MID-ATLANTIC FISHERY MANAGEMENT COUNCIL

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MEMORANDUM

Date: December 5, 2016

To: Council

From: Kiley Dancy, Staff

Subject: Summer Flounder Allocation Model Presentation and Peer Review Report

On Tuesday, December 13, the Council and the Atlantic States Marine Fisheries Commission's Summer Flounder, Scup, and Black Sea Bass Board (Board) will receive a presentation on an economic model evaluating the allocation between the recreational and commercial fisheries for summer flounder. The Council contracted this project to inform the development of the ongoing Comprehensive Summer Flounder Amendment, which may consider modifications to the current 60% commercial/40% recreational landings allocation. The model, developed by Dr. Kurt Schnier (University of California, Merced) and Dr. Rob Hicks (College of William & Mary), aims to determine which allocations would maximize marginal benefits to the commercial and recreational sectors, by combining recreational and commercial spatial discrete choice models to simulate behavior under alternative allocations between the sectors.

The Council convened a peer review panel to review this project on Friday, November 18, 2016. The review panel consisted of members of the Council's Scientific and Statistical Committee (SSC), as well as other experts. The peer review agenda, background information, and terms of reference are available at: http://www.mafmc.org/council-events/2016/nov-18-sf-allocation-peer-review-meeting, as well as in the peer review report within this tab.

The following materials are enclosed for Council and Board discussion of this subject:

1) Allocation model report, updated draft (December 2, 2016)
2) Peer review report

Commercial and Recreational Allocation for Summer Flounder

Robert Hicks
Kurt Schnier

December 2, 2016

Draft: For Internal Circulation Only

Executive Summary

This work develops economic models for assessing the economic efficiency from allocation decisions made between the recreational and commercial fishing sectors for summer flounder along the Atlantic Coast of the United States. In this work, we rely on existing datasets to analyze economic welfare changes for commercial and recreational stakeholders having direct engagement fishing for summer flounder. Our work shows that

- The existing 60/40 commercial/recreational allocation is not suboptimal from an economic efficiency perspective
- Minor changes to a 60/40 allocation *in either direction* would most likely not lower the economic benefits received from the fishery

In the work, we note numerous caveats and will not list them again here. But any discussion or use of the results in this report must bear in mind the limitations of the models, the data, and the policy analysis. Even given these caveats, this work provides a useful metric for assessing the economic efficiency of various allocations across the commercial and recreational sectors for directly engaged stakeholders.

Document Roadmap

Chapter 1 provides a broader introduction to this report. To motivate the empirical approaches taken in this report we present a small description of some historical data characterizing the commercial and recreational fisheries in Chapter 2. We develop economic models for the recreational (Chapter 3) and commercial (Chapter 4) sectors. In Chapter 5 we combine the recreational and commercial models for performing the allocation analysis, describe important caveats, and provide recommendations.

Contents

List of Figures

List of Tables

Chapter 1

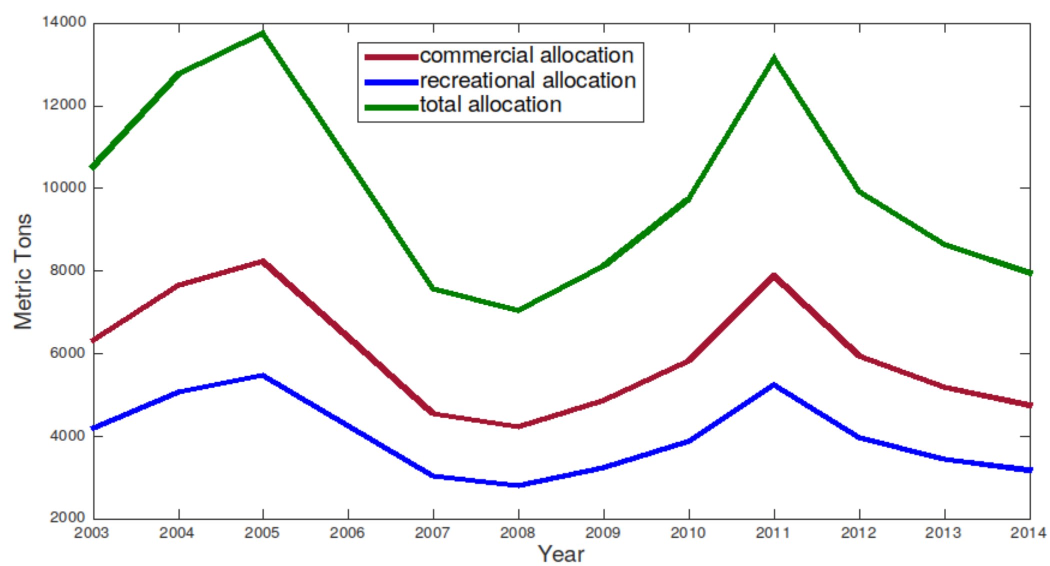
Introduction

Summer flounder, also know as fluke, is an important commercial and recreational species, and are found in pelagic and demersal waters from the Gulf of Mexico through North Carolina, with larger concentrations in the mid-Atlantic and northwest Atlantic region. They spawn during the Fall and Winter along the continental shelf and they exhibit a strong seasonal inshore-offshore movement. They inhabit shallow coastal waters in the warmer months and then remain offshore during the colder months (MAFMC 2016). This strong seasonality is an important aspect of the commercial fleet, which consists of a winter offshore and a summer inshore fishery. The recreational fishery also responds to this seasonality with most directed summer flounder trips occurring during the warm summer months. The nature of the harvesting also requires management coordination because fishermen operate within both state (less than 3 miles offshore) and federal (3-200 miles offshore) waters.

The commercial and recreational landings for summer flounder were exceptionally high in the late 1970s through the 1980s, peaking at 26,100 metric tons in 1983. During the late 1980s and early 1990s the landings substantially decreased as the stock was overfished and a limited access fishery program was implemented. The first Fishery Management Plan (FMP) for summer flounder was conducted in 1988, shortly after the stock had been declared overfished Terceiro (2012). The management of the stock is conducted jointly by the Mid-Atlantic Fishery Management Council (MAFMC) and the Atlantic States Marine Fisheries Commission (ASMFC). Official policies are established by the National Marine Fisheries Service (NMFS). In 2012 the stock was declared rebuilt. The most recently published stock assessment for summer flounder was conducted in 2013. At that time it was concluded that the summer flounder stock was not overfished and that fishing mortality had decreased since 1997 (57th SAW 2013). However, in 2016 the summer flounder quota was reduced by 29% because of the observed overfishing in 2014 and the below-average recruitment rates observed in the year classes from 2010-2013 (MAFMC 2015). This reduction is part of a larger phase-in policy to reduce the total allowable catch over the coming years (MAFMC 2015). Therefore, the stock dynamics for summer flounder have recently undergone a substantial transition in the perception of overall health.

Under Amendment 2 (ratified in 1992) of the summer flounder FMP, the total allowable catch for summer flounder is divided between the commercial and recreational sectors. Currently, 60% of the total allowable catch is allocated to the commercial sector and 40% is allocated to the recreational sector. All allocations were based on historical catch rates observed between 1980-89. In addition, the commercial landings were further subdivided among the states that landed summer flounder based on their historical landings between 1980-1989 (Terceiro 2012). Sector allocations from 2003-2014 are illustrated in Figure 1.1 and are based on the limits reported on the MAFMC website.

Figure 1.1: Historical Recreational and Commercial Summer Flounder Allocations Plots



1.1 Allocation Analysis

To formulate a recommendation regarding the allocation of summer flounder across the commercial and recreational fishing sectors we will employ the equimarginal principal.

This method solely focuses on the economic impacts of the allocation, however distributional issues and social impacts may also be an important concern for policymakers (Edwards 1990). Given that one's value for summer flounder will depend on the current allocation of summer flounder to their respective sector, we account for this by calculating one's marginal value for a pound of summer flounder conditional on their current sector allocation. By equating marginal values between the commercial and recreational sectors we will be able to determine the sector allocations that maximize the total welfare.

Estimating the marginal value per a pound of summer flounder in the recreational sector utilizes a random utility model of site choice and follows an established literature discussed in Chapter 4. We develop a full model of recreational fishing along the Atlantic Coast and the model allows for mode, target, and species choice.

In order to estimate the marginal value per a pound of summer flounder in the recreation sector we use data from the NOAA Fisheries Office of Science and Technology's Marine Recreational Information Program. This data allows us to use better weighting methodology to improve our valuation models considerably (compared to the Marine Recreational Fisheries Statistics Survey Data). By linking policy changes to changes in expected catch in our model, we are able to develop measures of changes in the economic value of recreational fishing due to policy changes. Our measures are comparable to previous summer flounder studies (Gentner et al. (2010)) and Massey, Newbold and Gentner (2006)) and from our model we are able to develop marginal value estimates for a wide range of allocation possibilities.

Estimating the marginal value per a pound of summer flounder in the commercial sector has been traditionally approached from the consumer demand perspective (Carter et al. 2008; Gentner et al. 2010). However a limitation of this method is that it approaches it from a profit function perspective where harvest rates are a selection variable in a firm's profit maximization problem, whereas the modeling used to estimate recreational demand comes from a random utility model specification. The approach we elect to utilize in our modeling efforts utilizes the same random utility model foundation used in the recreational demand literature and combines it with fishery simulations to estimate the marginal values per a pound of summer flounder.

To estimate marginal value per a pound of summer flounder in the commercial fleet we will use observer data as well as trip level cost data from 2000 through 2014. The observer data contains detailed landings data for a sub-sample of the fleet operating off the east coast of the United States from Maine down to North Carolina. This includes the vessel's trip-level landings of summer flounder as well as all other species caught. The trip-level cost data contains detailed information on the costs vessels incurred during their fishing trips. These costs include fuel, food, bait, ice and other supply costs associated with the trip. Combining the information garnered from these two data sets we are able to construct expected profits from fishing in a particular location at a particular point in time and construct a fishery simulation to estimate marginal values.

1.2 Document Roadmap

To motivate the empirical approaches taken in this report, we next present a small description of some historical data characterizing the commercial and recreational fisheries. We focus our discussion on the data we will ultimately use for the analysis since numerous fisheries summaries exist elsewhere (e.g. Terceiro (2012))

To perform the allocation analysis, we develop parallel models in the recreation (Chapter 3) and commercial (Chapter 4) sectors. In the recreational chapter, we discuss conceptual issues relating to defining the recreational choice problems, implement these, and present estimation results for a behavioral model of summer recreational flounder fishing. We describe how we use the model results to develop and marginal value schedule for quota allocation changes and discuss caveats. In the commercial chapter, we develop a new way of analyzing the impacts of policies on commercial fishermen. The model uses a similar methodology to Chapter 3, but then uses this methodology to simulate fleet behavior when quota allocation changes. This allows us to measure changes in seasonal profits under various quota allocation levels, from which we derive the marginal value schedule for the commerical fishery.

In conclusion, we perform the allocation analysis, describe important caveats, and provide recommendations in Chapter 5

Chapter 2

Fishery Summaries

2.1 Commercial Fishery Summary

The commercial allocation, annual landings and annual value for summer flounder from 2000 through 2014 are illustrated in Table 2.1. The recent commercial allocations have been decreasing, however the market value has remained relatively stable. In 2014 the commercial landings for summer flounder were 4,941.2 metric tons, which is slight over the commercial allocation of 4,767.3 metric tons. This catch resulted in a value of $32,299,399. Between 2000 and 2014 the commercial allocation has not always been completely executed. This occurred in 2003, 2004, 2007, 2008, 2010 and 2013.

The commercial allocation is divided up among the states that harvest summer flounder. The state allocations are contained in Table 2.2. The states with the largest share of the summer flounder quota are North Carolina, Virginia, New Jersey and Rhode Island. The annual landings by state and year are contained in Table 2.3. The distribution of annual landings by state is similar to the percentages allocated to each state, which implies that no one state systematically executes lower than their percentage allocation.

