports	1.8	1.6	2.0	1.71	2.1	2.0
New Hampshire (all ports)	1.6	1.4	1.7	1.24	1.6	2.2
Rhode Island						
Point Judith	1.0	0.8	1.2	1.46	1.4	1.3
Other RI ports	0.3	0.2	0.5	1.54	0.3	0.4
Connecticut (all ports)	0.1	0.1	0.1	1.21	0.1	0.1
New Jersey (all ports)	0.0	0.0	0.1	1.81	0.0	0.0
New York (all ports)	0.0	0.0	0.0	0.17	0.1	0.5

Table 5- Alternative 1/No Action groundfish species revenue predictions by vessel size category, with 5% and 95% confidence intervals, nominal dollars (millions).

Vessel Length Category	FY20 Prediction	p(5%) Revenue	p(95% Revenue)
75'+	23.0	21.2	24.8
50'to<75'	16.2	15.1	17.4
30'to<50'	6.7	6.2	7.2
<30'	0.0	0.0	0.1

Results- Alternative 2, Revised ACLs for FY2020

Predicted groundfish revenue for FY2020 is $48.9M, representing a $5.8M decrease from the FY2019 prediction in FW58, and a $0.5M decrease from the FY2018 realized value of $49.4M (Table 2). Total gross revenues from groundfish trips for FY2020 is $69.9M. This represents an $8.1M decrease from the FY2019 prediction of $78.0M, and a $2.2 decrease from the FY2018 realized value of $72.1M. Operating profit predictions for FY2020 are also lower than predictions from the previous two years, as well as the realized FY2018 value. A major contributor to a lower predicted value for FY2020, as compared to the previous two FY predictions from the QCM, is a decline in ex-vessel prices. FY2018 (the input year for the FY2020 prediction) exhibited lower groundfish prices for nearly every groundfish stock as compared to FY2016 and FY2017. These price decreases are likely the product of a multitude of factors including, but not limited, to changes in landings, changes in market categories, and a shift in consumer demand.

At the stock-level (Table 6), a number of stocks which would have lower sector sub-ACLs under Alternative 2, relative to FY2019, are predicted to have high rates of utilization in FY2020. Among these stocks, in decreasing order of predicted ex-vessel value, are white hake, GB winter flounder, GB cod west, GOM cod, and SNE/MA yellowtail flounder. The four stocks with highest predicted ex-vessel value (GB haddock west, GOM haddock, redfish, and plaice) are not predicted to have high rates of utilization in FY2020. In general, predicted FY2020 ex-vessel value at the stock level are comparable to realized FY2018 values, with the caveat that FY2018 prices are incorporated into the FY2020 predictions.

At the port-level (Table 7), many of the major groundfish ports have lower predicted values for FY2020 than were predicted for FY2018 or FY2019. Gloucester is predicted to be the top groundfish port ($12.5M), with ~25% of ex-vessel value in the sector groundfish fishery. Boston is predicted to be the second highest grossing port ($11.6M), followed by New Bedford ($8.1M), and Portland ($7.4M).

By vessel length (Table 8), vessels >75'+ are predicted to generate ~50% of sector groundfish revenue in FY2020. Vessels in the 50 to <75' category are predicted to generate ~35% of sector groundfish revenue, and vessels in the 30' to <50' category are predicted to generate ~15%.

The results presented here are under the inclusion of all action items (Options A2, B2, C2, D2, and E2) under Alternative 2. The QCM was also run under Options B1 and E1. Under Option B1, there would be no reallocation of quota for GOM cod and GOM haddock between the recreational and commercial fisheries. Under Option B1, the sector sub-ACL for GOM cod would be 287mt (as opposed to 267mt under Option B2) and the sector sub-ACL for GOM haddock would be 7,621mt (as opposed to 6,939mt under Option B2). While GOM cod was consistently predicted to be a constraining stock for FY2020, groundfish revenue under Option B1 as predicted to be very similar to Option B2. Under Option E1, the sector groundfish fishery would have a 2mt sub-ACL for SNE/MA yellowtail flounder (as opposed to 12mt under Option E2). Sector groundfish revenue was predicted to be ~$1.0M lower from the $48.9M prediction in Table 2.