2.2 Fisheries Data

The primary data set we utilize for our analysis is the fishery observer data. This data set contains detailed spatial production data, however only a small percentage of vessels are contained in the observer data. To investigate the robustness of this data set we will compare it to the vessel trip report (VTR) data that contains a larger percentage of the fleet activity. Because the VTR data does not contain detailed and sequenced spatial

Table 2.1: Annual Landings and Value for Summer Flounder

Year	Commercial Allocation	Metric Tons Landed	Pounds Landed	Value
2000	5,039.9	4,998.3	11,019,193	19,692,892
2001	6,480.4	4,860.6	10,715,630	17,331,869
2002	6,316.4	6,453.5	14,227,332	21,071,477
2003	6,341.2	6,499.2	14,328,181	23,188,120
2004	7,674,8	8,139.8	17,945,026	28,882,286
2005	8,246.3	7,749.1	17.083,575	30,118,259
2006	6,418.3	6,331,9	13,959,339	29,764,388
2007	4.549.5	4,445.5	9,800,522	23,848,565
2008	4,227.5	4,096.1	9,030,351	21,926,159
2009	4,871.6	4,896.6	10,795,138	22,358,627
2010	5,842.3	5,971.1	13,163,869	28,562,911
2011	7,883.4	7,218.0	15,912,725	31,775,642
2012	5,960.2	5,672.2	12,504,943	30,389,195
2013	5,189.1	5,395,3	11,894,588	28,613,558
2014	4,767.3	4,941.2	10,893,454	32,299,399

Table 2.2: State Allocations of Summer Flounder as a Percentage of Total Allocation

State	Percentage SF
ME	0.0476%
NH	0.0005%
MA	6.8205%
RI	15.6830%
CT	2.2571%
NY	7.6470%
NJ	16.7250%
DE	0.0178%
MD	2.0391%
VA	21.3168%
NC	27.4458%

Table 2.3: Annual Landings by Year and State in Metric Tons

Year	ME	MA	RI	CT	NY	NJ	DE	MD	VA	NC
2000	3.1	357.9	772.2	112.2	368.3	838.3	5.6	0.0	1,001.0	1,536.1
2001	10.0	314.8	815.9	112.1	341.0	791.7	3.4	0.0	1,206.4	1,263.2
2002	0.2	457.9	1,037.1	161.8	477.6	1,091.8	1.2	0.0	1,347.3	1,873.0
2003	0.0	419.9	988.0	143.7	486.8	1,081.9	2.5	0.0	1,597.5	1,620.5
2004	0.1	541.0	1,399.1	184.2	723.2	1,192.9	3.4	119.1	1,771.8	2,197.3
2005	1.6	578.1	1,326.9	203.5	815.9	1,065.5	2.5	153.2	1,755.0	1,843.6
2006	0.0	417.5	963.1	143.6	553.3	1,079.5	1.6	112.4	1,250.5	1,806.0
2007	0.0	299.4	687.5	93.0	427.1	769.7	1.0	103.8	841.7	1,211.2
2008	0.0	292.4	668.3	100.1	388.4	698.9	0.6	94.4	750.1	1,091.6
2009	0.0	331.7	813.7	113.7	517.9	815.9	1.3	96.9	898.3	1,296.9
2010	0.0	386.4	1,038.5	139.9	618.5	982.2	0.8	118.6	1,175.8	1,501.9
2011	0.0	513.6	1,281.0	182.1	688.1	1,284.0	0.4	117.7	1,843.7	1,294.6
2012	0.0	404.4	1,092.9	143.1	561.5	1,029.1	0.4	75.0	1,869.8	494.5
2013	0.0	389.8	994.5	128.9	468.7	909.1	0.4	80.7	2,174.6	245.7
2014	0.0	315.7	932.1	115.0	378.1	828.5	0.8	117.4	929.4	1,320.8

behavior information we are unable to utilize it for our analysis. Table 2.4 contains information on the spatial distribution of effort within the VTR and observer data from 2012 through 2014, the last few years of our analysis. For the most part the spatial distribution of effort is similar across both data sets, however there a few sites where the rates of visitation are different.[1]

Table 2.4: Commercial Percentage of Effort by Year and Area

	VTR Data			Observer Data		
area_id	2012	2013	2014	2012	2013	2014
464	0.15	0.11	0.21	0.46	0.04	0.29
465	0.03	0.05	0.05	0.00	0.16	0.00
511	0.01	0.02	0.01	0.00	0.12	0.00
512	0.80	0.99	0.68	0.62	0.37	0.00
513	3.39	5.49	5.30	4.29	3.17	5.59
514	8.03	6.50	5.41	16.75	8.39	13.64
515	2.95	3.57	3.95	5.36	3.64	8.67
521	7.37	9.51	7.76	8.72	9.36	6.12
522	8.55	6.90	6.27	10.74	10.51	7.57
525	2.20	1.80	2.78	2.47	2.27	0.92
526	2.23	3.29	1.71	0.36	1.42	0.77
533	0.00	0.01	0.01	0.01	0.00	0.00
537	9.53	11.02	11.64	9.28	7.61	17.11
538	1.23	1.12	1.47	1.81	1.18	0.00
539	5.32	5.95	4.99	4.09	6.62	5.64
561	2.25	1.97	1.10	2.02	0.94	0.72
562	3.26	2.09	2.31	1.09	1.31	0.53
611	2.29	2.73	2.32	1.26	4.08	1.20
612	4.95	4.60	5.45	4.95	6.54	0.48
613	8.07	7.53	10.02	4.70	7.05	2.22
614	0.92	1.17	0.89	0.19	1.07	0.00
615	7.14	6.23	4.78	0.94	1.76	1.01
616	4.38	4.26	6.55	11.29	9.90	15.18
621	2.30	1.78	2.27	1.67	3.08	0.96
622	3.45	2.53	1.84	3.19	4.57	6.70
623	0.21	0.05	0.15	1.01	0.18	0.29
625	1.22	1.03	0.66	0.00	0.16	0.00
626	0.90	0.71	1.32	1.18	2.65	1.88
627	0.01	0.02	0.03	0.15	0.16	0.00
631	1.40	1.07	0.53	0.07	0.21	0.00
632	0.24	0.23	0.18	0.51	1.13	0.00
635	1.24	1.84	3.46	0.79	0.14	0.77
636	0.06	0.15	0.19	0.03	0.22	1.59
701	0.09	0.33	0.21	0.00	0.00	0.05
702	0.01	0.02	0.01	0.00	0.00	0.10

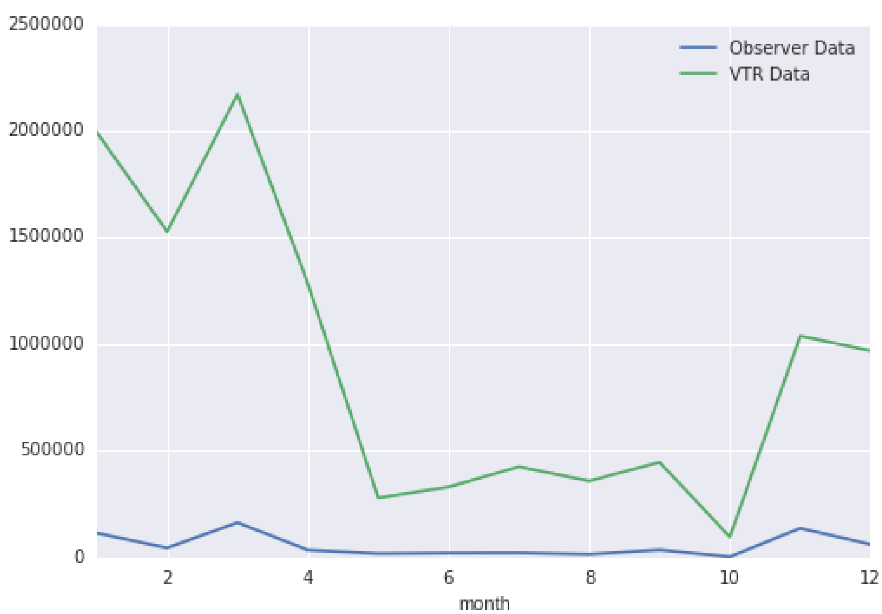
[1] VTR and Observer site selection by year are highly correlated (.754) for the period 2012-2014.

Price information is also an important element of our analysis as we will utilize it to construct expected revenue calculations within the summer flounder fishery. Table 2.1 contains information on the average daily, weekly and monthly price for summer flounder in 2014. The price for summer flounder is lower in the winter months, the time period when much of the summer flounder quota is landed, and higher in the summer months, the time period when landings are lower. Therefore, there does appear to be a correlation between the availability of summer flounder in the market and its ex-vessel price.

Figure 2.1: Summer Flounder Ex-Vessel Price (2014)

The seasonal variation in the catch of summer flounder is observed in Table 2.5 and Figure 2.2. The bulk of the summer flounder allocation is landed between the winter months of November through March. However, the sites visited differ between November and December and those fished from January through March. The predominate sites visited in November and December are 615, 616 and 621 with increased activity in site 537 in December. Site 537 is a highly fished site in January through March as well as sites 525 and 526. Fishing activity in the summer months is more spread out across the other sites, but little effort is spent fishing in the more highly visited winter sites. This pattern is a result of the seasonal migration patterns for summer flounder. The seasonal fishing patter figure, Figure 2.2, graphical illustrates the fishing patterns. Given that the observer data contains only a fraction of the total harvest observed in the VTR data the patters are not as evident. However, as will be illustrated in the upcoming sections of the report (see Figure 4.3) the seasonal patterns are similar to those observed in the VTR data.

Figure 2.2: Commercial Summer Flounder Catch By Month (2013)



2.3 Recreational Fishery Summary

In this section, we outline the important trends with respect to summer flounder catch, regulation, and participation by recreational anglers. Unless otherwise stated, all summary statistics in this section are obtained from *National Marine Fisheries Service* (2016). The summer flounder fishery is one of the largest and extensive recreational fisheries along the Atlantic Coast of the United States, if not the entire United States. For example, from North Carolina to Rhode Island in 2014 of the approximately 25 million recreation fishing trips 16.13% were primarily targeting summer flounder and 14.13% caught summer flounder.

2.3.1 Regulatory Background

There are three primary management policies set annually for limiting recreational harvest: Bag and Minimum Size Limits; and season limits. Tables 2.6 and 2.7 show the levels set for these management policies for the years 2009 and 2014, respectively.[2] Examining minimum size limits shows there is substantial variation across states. In 2009, Connecticut and New York anglers are required to release more fish (smaller than 21 and 19.5 inches respectively), whereas anglers further south in some states could keep fish as small as 15 inches in 2009 (North Carolina). In comparison, in 2014 there is somewhat more harmonization in Minimum Size Limits with a more stark North/South divide at New Jersey. There is also substantial.

We see similar patters with respect to bag limits. In 2009 there was more heterogeneity than in 2014, with a similar North/South delineation around New Jersey, except that the from New Jersey northwards (excluding Massachussetts), anglers were allowed to retain more summer flounder. We also see that seasons are more restricted in the Northern Regions of the study area, in particular in New York, New Jersey, and Connecticut.

What variation we do see in the policies are dependent on seasonal trends with respect to harvest (a function of both biological factors and angler decisions), and as we will see shortly the majority of recreational harvest occurring in New Jersey and New York. The net effect of the three policies enacted by managers is an annual harvest in the recreational sector, that is estimated because not every recreational trip is observed

[2]These data are supplied by the Mid-Atlantic Fisheries Management Council, data for years 2009-2014 are available from the authors.

landing at the dock. The policies outlined in Table 2.7 lead to the mean total summer flounder harvest of 7,398,558 pounds as reported in Table 2.8[3]

2.3.2 Historical Recreational Trends

The mean estimated catch, harvest, and pounds harvested are reported in Table 2.8.[4] Notice that catch has been declining while harvest and harvested pounds has been mostly increasing (from 2009-2014).

Catch Trends

Table 5.1 contains the detailed catch data by state and year that fleshes out the trends we saw in Table 2.8.[5] What stands out is the catch amounts from New York and New Jersey making these states a really important focus for management. This table also shows the percentage standard errors (% SE), which demonstrates the sizable amount of uncertainty associated with the state-level totals.

To visualize what has been happening with respect to catch, we have Figures 2.3a and 2.3b showing the declining catch trends by year (for New York and New Jersey) and mostly declining trends (for other states). With the exception of Connecticut and North Carolina, nearly every state is exhibiting declining total catch per year.

[3]It is also highly likely that polices with respect to other recreational species also impact summer flounder harvest, but for the purposes of this study we ignore this.

[4]It is important to note that the point estimates presented in this table are point estimates that have associated uncertainties associated with them. For example, total catch in 2014 has a +- error of 7.3%.

[5]By catch, we mean any fish caught whether harvested or released, comprised of what NMFS calls `A+B1+B2`.

Table 2.5: Commercial Summer Flounder Catch By Area and Month (Observer Data)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
514	0.0	0.0	0.0	0.0	5.9	2.0	0.0	0.0	0.0	0.0	0.0	0.0
522	0.0	0.0	0.0	19.8	100.5	154.0	1012.0	76.0	0.0	95.0	0.0	0.0
525	24113.0	473.0	0.0	6441.2	162.0	502.9	0.0	0.0	0.0	0.0	0.0	0.0
526	40668.0	3545.0	16494.0	306.0	88.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0
537	9015.0	19771.0	100426.4	15676.5	768.0	621.5	281.2	50.0	30.0	0.0	911.1	39775.9
538	0.0	0.0	0.0	4.1	45.1	132.0	504.0	0.0	0.0	0.0	0.0	0.0
539	1740.0	541.0	454.0	4711.9	813.5	1779.9	1390.7	804.0	658.0	268.0	4084.5	1568.2
561	0.0	0.0	0.0	0.0	0.0	43.0	0.0	0.0	0.0	0.0	0.0	0.0
562	322.0	0.0	0.0	0.0	14.4	0.0	0.0	0.0	0.0	0.0	0.0	10.0
611	0.0	0.0	0.0	735.9	1981.9	3180.2	2800.9	50.0	410.0	484.0	503.2	0.0
612	80.0	54.0	24.0	258.5	8686.1	8506.9	10202.5	6854.8	28120.2	481.0	18532.7	50.0
613	21814.0	9948.0	3960.0	204.3	2620.0	1210.5	986.1	1907.4	397.0	187.3	10574.6	311.0
614	0.0	0.0	0.0	0.0	0.0	3076.0	2871.9	3378.3	3987.0	0.0	6.3	0.0
615	129.0	100.0	772.0	0.0	173.1	75.0	0.0	667.0	110.0	0.0	30506.4	355.0
616	14079.5	4396.5	26449.4	4756.8	1512.1	0.0	0.0	0.0	0.0	0.0	44707.1	17384.0
621	0.0	15.0	0.0	0.0	0.0	69.0	94.3	40.0	282.0	130.9	21015.5	184.0
622	199.0	3472.4	12814.5	293.0	0.0	0.0	0.0	0.0	0.0	0.0	41.6	0.0
623	69.0	726.0	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
625	0.0	0.0	0.0	0.0	0.0	0.0	77.0	0.0	0.0	0.0	1370.0	0.0
626	0.0	0.0	231.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1765.0	0.0
627	0.0	134.3	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1000.0	0.0
631	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	290.0	0.0	0.0

Table 2.6: Summer Flounder Recreational Regulations by State 2009

State	Minimum Size (inches)	Possession Limit	Open Season
Massachusetts	18.5	5 fish	July 1 – Aug. 13
Rhode Island	21.0	6 fish	June 17 – Dec. 31
Connecticut	19.5	3 fish	June 15 – Aug. 19
New York	21.0	2 fish	May 15 - June 15 and July 3-Aug. 17
New Jersey	18.0	6 fish	May 23 – Sept. 4
Delaware	18.5	4 fish	All Year
Maryland: **Atlantic & Coastal Bays** **Chesapeake Bay**	 18.0 16.5	 3 fish 1 fish	April 15 - Sept. 13
Potomac River Fisheries Commission	16.5	1 fish	April 15-Sept. 13
Virginia	19.0	5 fish	All year
North Carolina	15.0 in all waters except the following: 14.0 in Pamlico Sound[D], Albemarle Sound[E], and Browns Inlet South[F] (lat/log are listed below)	8 fish	All Year

A. **PAMLICO SOUND** - No person may possess flounder less than 14 inches total length taken from internal waters for recreational purposes **west of a line** beginning at a point on Point of Marsh in Carteret County at 35° 04.6166'N – 76° 27.8000'W, then running northeasterly to a point at Bluff Point in Hyde County at 35° 19.7000'N – 76° 09.8500'W. In Core and Clubfoot creeks, the Highway 101 Bridge constitutes the boundary north of which flounder must be at least 14 inches total length.

B. **ALBEMARLE SOUND** - No person may possess flounder less than 14 inches total length taken from internal waters for recreational purposes **west of a line** beginning at a point 35° 57.3950'N – 76° 00.8166'W on Long Shoal Point; running easterly to a point 35° 56.7316'N – 75° 59.3000' W near Marker "5" in Alligator River; running northeasterly along the Intracoastal Waterway to a point 36° 09.3033'N - 75° 53.4916'W near Marker "171" at the mouth of North River; running northwesterly to a point 36° 09.9093'N – 75° 54.6601'W on Camden Point.

C. **BROWNS INLET-SOUTH** – No person may possess flounder less than 14 inches total length in internal and Atlantic Ocean fishing waters for recreational purposes **west and south of a line** beginning at a point 34° 37.0000'N – 77° 15.000'W; running southeasterly to a point 34° 32.0000'N – 77° 10.0000'W.

Table 2.7: Recreational Regulations by State 2014

Region	State	Minimum Size (inches)	Possession Limit	Open Season
1	**Massachusetts**	16	5 fish	May 22-September 30
2	**Rhode Island**	18	8 fish	May 1-December 31
3	**Connecticut**	18 16 (at 45 designated shore sites)	5 fish	May 17- September 21
	New York	18	5 fish	May 17- September 21
	New Jersey	18	5 fish	May 23- September 27
		16 (1 pilot shore site)	2 fish	May 23-September 27
4	**Delaware**	16	4 fish	January 1- December 31
	Maryland	16	4 fish	January 1- December 31
	PRFC	16	4 fish	January 1- December 31
	Virginia	16	4 fish	January 1- December 31
5	**North Carolina**	15	6 fish	January 1- December 31

Table 2.8: Total Recreational Catch, Harvest, and Pounds Landed (2010-2014)

Year	Catch	Harvest	Pounds
2010	23,721,520	1,501,465	5,108,357
2011	21,558,699	1,839,877	5,955,716
2012	16,528,040	2,272,135	6,489,675
2013	16,151,332	2,534,355	7,386,644
2014	19,455,661	2,459,205	7,398,558
2015	12,485,456	1,676,794	4,870,174

(a) New York and New Jersey

(b) Other Atlantic States

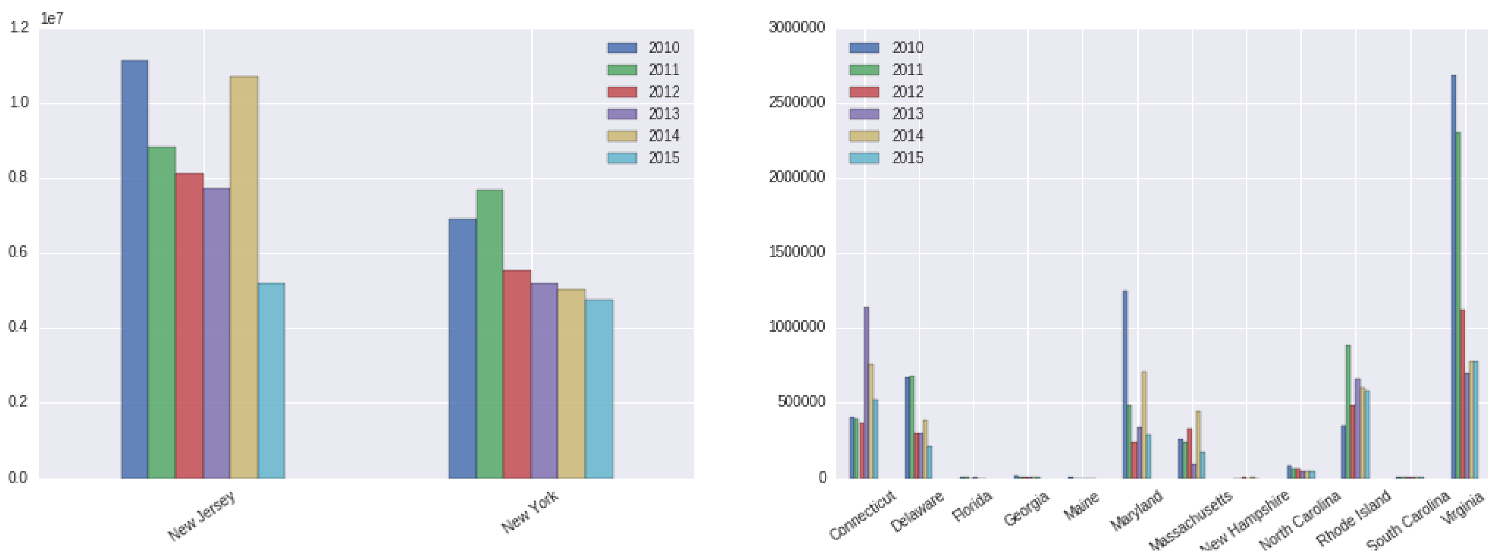


Figure 2.3: Total Recreational Catch (2010-2014)

Harvest Trends

State level harvest for years 2010-2015 are reported in Table 5.2 and the data can be visualized in Figure 2.4a for New York and New Jersey and 2.4b for other Atlantic States. [6]

Despite seeing catch falling in nearly every state during the period 2010-2015, we see harvest increasing substantially in New Jersey (except for a really steep decline in 2015) and generally upward trends in nearly every state except North Carolina and Virginia. Examining regulatory changes in New Jersey from 2014 to 2015 reveal no real change in management with bag limits stable at 5, size limits unchanged at 18 inches, and season length virtually unchanged. We also see stable regulations for Virginia and North Carolina. We see a fairly large drop in trips to New Jersey and in Virginia from 2014 to 2015.

[6] Harvest is fish landed and is comprised of what NMFS calls `A+B1`, which is observed and reported harvest.

(a) New York and New Jersey

(b) Other Atlantic States

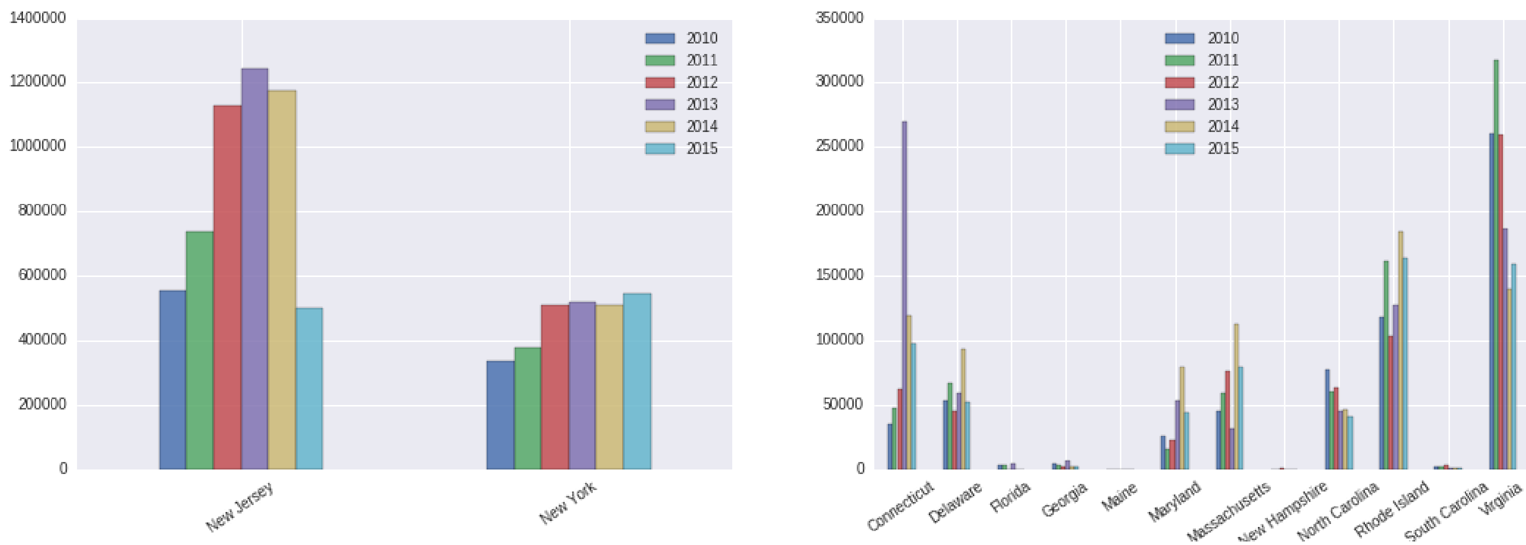
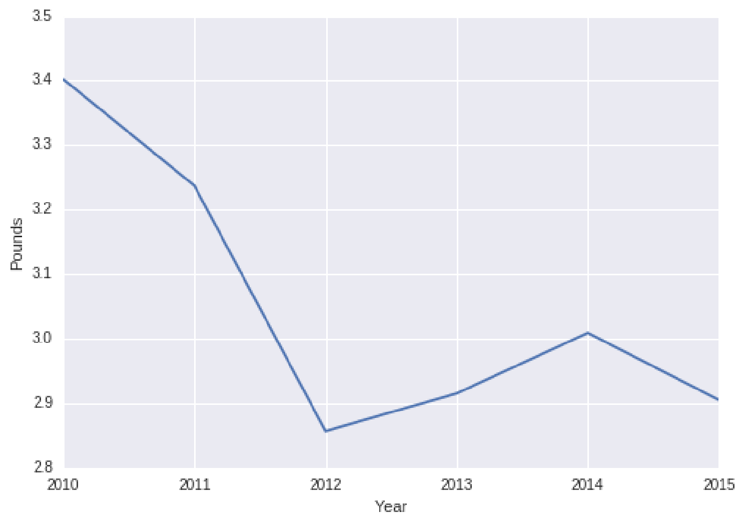


Figure 2.4: Total Recreational Harvest (2010-2014)

We see very similar trends in harvested weight in Figure 5.2. Averaging across states for a given year, the weight of the average fish harvested[7]. Figure 2.5 shows the average weight of summer flounder caught per year taken across all summer flounder catches, states, and wave. This average is influenced by biological factors (annual recruitment patters and the spatial distribution of fish), regulation (more stringent size limits will lower catch but increase the average size of this fish), and the spatial distribution of fishing (trips taken to states with lower size limits will tend to lower the average weight.).