Table 6- Alternative 2 stock-level catch and revenue predictions with 5% and 95% confidence intervals, nominal dollars (millions). Shaded stocks would have decreased sector sub-ACLs under Alternative 2 relative to FY2019. Stocks are presented in order of FY2020 predicted ex-vessel value.

Stock	Sub-ACL (mt)	Predicted Catch (mt)	Predicted Utilization	FY20 Prediction	p(5%) Revenue	p(95% Revenue)	FY19 Predicted Revenue	FY18 Predicted Revenue	FY18 Realized Revenue
GB Haddock West	52,335	4,445	8.5%	7.6	6.5	8.8	7.1	7.3	7.7
GOM Haddock	6,939	2,735	39.4%	6.1	5.6	6.5	6.8	5.7	6.3
Redfish	11,173	4,855	43.5%	5.3	4.7	6.0	5.9	6.0	5.9
Plaice	2,574	1,104	42.9%	5.0	4.6	5.3	7.3	7.9	4.8
Pollock	13,803	2,935	21.3%	4.6	4.3	5.0	6.0	6.4	5.4
White Hake	2,004	1,843	92.0%	4.0	3.7	4.3	5.9	5.8	4.4
GB Winter Flounder	501	498	99.4%	3.6	3.0	3.7	3.5	4.6	3.0
Witch Flounder	1,275	826	64.8%	3.5	3.1	3.7	2.5	3.0	3.1
SNE Winter Flounder	462	311	67.3%	2.9	2.7	3.1	2.9	2.7	2.8
GB Cod West	859	826	96.1%	1.7	3.1	3.7	2.7	2.6	1.4
GOM Cod	267	267	99.9%	1.4	1.4	1.4	1.8	2.0	1.6
GB Haddock East	16,084	704	4.4%	1.2	0.8	1.7	0.7	1.3	1.0
GB Cod East	185	135	73.0%	0.6	0.4	0.9	0.3	0.4	0.5
GOM Winter Flounder	272	95	35.0%	0.5	0.5	0.6	0.9	1.0	0.5
CC/GOM Yellowtail Flounder	651	178	27.4%	0.4	0.4	0.4	0.8	1.3	0.4
GB Yellowtail Flounder	93	28	29.7%	0.1	0.1	0.2	0.1	0.2	0.1
SNE/MA Yellowtail Flounder	12	12	99.8%	0.0	0.0	0.0	0.1	0.1	0.0

Table 7- Alternative 2 groundfish species revenue prediction by port, with 5% and 95% confidence intervals and average fish prices on groundfish trips, nominal dollars

State/Port	FY20 Prediction	p(5%) Revenue	p(95% Revenue)	Avg. Price	FY19 Prediction	FY18 Prediction
Massachusetts						
Gloucester	12.5	11.4	13.7	0.8	14.6	14.0
Boston	11.6	10.3	12.8	1.1	13.5	13.2
New Bedford	8.1	7.0	9.2	1.3	8.1	13.2
Chatham	0.5	0.4	0.7	1.7	0.6	0.4
Other MA ports	3.7	3.1	4.3	1.29	4.3	3.4
Maine						
Portland	7.4	6.3	8.7	0.8	9.2	8.3
Other ME ports	1.8	1.6	2.0	1.76	2.1	2.0
Rhode Island						
Point Judith	1.2	1.0	1.5	1.43	1.4	1.3
Other RI ports	0.4	0.2	0.7	1.54	0.3	0.4
New Hampshire (all ports)	1.4	1.3	1.6	1.29	1.6	2.2
New Jersey (all ports)	0.3	0.1	0.5	2.08	0.0	0.0
Connecticut (all ports)	0.2	0.2	0.2	1.21	0.1	0.1
New York (all ports)	0.0	0.0	0.0	0.17	0.1	0.5

Table 8- Alternative 2 groundfish species revenue prediction by size class, with 5% and 95% confidence intervals, nominal dollars (millions)

Vessel Length Category	FY20 Prediction	p(5%) Revenue	p(95% Revenue)
75'+	25.4	23.4	27.3
50'to<75'	16.8	15.4	18.0
30'to<50'	6.7	6.3	7.2
<30'	0.0	0.0	0.1