Figure 2.5: Average Recreational Weight per Fish Landed by Year



[7]This number is absolutely a function of recreational regulations and should not be confused with the average summer flounder size.

2.3.3 Study Year: 2014

The recreation demand model in the next chapter uses data from year 2014, consequently, we focus on the 2014 data more here. Table 2.9. New Jersey alone accounts for 47.80% of harvest and 48.78% of the pounds landed in the recreational fishery in 2014. New York and New Jerset combined account for 68.5% of harvest and 71.46% of pounds landed. The next largest states are Rhode Island, Connecticut, and Virginia (the ranking depend on if you examine numbers of fish caught or pounds landed).[8]

In Table 2.10, we see that the states of North Carolina and New Jersey have the largest number of trips (accounting for approximately 40% of the trips in our study area), followed by New York and Massachussetts. Within states, we see that a very high percentage of trips are directly targeting summer flounder in New York and New Jersey (28.53% and 36.86%, respectively), and in every state in the study area (except Massachussetts, Maryland, and North Carolina), summer flounder are targeted by more than 10% of trips.

In Table 2.10, we see similar patters with respect to trips harvesting summer flounder. In New Jersey, nearly one third of trips come back with summer flounder. For many other states (except Massachussetts, Maryland, and North Carolina), more than 10% of trips land summer flounder.

2.3.4 Catch Compositions

In other work not included here for the sake of brevity, we have examined catch compositions by state for

1. trips targeting summer flounder (`prim1`), in order to ascertain what other species are commonly caught with summer flounder on "summer flounder" trips by state.
2. trips not actively targeting summer flounder, but that caught summer flounder, in order to ascertain what other species are commonly targeted on trips that have non-targeted catch summer flounder.

We find that summer flounder is such a dominant species in recreational fishing and that it is quite common to find small game (e.g., striped bass and bluefish) and

[8]This table omits the states of Maine, New Hampshire, South Carolina, Georgia, and Florida since they are dropped from the analysis due to the relatively small amounts of summer flounder activity relative to the core study area.

bottom fish (e.g. sea basses and blackdrum) catch when summer flounder is targeted. Furthermore, it is common for targeters of small game and bottom fish to catch summer flounder. What wasn't common was mixes of summer flounder with big-game fish such as tuna or marlin.

Table 2.9: Total Recreational Summer Flounder Harvest and Harvested Weight 2014

State	Harvest	% SE	Weight (lbs)	% SE
Connecticut	119502	21.1	391168	20.1
Delaware	93029	15.8	227913	16.5
Maryland	79513	56.1	179313	56.0
Massachusetts	112840	41.1	238604	36.0
New Jersey	1175383	11.7	3608939	12.1
New York	509131	14.7	1677717	16.1
North Carolina	45708	20.2	67791	22.1
Rhode Island	184668	22.5	636207	22.7
Virginia	139431	15.3	370906	17.0

Table 2.10: Recreational Trips by State 2014

	Total		SF Directed		SF Harvested	
State	Trips	% SE	Trips	% SE	Trips	% SE
Connecticut	1364928	10.9	208154	20.8	188305	16.4
Delaware	867379	10.3	182728	10.0	128873	10.1
Maryland	2472802	6.8	219234	22.7	184802	22.8
Massachusetts	3397199	6.9	66630	29.3	78065	31.0
New Jersey	4868080	6.6	1794480	9.7	1513879	10.6
New York	3955151	7.1	1128222	9.7	1019136	9.9
North Carolina	4954073	5.3	884	59.0	41738	17.4
Rhode Island	1099260	10.3	147442	16.3	121575	14.3
Virginia	2182392	8.3	310947	9.2	278128	11.6

Chapter 3

Recreational Model

Our work follows closely follows previous work in the valuation of marine recreational fishing using recreational fishing data from the National Marine Fisheries Service. Unlike many previous studies using the Marine Recreational Fishing Statistics Survey (Bockstael, McConnell and Strand (1989), McConnell and Strand (1994), McConnell, Strand and Blake-Hedges (1995), McConnell, Strand and Blake-Hedges (1995), Hicks et al. (1999), Haab, Whitehead and McConnell (2001), and Haab et al. (2008)), our work follows uses the new Marine Recreational Information Program (MRIP). This data continues to support recreational valuation models like those estimated using MRFSS data, but includes more refined survey methodology enabling for better estimation accounting for on-site sampling (see Lovell and Carter (2014), Hindsley, Landry and Gentner (2011), and Gentner et al. (2010)) and uses the Marine Recreational Information Program survey data (hereafter MRIP). Taken together, the recreational valuation model presented here

- Accounts for on-site sampling and weights the statistical model appropriately
- Constructs a full choice structure of recreational fishing
  - Anglers not observed targeting Summer Flounder may still receive economic value from an allocation change
  - Anglers observed targeting Summer Flounder have many other species substitutes for targeting
- Estimates the WTP for summer flounder angling consistent with values observed in the literature (e.g. Massey, Newbold and Gentner (2006) and Gentner et al. (2010))

- Allows for the simulation of behavior and angler willingness to pay under different quota allocations.

3.1 The Choice Structure

It is important to note that our model considers choices *ex ante*, that is before any targeting or location decisions are made. This allows our model to capture angler choices over the full range of species they might catch. This feature of our model is important as summary data suggests that even those not directly targeting summer flounder may catch summer flounder and therefore, we develop a model that allows expected trip values to be influenced by a broad range of species.

Consistent with prior work in recreational fishing valuation (e.g. McConnell and Strand (1994), Gentner et al. (2010), and Hicks et al. (1999)) we model the choice of mode [shore, private/rental, party/charter], species group [small game, bottom fish, summer flounder][1], and fishing site (at the county level). Furthermore, we calculate site-specific quality measures (e.g. mean catch) per wave. Taken as a whole, the entire choice structure consists of **80 x 3 x 3 = 720** potential choice alternatives per observed trip in the data.

3.1.1 Species Groupings

To implement the choice structure, we had to make some aggregations over species. As shown by Haab et al. (2008), it isn't possible to include species-specific choice nodes for every (or even many) species, because for each choice node we must calculate expected catch for each site and wave. This places high data requirements and to overcome this problem, past studies (e.g. McConnell and Strand (1994) and Hicks et al. (1999)) have aggregated over many species for which there is insufficient data.

We employ the McConnell and Strand (1994) aggregation scheme shown in Figure 3.1, with two notable exceptions.[2].

1. Because we have (a) a policy interest in summer flounder and (b) summer flounder

[1] Other species groups such as big game, other flat-fish, non-specific targets are ommitted from our analysis based on our analysis of catch profiles for recreational trips involving summer flounder.

[2] The reader may notice some species listed which are rarely, if ever, caught in the study area. This is because McConnell and Strand (1994) examined the entire Atlantic seaboard as well as the panhandle of Florida. However, their species group assignment is valid for the study area as it embodies both biological characteristics and recreational fishing experience when categorizing species.

is one of the most targeted and caught species in the United States, we break Summer Flounder out of the Flat Fish group

2. After breaking summer flounder out of the flat fish group, we don't have enough data to include an "other flatfish" category, so all other flatfish are dropped for our analysis.

3. When conducting our species composition analysis, we found that there was virtually no overlap between McConnell and Strand's "Big Game" category and summer flounder, so it is dropped from the analysis.

Table 3.1: The McConnell Strand Species Groupings Employed in this Study

	Small Game	
Striped Bass	Bluefish	Jack
Pompano	Seatrout	Bonefish
Bonito	Snook	Red Drum
Barracuda	Mackerel	
	Bottom Fish	
Sandbar Shark	Dogfish Shark	Cat Shark
Sand Tiger Shark	Smooth Dog Shark	Carp
Catfish	Toadfish	Cod/Codfish
Pollack	Hake	Sea Robin
Sea Bass	Sawfish	Grunt
Kingfish	Mullett	Tautog
Butterfish	Nurse Shark	Brown Cat Shark
Porgy/Scup	Sheepshead	Pinfish
Snapper	Grouper	Perch
Black Drum		
	Flat Fish	
Summer Flounder	Winter Flounder	Southern Flounder
Sole	Founders	
	Big Game	
Blue Shark	Tuna	Marlin
Thresher Shark	Great Hammerhead	Swordfish
Shortfin Mako Shark	Tiger Shark	White Shark
Smooth Hammerhead	Scalloped Hammer	Tarpon
Billfish	Sailfish	Dolphin
Cobia	Wahoo	
	Other Fish	
Herring	Eel	Skate
Puffer	Blacktip Shark	Requiem Shark
Dusky Shark	Atlantic Sharpnose	Bull Shark
Smalltail Shark		

3.1.2 Limiting the Choice Set Based on Distance

From the MRIP survey we have approximately 30,000 trips (in NC-MA in 2014) $\times$ 720 choice alternatives.[3] Past studies (e.g. McConnell and Strand (1994) and Hicks et al. (1999)) have limited the choice structure by only modeling single-day trips where the one way travel distance is less than 150 miles from the recreator's home. We use the NOAA Fisheries S&T distance files (these files calculate the distance from each intercepted angler's home to every coastal county within 150 miles), and therefore, we continue with past practices for limiting the choice structure to those sites within 150 miles of the respondents home. This necessarily eliminates all persons in the MRIP sample living far away (>150 miles) from their chosen site. Practically speaking, this reduces the size of the choice set from 720 to approximately 220 choices per individual in the intercept survey.

It is important to note that there are *very good* behavioral reasons for reducing the choice set in this way. Individuals on single-day angler trips are making decisions in a way consistent with our theoretical model. Multiple day trips (e.g. an angler from NC going to Maine who takes a marine fishing trip) are probably engaging in a plethora of other activities and this makes the link between travel cost and resource we are valuing tenuous at best.

3.1.3 Summary Statistics Weighting

This study uses the MRIP data, which has information enabling proper weighting for summary statistics (e.g. mean catch of summer county per wave). Since strata are potentially over or under sampled in MRIPS, we use the supplied sample weights for calculating **any** summary statistic (e.g. average per site catch for summer flounder) in this study unless noted otherwise.[4]

3.1.4 Opportunity Cost of Time and the Price of the Trip

In the valuation of recreational resources, we need to link a non-market resource like trip quality (which for our case is catch) to a trade-off made by recreators. This study makes this link using the travel cost method. The choice set describes the trip quality along

[3]When we estimate the model, this would equate to 21.6 million rows of data

[4]We use the R Survey package for all summary statistics weighting in this chapter Lumley et al. (2004).

the coast and we construct the price of the trip as travel cost to each site s for individual i based on distance as follows:

$$tc_{is} = \$0.56 \times dist_{is}$$

where \$.56 is the federal reimbursable rate for 2014 per mile. In this study we don't have access to an economic add-on information for discerning what the literature terms "opportunity cost of time" (McConnell and Strand, 1981). Past studies using MRFSS data such as McConnell and Strand (1994) and Hicks et al. (1999) employed data for which there was a complementary economic add-on for discerning if the individual took time off work, without pay as a signal for whether the time spent traveling or on-site had costs to the individual by way of foregone wages. Gentner et al. (2010) also don't have an available economic add-on an estimate a model like ours and estimates one similar to ours and one that approximates the "opportunity cost of time" using Census data. In our work we don't attempt the approximation and agree with Gentner et al. (2010) that our model presents a lower-bound estimate. It is important to note that Gentner et al. (2010) contend that their approximation method is an upper bound to the true willingness to pay value.

3.2 Random Utility Model of Recreational Site Choice

We assume an individual will choose species group g, mode n, and site s by comparing the alternative specific utilities if it is the best one:

$$U(g,n,s) + \epsilon_{g,n,s} > U(i,j,k) + \epsilon_{i,j,k} \forall i \in G, j \in M, k \in S$$

where all species groups are denoted by G, all modes M, and all sites S.

In this study we need to be able to alter landings (keep) of SF. So we calculate mean landings and release rates (numbers of fish) for each mode and site for summer flounder.

Ignoring subscripts indexing individuals, we have for summer flounder the utility at each site k and mode j:

$$\begin{aligned} U(SF,j,k) = &\beta_{tc} TC_k + \beta_{lnm,k} log(M_k) \\ &+ \beta_{SH}(mode_j == SHORE) \\ &+ \beta_{PR}(mode_j == PRIVATE/RENTAL) \\ &+ \beta_{SF,K}\sqrt{Keep_{SF,j,k}} + \beta_{SF,R}\sqrt{Release_{SF,j,k}} \end{aligned} \quad (3.1)$$

For the other two species, we have similar specifications. For example, for bottom fish the utility at each site k and mode j:

$$\begin{aligned} U(BT,j,k) =& \beta_{tc}TC_k + \beta_{lnm,k}log(M_k) \\ &+ \beta_{SH}(mode_j == SHORE) \\ &+ \beta_{PR}(mode_j == PRIVATE/RENTAL) \\ &+ \beta_{BT}\sqrt{Catch_{BT,j,k}} \end{aligned} \tag{3.2}$$

Following normal conventions on assumptions about site, mode, and species specific errors (ϵ), we can model the probability that an individual chooses g (species), m (mode), and s (site) as

$$P(d^i_{g,m,s}|\beta, \mathbf{X}) = \frac{e^{U(g,m,s)}}{\sum_{l\in G}\sum_{m\in M}\sum_{k\in S} e^{U(l,j,k)}}$$

Using likelihood contributions like this for each individual, we define the log-likelihood function using the Weighted Exogenous Sample Maximum Likelihood Estimation (WESMLE) approach that accounts for on-site sampling (see Lovell and Carter (2014) and Manski and Lerman (1977)),[5]

$$LL(\mathbf{d}|\beta, \mathbf{X}) = \sum_{i\in N}\sum_{g\in G}\sum_{m\in M}\sum_{s\in S}\frac{Q_s}{H_s} d_{igms} log P(d^i_{g,m,s}|\beta, \mathbf{X})$$

where the weight ($\frac{Q_k}{H_k}$) is comprised of

$$Q_k = \frac{T_k}{T}, H_k = \frac{s_k}{S}$$

and where d_{igms} is equal 1 if individual i chooses alternative $[g,m,s]$ and T_k are total (population) trips taken to site k, T are total trips (across all sites), s_k are sampled trips from site k and S is the survey sample size.[6].

3.3 Estimation Methods

We experimented with using classical maximum likelihood techniques for estimating the model but due to the size of the dataset, we resorted to using Bayesian Sampling

[5] We didn't attempt a nested estimation of this model.

[6] Using Monte-Carlo techniques generating toy data consistent with the MRIP data collection method (where sites are over and under sampled), we found the WESMLE to out-perform the choice-based sampling weight approach outlined in Haab and McConnell (2002)). These results are unreported but available from the authors.

techniques for recovering the posterior distribution of our parameters by constructing Monte Carlo Markov Chains. From Bayes Rule, we have the posterior of our parameters ($P(\beta|\mathbf{d},\mathbf{X})$) is

$$P(\beta|\mathbf{d},\mathbf{X}) \propto P(\mathbf{d}|\beta,\mathbf{X})P(\beta|\beta^0)$$

where $P(\mathbf{d}|\beta,\mathbf{X})$ is the likelihood function where $P(\beta|\beta^0)$ are our priors on the model parameters. In this work we assume flat priors (any real numbered parameter vector is equally likely, making our posterior

$$P(\beta|d^i_{g,m,s},\mathbf{X}) \propto P(\mathbf{d}|\beta,\mathbf{X})$$

consequently, when we use sampling techniques to sample from the posterior distribution of parameters, we are sampling exactly from the distribution of parameters that maximizes the likelihood. When constructing our markov chain, we used the weights employed by WESMLE to account for on-site sampling. Sampling from the posterior in this way allows us to construct the distribution of our parameter estimates directly and all inference (e.g. parameter estimates and standard errors) are self weighting.

We implemented this approach in Python using the `pymc3` package (Salvatier, Wiecki and Fonnesbeck, 2016) employing the "No U-turn Sampler" (Hoffman and Gelman, 2014). This package is capable of very fast sampling when likelihood functions are computationally expensive.

3.4 Results

Summaries of the posterior distribution of the parameters are reported in Table 3.2.[7] Note that our Monte Carlo Markov Chain is comprised of 1000 samples (after burn-in) from the posterior distribution of the parameters. We summarize these samples in this table. We report the mean, the standard deviation (analogous to standard errors), and various percentiles. Looking at the parameters, we can see that the the 99% confidence intervals never overlap zero. For example, for travel cost (β_{tc}), the 99% confidence interval is [-.101449,-.096878]. P-values (not shown) for each of these variables shows these are all significant at the 5% (and 1%) levels. We also see that the dummy variables on mode (normalizing on party charter) are positive and roughly equal. This indicates that anglers are more likely to choose something besides party/charter trips.

[7]Recall that in our specification, catch rates (and keep rates for summer flounder) enter in square root form.

All of the parameters are also of the expected sign. The travel cost coefficient is negative, the aggregation term (β_{lnm}) correcting for the number of sites in each county is positive. All of the catch coefficients for each of our species/species groups are also positive. Note that in relative terms, the bottom fish has the smallest mean estimate, whereas summer flounder is the highest (landed). Summer flounder landed ($\beta_{sf,land}$) is significantly higher than summer flounder caught and released ($\beta_{sf,rel}$). This indicates that while anglers might enjoy catching summer flounder and releasing them, they are much happier keeping landed summer flounder.[8]

Figure 3.1 summarizes our results visually for five separate Monte Carlo Markov Chains (we construct 5 so we can test that the chains have converged, which they have based on the Geweke (Geweke, 2005) and Gellman-Rubin tests (Gelman et al., 2014)). In the left pane we see for each parameter the marginal distribution. These can be viewed like a histogram. For example, the probability mass for β_{tc} is centered around -.9995 and the bulk of the samples are in the approximate range [-.102,-.0975]. In the right hand pane we have the trace plot for the Markov Chain sampling process where the x axis is the sample number. Notice these "flat-line" trace plots show that the sampler is moving around the posterior space near the model parameters that maximize the likelihood function and visually confirm convergence.

3.5 Welfare Estimation

The standard welfare calculation (defined as compensating variation (CV)) for a change in policy affecting site-specific variables from $\mathbf{x}^0$ to $\mathbf{x}^1$ for individual i is defined as:

$$CV(\mathbf{x}_i^0 \rightarrow \mathbf{x}_i^1) = \frac{log\left(\sum_{i\in S} e^{\mathbf{x}_i^0\beta}\right) - log\left(\sum_{i\in S} e^{\mathbf{x}_i^1\beta}\right)}{\beta_{tc}} \tag{3.3}$$

This gives us the mean compensating variation *per trip*.[9]

3.5.1 Modeling Policy Changes

For our purposes, all $\mathbf{x}_i$'s will remain as observed in the data from year 2014, except for landings and released historical catch averages for summer flounder. Note that by

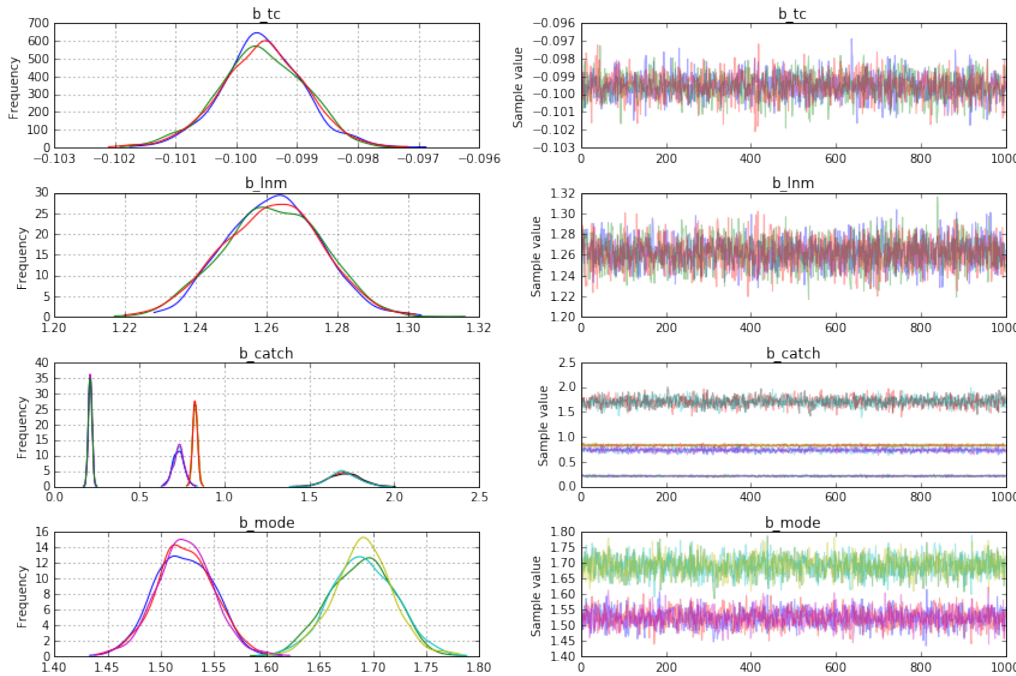
[8]It bears mentioning again that all of the catch rate variables included in the model are calculated from *sample weighted* MRIPS data that accounts for the problems with on-site sampling.

[9]Recall that since there is no economic add-on in 2014, the results presented in this section are lower bound estimates.

Table 3.2: Recreational Random Utility Model Estimates

	β_{tc}	β_{lnm}	b_{bt}	β_{sg}	$\beta_{sf,land}$	$b_{sf,rel}$	β_{pr}	β_{sh}
Mean	-0.099572	1.261703	0.210776	0.828308	1.704043	0.730967	1.522743	1.690098
Std Dev	0.000687	0.013695	0.010831	0.014509	0.087752	0.032410	0.027029	0.029306
min	-0.102108	1.216995	0.169941	0.777885	1.384343	0.628437	1.433269	1.584659
0.5%	-0.101449	1.227577	0.184025	0.789383	1.471976	0.647675	1.454465	1.614740
2.5%	-0.100980	1.235180	0.189104	0.799830	1.531269	0.665325	1.469813	1.631867
5%	-0.100733	1.238977	0.192635	0.804790	1.561199	0.677568	1.479011	1.640069
50%	-0.099575	1.261834	0.210678	0.828181	1.702743	0.731825	1.522283	1.690711
95%	-0.098457	1.284005	0.228427	0.852046	1.850422	0.784601	1.566065	1.736475
97.5%	-0.098255	1.287781	0.231412	0.856292	1.877102	0.796230	1.574819	1.747441
99.5%	-0.097822	1.296705	0.238011	0.865643	1.932048	0.815577	1.593135	1.765785
max	-0.096878	1.315996	0.250116	0.877409	2.004679	0.841560	1.621508	1.788339

Figure 3.1: Recreational Random Utility Model Posterior Distribution Plots



assumption the allocation policy

- Does not alter expected total catch (combined keep and release)[10]
- Does alter the distribution of expected total catch between keep and release categories.

Pre-policy expected Keep and Release rates for summer flounder at site s, mode m is $Keep^0_{SF,s,m}$ and $Release^0_{SF,s,m}$. Following the policy change (for example giving the fraction Δ more Keep to recreational anglers) Keep and Release change to

$$Keep^1_{SF,s,m} = Keep^0_{SF,s,m} \times (1 + \Delta) \tag{3.4}$$

$$Release^1_{SF,s,m} = Release^0_{SF,s,m} - \Delta \times Keep^0_{SF,j,k} \tag{3.5}$$

Note that: $Keep^1_{SF,s,m} + Release^1_{SF,s,m} = Keep^0_{SF,s,m} + Release^0_{SF,s,m}$.

To make this more concrete, consider summer flounder landings and release averages in the Table 3.3, before (denoted as Policy 0) and after (Policy 1) a 10% increase

[10] This analysis doesn't consider cases where total recreational and commercial TAC *and* allocations are changed. Consequently, we can think of the Welfare estimation as from a 2014 baseline and TAC.

in summer flounder landings at some site. Under policy 1, more of the released fish are allowed to be kept. So the way we model the policy, total catch (combined catch and release) is unchanged, but the policy alters the distribution of that total between catch and release categories.

Table 3.3: Example Policy Impacts on Catch and Keep Rates

Policy	Total Catch	Landings	Release
0	5	3	2
1	5	3.3	1.7

Equation 3.3 is the compensating variation for angler i on an intercepted trip. Since angler i is part of the on-site sample, she might be over or under-represented compared to a population based random sample. Taking the simple mean across all CV_i's gives us an incorrect mean welfare effect. Consequently, we again used R's Survey package and the provided MRIP weights to calculate a weighted and correct mean CV. We have to do this for *every* allocation rule under consideration. We also sample from our posterior parameter values to calculate these weighted CV's for a wide range of likely parameter vectors. In the end, we are able to construct confidence intervals around our mean CV estimate.[11]

3.5.2 Aggregation to Population

Once we have recovered the correct mean compensating variation per trip, we perform aggregations to project our estimates into total economic values and total economic values per pound. Since policies impact the distribution of catch between kept and released summer flounder, we perform the following simple steps in our analysis for computing the totals described in our results below.

1. For a $\Delta\%$ change in quota, change every expected catch and keep rate for summer flounder as described above.

2. Using this change calculate CV as described above

[11]In addition to our uncertainty about parameter estimates, our confidence intervals also include uncertainty associated with 1) total landings and 2) summer flounder weight per fish.

3. From the NOAA Fisheries website, we know the total harvested summer flounder and total weight harvested (along with standard deviations) for each state. Draw randomly from each states distribution and sum for total harvest and total harvested weight.

4. For the $\Delta\%$ change in quota, scale total harvest and total harvested weight.

5. Calculate changes in compensating variations and changes in quota allocations across each subsequent quota allocation[12]. We then approximate the marginal value for the region between each policy step t and $t+1$ as $MWTP_{t+1} = \frac{TWTP_t - TWTP_{t+1}}{Landings_t - Landings_{t+1}}$ and for graphing purposes center at the mid-point between the two quota amounts $\frac{Landings_t - Landings_{t+1}}{2}$.

Note that this method explicitly assumes

1. that what fishermen value *ex ante* is exactly what will be observed with respect to aggregate harvests and weights *ex post*.

2. that landings will be consistent with quota levels.

3.5.3 Results

In Table 3.4 we show compensating variation for divergences from the 2014 quota allocation baseline. So a change in quota of 50,000 means that +50,000 more pounds are given to the recreational sector for total harvest of 7,398,558 + 50,000 pounds of fish. A negative change in quota is taking pounds away from the recreational sector. In Table 3.5 we calculate the marginal willingness to pay for quota allocation levels (rather than changes in quota as in Table 3.4). In Table 3.5 we also report quota allocation levels in metric tons for more direct comparison to the commercial chapter.

Based on estimation available from NOAA National Marine Fisheries Service, the total summer flounder harvested weight (in the study region) in 2014 was 7,398,558. Consequently, in our analysis, we consider a 100% reduction and 100% increase to the summer flounder recreational allocation.

Notice that as quota approaches zero, the required total compensating variation gets larger (more negative) at a non-linear rate. This is consistent with what economists

[12] In our work, we examine the following quota changes: -100%, -80%, -60%, -40%, -20%, -5%, +5%, +20%, +40%, +60%, +80%, +100% relative to the *observed* 2014 landings

call “diminishing marginal returns” and supports intuition about how fishermen value summer flounder quota: the less quota the angler community has, the higher the relative value a pound of quota. Conversely, if we increase quota to the recreational sector, the angler community benefits, but the incremental benefit for a pound of quota enjoyed by the community is less than the first pound of quota they receive.

Figures 3.2 and 3.3 show visually the total economic value and the marginal value, respectively, of quota for the recreational sector. In Figure 3.2 at a quota change of 0 pounds, Compensating Variation is zero. In Figure 3.2, we see that doubling the recreation quota leads to a gain in economic value for recreational anglers of approximately $20 million per year. By contrast, reducing the recreational sector leads to a loss in economic value of approximately $35 million per year.[13]

We see similar patterns in Figure 3.3. For very small quota allocations in the recreational sector, the value per pound of summer flounder is approximately $10. As quota is increased, the value per pound declines (this is due to diminishing marginal returns as discussed above), so that after a doubling of recreational quota, the value per pound is approximately $2.

It should be noted that in both of these figures, the confidence intervals flare out from the Change in Pounds Allocated at 0 (for Figure 3.2) and for Pounds Allocated at approximately 7.4 million pounds (for Figure 3.3) because both of these points represent the baseline observed levels in 2014. As we move further from that baseline, the uncertainty of our estimated economic values increase.

[13] While the model can be used for analyzing these large swings in quota relative to 2014, we are more confident in our model for analyzing smaller quota changes.

Table 3.4: Total Compensating Variation for Recreational Sector by Quota Change from 2014 Observed Landings

Change in Quota (Pounds)	Change in Quota (Metric Tons)	Lower 95% CI	Mean CV	Upper 95% CI
-7,398,558	-3,356	-40,518,534	-35,025,888	-29,756,109
-5,918,846	-2,685	-23,569,401	-20,433,425	-17,564,884
-4,439,135	-2,014	-15,833,755	-13,835,185	-11,959,676
-2,959,423	-1,342	-10,236,713	-8,653,824	-7,318,248
-1,479,712	-671	-4,795,840	-4,045,957	-3,366,934
-369,928	-168	-1,112,268	-983,208	-835,250
369,928	168	779,031	955,284	1,111,872
1,479,712	671	3,190,313	3,732,857	4,464,099
2,959,423	1,342	6,199,854	7,412,389	8,448,261
4,439,135	2,014	8,971,631	10,746,294	12,733,040
5,918,846	2,685	11,953,536	13,915,225	16,191,597
7,398,558	3,356	14,331,487	16,972,007	20,119,153

3.6 Caveats

As with any model, we make assumptions and simplifications over very rich economic and biological systems in order to distill important impacts due to policy changes in the fishery. Below we list the major caveats with our work:

1. This analysis focuses *only* on recreational fishermen and ignores changes in economic value in related sectors (e.g. party/charter owner operator profits, bait and tackle shop profits, etc.) that can be solely attributed to summer flounder quota changes. Consequently, this means the estimates presented here are *lower bound estimates.*

2. As discussed previously, our estimates ignore the opportunity cost of time and again means we are providing *lower bound estimates.* We discuss this in more detail in the following section where we present our preferred model.

3. Our analysis *does not* account for changes in trips due to quota changes. We might imagine that as quota is lowered trips decrease (via bag, seasonal restriction, bag and size limit changes, etc.). We hold trips constant at 2014 observed levels. This again means that our estimates are *lower bound* estimates.

Table 3.5: Marginal Willingness to Pay by Quota Allocation

Quota (Pounds)	Quota (Metric Tons)	Lower 95% CI	Mean CV	Upper 95% CI
739,856	336	6.02	9.86	14.02
2,219,567	1,007	2.03	4.46	6.93
3,699,279	1,678	1.91	3.50	5.40
5,178,991	2,349	2.22	3.11	4.13
6,473,738	2,936	2.17	2.76	3.37
7,398,558	3,356	2.31	2.62	2.92
8,323,378	3,775	2.01	2.50	3.08
9,618,125	4,363	1.66	2.49	3.38
11,097,837	5,034	0.86	2.25	3.80
12,577,549	5,705	0.39	2.14	3.91
14,057,260	6,376	-0.35	2.07	4.52

4. When altering expected catch and release of summer flounder as described in Section 3.5.1, we assume that there is some combination of bag, size limit, and season limit that could be changed to meet quota goals. Whether this tends to push our estimate towards an upward or lower bound is unknown.

3.7 Discussion

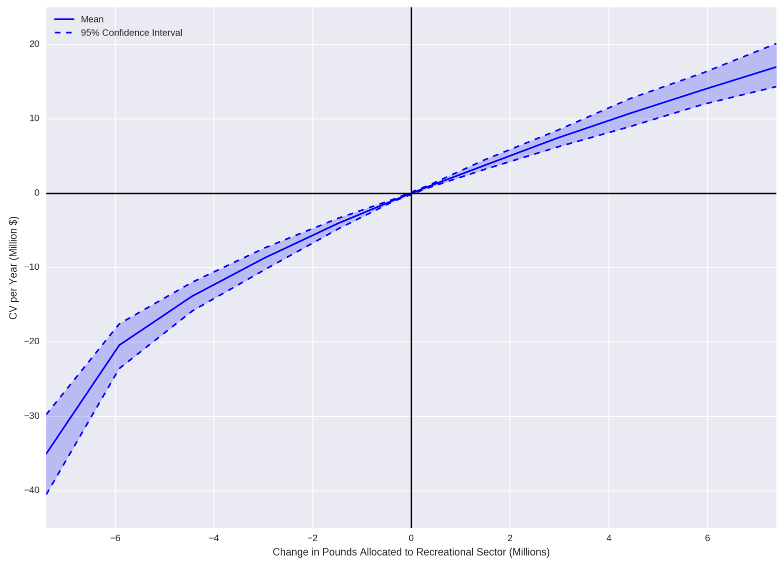
Despite the limitations of our work mentioned in the above section, the provided estimates are a very defensible *lower bound* estimates for the change in economic value associated with quota changes in the Summer Flounder Fishery. Table 3.6 lists several other studies and point estimates for marginal values associated with summer flounder.

To compare the results, it is important to note that all of the values per pound reported in Table 3.6 except ours, calculate a +1 change in expected catch *at each site for all trips*. Consequently, the policy change examines a case where every summer flounder trip probably catches and keeps an additional summer flounder. This change is much larger in magnitude than any considered in this study[15]. The most comparable estimate we produce to either Gentner et al. (2010) or Massey, Newbold and Gentner

[14] Calculated by dividing +1 fish estimate ($4.22) by 2.77 (Average weight of summer flounder used by (Gentner et al., 2010)). Also uses a sample of Maryland anglers who fished and not NOAA Fisheries MRIP data.

[15] 4,061,024 trips (MRIP estimated Summer Flounder directed trips along the Atlantic Coast) $\times$ + 1 fish $\times$ 2.77 pounds per fish = 11,249,036 additional pounds of recreational harvest.

Figure 3.2: Recreational Total Change in Economic Value



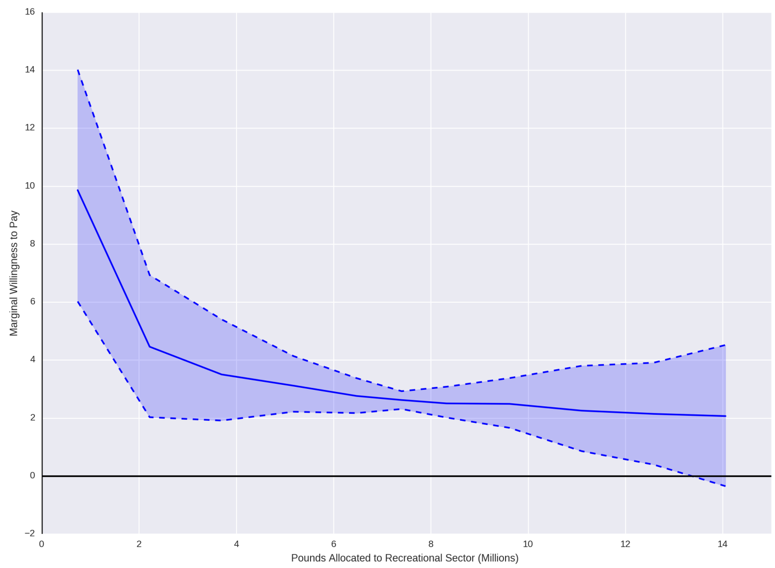
(2006) is $2.07 which corresponds to an allocation of an additional 7.4 million pounds of recreational quota.

Due to data constraints we were unable to estimate a model that fully accounts for the travel cost of recreation trips because a lack of data precluded us from accounting for the opportunity cost of time. It is well known and an established finding in the recreation demand literature that failing to include the opportunity cost of time in recreation demand models will bias welfare results (Bockstael, Strand and Hanemann (1987)). Examining the results in Gentner et al. (2010), they find that after using their opportunity cost of time correction, their economic value estimate was approximately 1.85 times higher for their preferred model.[16] Since we don't have access to data allowing us to include time in the construction of travel costs, we perform a benefits transfer by applying Gentner et al. (2010) scaling ratio to our estimates to approximate the results we would have found given complete data.[17] After applying the benefits transfer

[16]From Table 5.15 page 59.

[17]There is a well established literature on benefits transfer and the conditions under which it is a valid technique to use, particularly in a random utility model context (Parsons and Kealy (1994)). Given that both our study and Gentner et al. (2010) are using the same data (except for the including travel cost), the same study region, and the same modeling technique the literature shows benefits transfer to yield reliable estimates for welfare measures ((Parsons and Kealy (1994)).

Figure 3.3: Marginal Willingness to Pay Time Costs Excluded



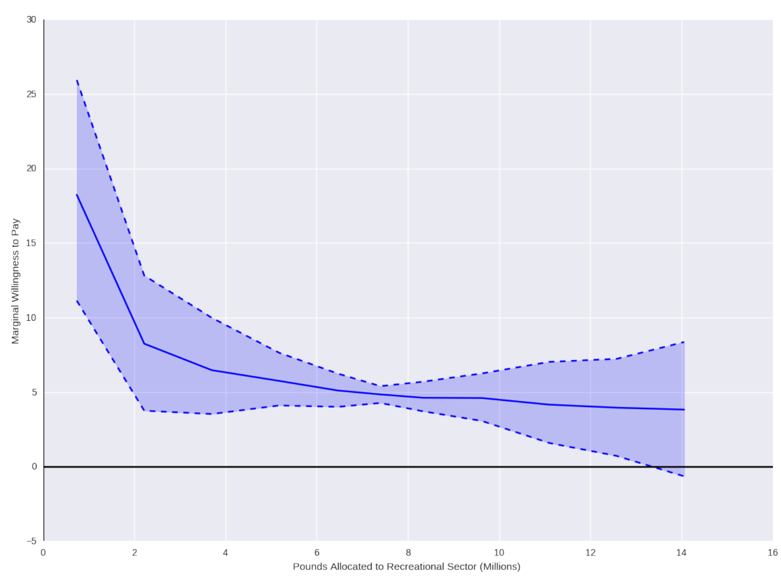
to approximate a situation where the opportunity cost of time had been included in our model, the marginal willingness to pay would have resided in the range [$18.24 to $3.83] depending on the quota level being analyzed. Consequently, our preferred marginal williness to pay estimates include the opportunity cost of time and are given in Figure 3.4 and are calculated by scaling either Figure 3.3 or the values in Table 3.5 by 1.85.

Our results show that the recreational summer flounder fishery is extremely valuable notwithstanding our caveats above. Furthermore, our results clearly show that this value responds to allocation decisions made by managers and responds in ways that we think is reasonable: when recreational anglers don't have very much quota they value an additional pound of quota more than if the sector had lots of quota. However, even as sector allocations for the recreational sector get large (relative to observed catches in 2014), they continue to have high value per pound for summer flounder.

Table 3.6: A comparison of Summer Flounder Valuation Estimates

Study	Mean Value per Pound	Opportunity Cost of Time	Weighting	Nested
Current Study	\$9.86 - \$2.07	Not Included	Yes	No
Gentner et al. (2010)	\$3.48	Included	No	Yes
	\$2.38	Not Included	No	Yes
	\$1.45	Included	No	No
	\$0.80	Not Included	No	
	\$0.99	Included	Yes	No
	\$0.53	Not Included	Yes	No
Massey, Newbold and Gentner (2006)[14]	\$1.59	Unknown	Unknown	No

Figure 3.4: Marginal Willingness to Pay (Time Costs Included)



Chapter 4

Commercial Model

Our analysis of the commercial sector substantially differs from the previous work that has been conducted on sector allocation Gentner et al. (2010), Carter, Agar and Waters (2008). However, the modeling structure closely follows the empirical methodology used in our analysis of the recreational sector as the random utility model is the foundation McFadden (1978). Our modeling efforts consist of four distinct steps that allow us to estimate the marginal value per a pound of summer flounder within the commercial sector. In the first stage we estimate trip-level costs for the trawl fleet targeting summer flounder. In the second stage we estimate a site choice model for vessels that caught summer flounder between 2000 and 2014. In our third stage we combine the trip-level cost estimates with site choice estimates to simulate fleet activity and the execution of the summer flounder fleet allocation. Lastly, using a convolution method we estimate the marginal value per a pound of summer flounder by determining the incremental profits earned when the allocation is increased for the commercial summer flounder fleet. In the following description we divide up each estimation step and discuss them in more detail.

4.1 Estimating Trip Costs

The first step in our analysis was estimating the expected trip-level costs using the trip-level cost data from 2000 through 2014. This data has been collected by the Social Sciences Branch (SSB) of the NMFS Northeast Fisheries Science Center on an annual basis as part of Northeast Fishery Observer Program's (NEFOP) data collection efforts Das (2013). The data are obtained either through the direct observation of the observer or through interviewing the vessel captain. The data used to construct our expected costs is a subset of the broader data set constructed by the NEFOP as it focuses on just those vessels who have landed summer flounder between 2000 and 2014 and are trawl vessels. Therefore, our estimation techniques and data utilized are slightly different from those used by Das (2013).

Given the narrowly defined subset of vessels that we elected to use in our analysis we extracted the tons of ice, the price of ice, the gallons of fuel purchased, the fuel price, costs incurred for vessel damages, general supply costs, food costs, water costs and bait costs from the NEFOP cost data to construct a total trip level cost. We also extracted information on the number of crew members employed, the month and year of harvest, vessel characteristics (i.e., gtons, hp, hold, length), the vessel's state, the steam time on the trip and the number of hauls conducted on the trip. This data was used to estimate a log-log ordinary least squares regression for trip-level costs. The covariates used to explain the total trip level costs included year fixed effects, month fixed effects, vessel-state fixed effects, vessel capital (i.e., vessel characteristics), crew, steam time, days fished and hauls conducted. The parameter estimates from our regression are contained in Table 4.1.

The regression results indicate that trip-level costs were the lowest in the early 2000s, which is most likely driven by the substantially lower fuel costs during this time period. Costs are also lower during the months of August and October which roughly corresponds with the seasonal fishing patterns within the summer flounder fishery. Vessels fishing from Connecticut, Maryland, New York and Rhode Island have lower trip level costs. This roughly corresponds with the areas that have the largest concentration of summer flounder. The fixed inputs that increase trip level costs are the vessels length and gross tonnage, whereas their horsepower and hold capacity have little impact on costs. As far as the variable inputs of production, the larger the crew size the higher the costs, but the second order effect is negative. Steam time also increases the trip-level costs but again the second order term is negative. The number of days increases the trip-level costs at an increasing rate and lastly, the number of hauls increases costs but at a decreasing rate.

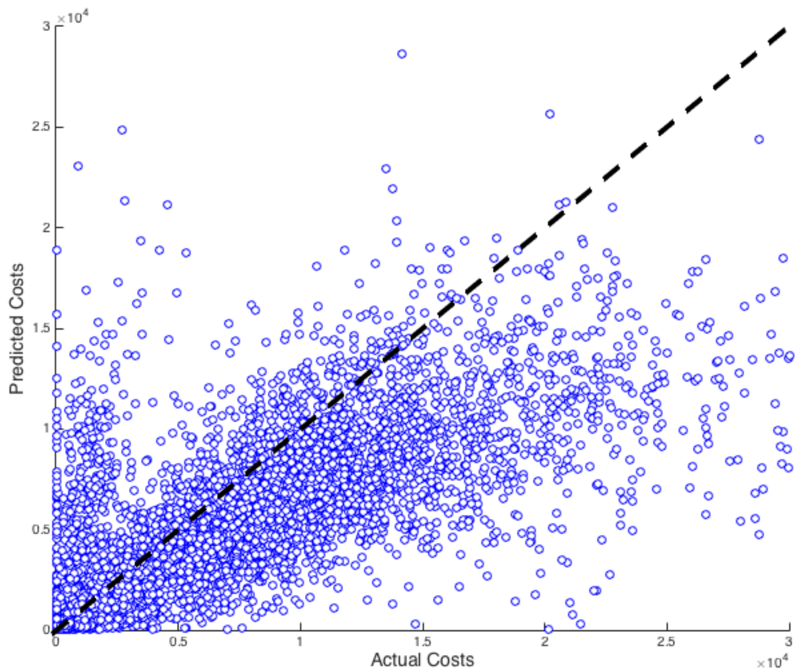
Using these parameter estimates we will estimate the expected costs per a haul within our simulation. Given that need for an accurate profile of costs we plot the actual and expected costs resulting from our regression estimates in Figure 4.1. In general our predicted trip-level costs are closely in line with those observed in the trip cost data. However, our estimates do tend to underestimate the expected trip level costs. This can be easily observed by noting that clustering of the data in Figure 4.1 below the 45-degree

Table 4.1: Trip-Level Cost Estimates

Parameter	Estimate	Parameter	Estimate	Parmeter	Estimate
Constant	-0.0457	February	-0.0858	New York	-0.4056***
	(0.7732)		(0.0916)		(0.1472)
Year 2000	-0.6720***	March	0.0151	North Carolina	0.0253
	(0.1996)		(0.0918)		(0.1783)
Year 2001	-0.7971***	April	0.0024	Rhode Island	-0.3363***
	(0.1894)		(0.1000)		(0.1343)
Year 2002	-0.3774**	May	-0.0509	ln(length)	0.8328***
	(0.1798)		(0.0927)		(0.2516)
Year 2003	-0.2969*	June	-0.0830	ln(gtons)	0.2952***
	(0.1703)		(0.0894)		(0.0897)
Year 2004	-0.4045**	July	-0.1384	ln(hp)	0.0197
	(0.1596)		(0.0854)		(0.0724)
Year 2005	0.0972	August	-0.2273***	ln(hold)	0.0076
	(0.1541)		(0.0876)		(0.0244)
Year 2006	0.2378	September	-0.1249	ln(crew)	0.2631**
	(0.1610)		(0.0903)		(0.1268)
Year 2007	0.1946	October	-0.1713*	ln(crew)*ln(crew)	-0.0659***
	(0.1597)		(0.0893)		(0.0704)
Year 2008	0.3645**	November	-0.0655	ln(steam)	0.3362***
	(0.1598)		(0.0882)		(0.0673)
Year 2009	-0.2033	Connecticut	-1.7158***	ln(steam)*ln(steam)	-0.0746***
	(0.1553)		(0.1972)		(0.0212)
Year 2010	0.1628	Maine	0.2317	ln(days)	0.7823***
	(0.1583)		(0.1620)		(0.1060)
Year 2011	0.3049*	Maryland	-1.0701***	ln(days)*ln(days)	0.1319***
	(0.1582)		(0.1826)		(0.0524)
Year 2012	0.1211	Massachusetts	0.0894	ln(hauls)	0.7095***
	(0.1598)		(0.1299)		(0.0707)
Year 2013	0.1334	New Hampshire	-0.1484	ln(hauls)*ln(hauls)	-0.1407***
	(0.1593)		(0.1724)		(0.0224)
January	-0.1165	New Jersey	-0.0608		
	(0.0888)		(0.1365)		
	Number of Obs.		13,667		
	Adjust. R^2		0.4064		

line. Although this does introduce a bias into our simulation results, as long as this bias permeates all of the trips within the simulation this will not introduce a substantial bias to our marginal valuation estimates. This will become more evident in our discussion of the simulation results.

Figure 4.1: Predictive Accuracy for the Trip-Level Cost Estimates



4.2 Random Utility Model

The random utility model has been extensively used in the fishery economics literature focused on spatial discrete choices Curtis and Hicks (2000), Hicks and Schnier (2008), Haynie, Hicks and Schnier (2009), Holland and Sutinen (1999), Holland and Sutinen (2000) and Smith and Wilen (2003). Assuming that there are N different sites that a fisherman can select from, they will select location i in time period t if the utility of selecting location i exceeds the utility they can derive from all other locations. This is expressed as,

$$U(i,t) + \epsilon_{i,t} > U(j,t) + \epsilon_{i,t} \forall j \in N$$

The error structure $\epsilon_{i,t}$ is assumed to be known by the decision agent (the fisherman) but not by the researcher. Ignoring the subscripts indexing locations and time the utility specification we utilize for our model is,

$$U(i,t) = \gamma_i + \beta_1 Distance + \beta_2 SF_{Revenues} + \beta_3 BSB_{Revenues} + \beta_4 SCUP_{Revenues} + \beta_5 Other_{Revenues} + \beta_6 No_{Choice} + \epsilon \quad (4.1)$$

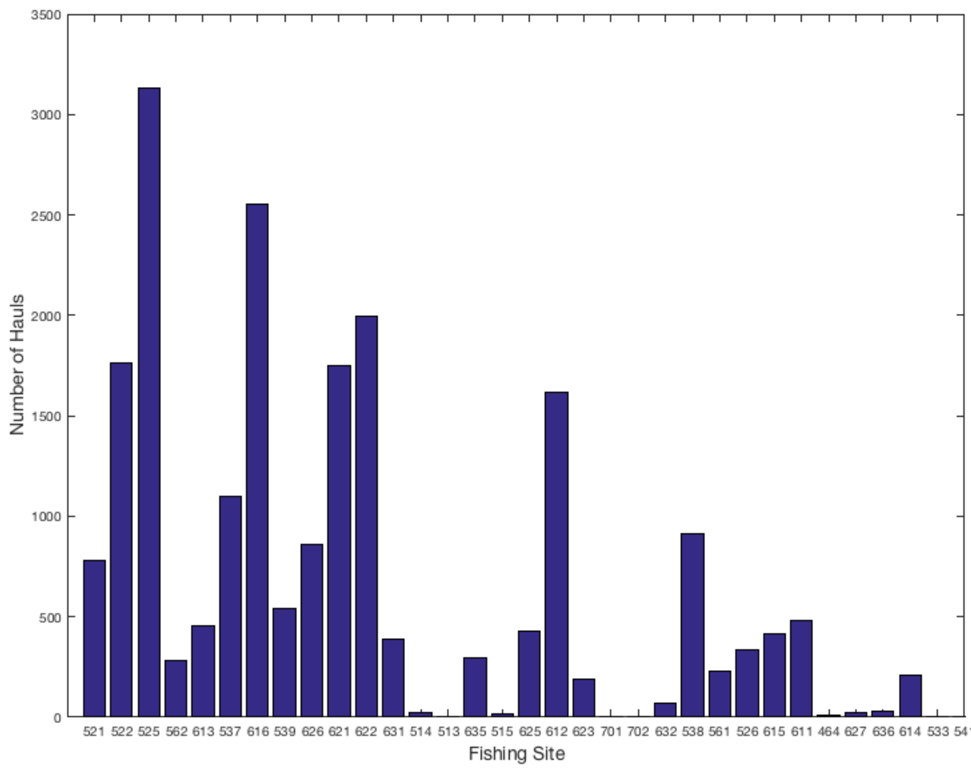
In this model γ_i are site specific constants to control for site-specific factors that are unobserved in our data set, but that drive site choice selection. The use of these alternative specific constants have proven to be exceptionally valuable in the fishery economics literature Timmins and Murdock (2007), Smith (2005) and Hicks, Horrace and Schnier (2012). *Distance* is the expected distance that a vessel will travel from the current location to all other potential locations. Within the data set on a vessel's first haul we calculated the distance using their home port as the point of origination. $SF_{Revenue}$ is the expected summer flounder revenues that a fisherman will earn if they visit the site in question in the current time period. $BSB_{Revenues}$, $SCUP_{Revenues}$ and $Other_{Revenues}$ are similar variables constructed for black sea bass, scup and all other species landed. All expected revenue calculations are constructed using a 60-day lag of the observed revenues earned in the respective locations [1]. We elected to partition out black sea bass and scup from the other species as these two species are jointly managed with summer flounder. The variable No_{Choice} is a dummy variable that indicates whether or not a location has not been visited within the past 60-days (the time window used for the revenue expectations). This helps to control for temporal variations in the sites that vessels fish, which is important given the seasonal trends that exist within this fishery.

To estimate our model we use observer data from 2000 through 2014. To ensure that we are capturing vessels that caught summer flounder during this time period we restrict the sample to trawl vessels that landed summer flounder during this time period. There were 33 distinct 3-digit NFMS zones that were fished by vessels during this time. Figure 4.2 plots a histogram of the number of hauls that were conducted in each of these sites within our sample. The top five most visited sites were locations 525, 616, 622, 621 and 522. The data set consists of 2,337 unique fishing trips and 20,900 unique hauls.

The parameter estimates from our random utility model are contained in Table 4.2. The parameter estimates are consistent with the site visitation rates. The highest

[1] We explored the use of alternative lagged time framings (i.e., 30-day, 60-day, 90-day, 180-day, 1-year) and our results were relatively robust to alternative specifications

Figure 4.2: Histogram of Hauls per a Site



valued site is location 525, which is also the most visited site, and the other highly visited sites (i.e., 616, 622, 621 and 522) have high site-specific constants. The sites with low visitation rates (i.e., 701 and 702) have larger negative site-specific constants that are consistent with our expectations. We only estimate 30 site-specific constants in our model because three of the sites had exceptionally small visitation rates and we set their site-specific constants to zero. The other parameter estimates are also consistent with our expectations. The coefficient on expected distance traveled is negatively and highly significant [2]. The revenue coefficients indicate that a higher expected summer flounder revenue as well as black sea bass revenue increases the probability that a vessel will fish in a given location, whereas a high expected revenue for all other species reduces the probability that one will fish in a given location. The expected revenues for scup

[2]The distance variable was scaled by 1000 miles

did not influence the site visitation probability [3]. Lastly, the coefficient on No_{Choice} indicates that vessels are less likely to visit a location that they have not visited in the past 60-days. The parameter estimates from this regression provides the foundation for the simulation model that will be discussed in the upcoming section.

4.3 Simulation Model

The simulation model utilizes the parameter estimates to simulate fleet activity and the execution of the total allowable catch within the commercial fishery sector. The simulation is a multi-step process that invokes different elements of existing policy limitations and seasonality to reflect the true fleet activity within the fishery. Each step is discussed in detail below.

Step One: We initialize the current total allowable catch to the commercial sector. Within the simulation we initialize the allocation at 1,000 metric tons and increase it by 1,000 metric tons until the allocation reaches 24,000 metric tons. Although 24,000 metric ton is substantially higher than recent allocations, it is near the peak level catches observed in the 1980s and it is reasonable to assume that it is highly unlikely that future allocations will ever reach that level.

Step Two: We take a random draw from the parameter distribution resulting from the random utility model. The random draw uses the parameter estimate vector as well as the variance covariance matrix for the estimates to generate a new parameter vector. This is conducted to ensure that our parameter estimate draws reflect the underlying parameter distribution.

Step Three: We randomly draw a fishing trip from the observer data and use the parameter vector from *Step Two* to predict the site visitation probabilities for each haul on the randomly drawn trip. The estimated probabilities are calculated using the following equation

$$P(i,t) = \frac{e^{U(i,t)}}{\sum_{j \in N} e^{U(j,t)}}$$

This estimated probability surface is then multiplied by the expected catch rates, $SFExp_{i,t}$ (estimated using 60-day lags) at each location in time period t, $P(i,t) * SFExp_{i,t}$, and then is summed up across all locations, $Catch_t = \sum(P(i,t) * SFExp_{i,t}$, to determine

[3] All revenues were scaled by 10,000 dollars.

Table 4.2: Random Utility Model Site Choice Estimates

Parameter	Estimate	Parameter	Estimate	Parmeter	Estimate
Site 521	4.4020***	Site 635	-0.4230	Site 464	1.8833***
	(0.3006)		(0.3371)		(0.3911)
Site 522	5.3505***	Site 515	2.4091***	Site 627	-0.5034
	(0.3031)		(0.4037)		(0.3667)
Site 525	5.800***	Site 625	1.2879***	Site 636	-2.2462***
	(0.3037)		(0.3135)		(0.3974)
Site 562	3.7990***	Site 612	2.7808***	Site 614	1.9025***
	(0.3094)		(0.3025)		(0.3084)
Site 613	2.8342***	Site 623	0.8327***	Distance	-0.0348***
	(0.2994)		(0.3085)		(0.0003)
Site 537	4.0702***	Site 701	-3.6686***	SF Revenues	3.2105***
	(0.2962)		(0.7723)		(0.2709)
Site 616	3.9001***	Site 702	-3.6686***	BSB Revenues	1.0919**
	(0.2975)		(0.5113)		(0.5360)
Site 539	2.3813***	Site 632	-0.5209	SCUP Revenues	0.0218
	(0.2999)		(0.3440)		(0.4275)
Site 626	2.1421***	Site 538	3.3288***	Other Revenues	-0.3236***
	(0.3095)		(0.2978)		(0.0871)
Site 621	2.5530***	Site 561	3.4560***	No Choice	-1.7184***
	(0.3071)		(0.3122)		(0.0857)
Site 622	3.2530***	Site 526	2.9459***		
	(0.3027)		(0.3032)		
Site 631	0.2867	Site 615	2.2182***		
	(0.3248)		(0.3028)		
Site 514	1.2294***	Site 611	2.4216***		
	(0.3077)		(0.3004)		
	Number of Obs.		20,900		
	Log Likelihood (parameters=0)		-73,077		
	Log Likelihood (estimates)		-17,219		

the expected catch in time period t. These expectations are also estimated for black sea bass as well as scup.

Step Four: We reduce the allocation of summer flounder to the commercial fleet by the $Catch_t$ to determine the remaining allocation of summer flounder. In addition, we set the total allowable catch of black sea bass to 2.5 million pounds and the total allowable catch for scup to 22 million pounds. If the catch for either or these species exceeds this allocation the expect catch is set to zero to reflect that they must be discarded.

Step Five: We calculate the expected revenue from each haul using the following formula $Rev_t = \sum(P(i,t) * (SFRevenues_{i,t} + BSBRevenues_{i,t} + SCUPRevenues_{i,t} + OtherRevenues_{i,t})$. To account for the costs incurred on the trip we subtracted the expected costs from fishing that trip using our cost estimates (see Table 4.1) discussed earlier to get a profile of trip-level profits.These profits were then added up for all fishing activity that occurred within the simulation to determine the fleet wide profits for the given allocation of summer flounder.

Step Six: We determine whether or not the current aggregate catch of summer flounder for the fleet has exceeded the allocation and if it has not we return to *Step Two* until the allocation of summer flounder is exhausted.

The above mentioned six steps represent the core of the simulation, which we refer to as *Model One*, however additional complexities have been added to make the simulation more realistic. The additional features are summarized below.

4.3.1 State Allocations for Summer Flounder, Black Sea Bass and Scup

The commercial fleets allocation of summer flounder is further subdivided among the states that harvest summer flounder. This is also true for the allocations of black sea bass and scup. Given this, we added these constraints to our second simulation model, *Model Two*. The state allocations we used for each of the three species are indicated in Table 4.3.

In order to incorporate the state allocations into the simulation model we tracked the catch of summer flounder (SF), black sea bass (BSB) and scup through the simulation. In the case that state allocation for summer flounder was exceeded we removed all vessel-trips originating from that state in *Step Three* of the simulation. This way only those

Table 4.3: State Allocations for Summer Flounder, Black Sea Bass and Scup

State	Percentage SF	Percentage BSB	Percentage SCUP
ME	0.0476%	0.1210%	0.5000%
NH	0.0005%	0.0000%	0.5000%
MA	6.8205%	21.5853%	13.0000%
RI	15.6830%	56.1894%	11.0000%
CT	2.2571%	3.1537%	1.0000%
NY	7.6470%	15.8232%	7.0000%
NJ	16.7250%	2.9164%	20.0000%
DE	0.0178%	0.0000%	5.0000%
MD	2.0391%	0.0119%	11.0000%
VA	21.3168%	0.1650%	20.0000%
NC	27.4458%	0.0249%	11.0000%

vessel-trips that were eligible to fish for summer flounder, per the state allocation rules, were eligible for random selection. If a states allocation for black sea bass or scup were exceeded, we still allowed for the vessel-trip to be selected in *Step Three*, but we zeroed out the catch of the species that had already exceeded its state allocation limit.

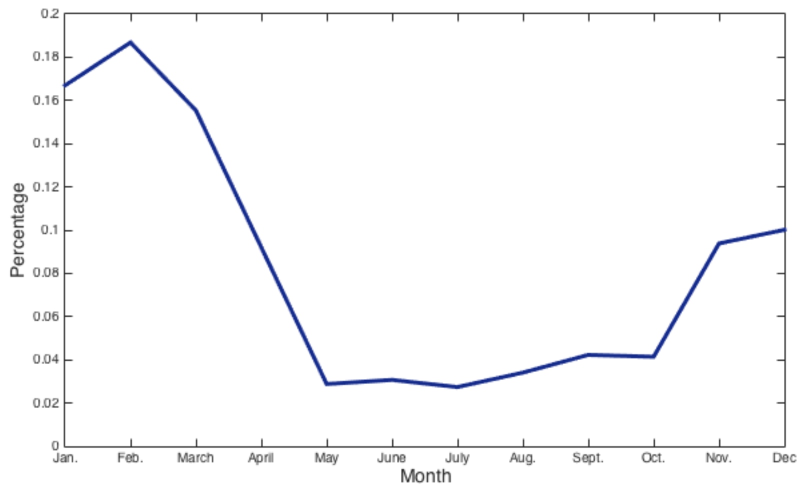
4.3.2 Seasonal Patterns in Fishing Behavior

The summer flounder fishery is a seasonal fishery will a large percentage of the catch occurring in the winter months. Figure 4.3 graphically illustrates the average percentage of the landings that occurred by month within the observer data. It is clear that a bulk of the catch arises in the months of November, December, January, February and March. Given that we are randomly generating a vessel-trip from the set of all vessel-trips, we added a seasonal constraint to the model that ensures that the simulated fleet behavior mirrors the temporal distribution of catch within the fishery. This was achieved by altering our *Step Three* by first randomly sampling a month from the distribution illustrated in Figure 4.3 and then randomly selecting a vessel-trip from within that month.

4.4 Construction of Marginal Values

For each of the different summer flounder allocations we conducted 40 different simulations. This allows us to construct confidence intervals on our estimates of the marginal

Figure 4.3: Seasonal Pattern for Summer Flounder Harvest



value per a pound of summer flounder. To calculate the marginal value we estimated the following equation

$$\text{Marginal Value}_k = (Profit_k - Profit_{k-1})/(1000 * \text{Metric Ton})$$

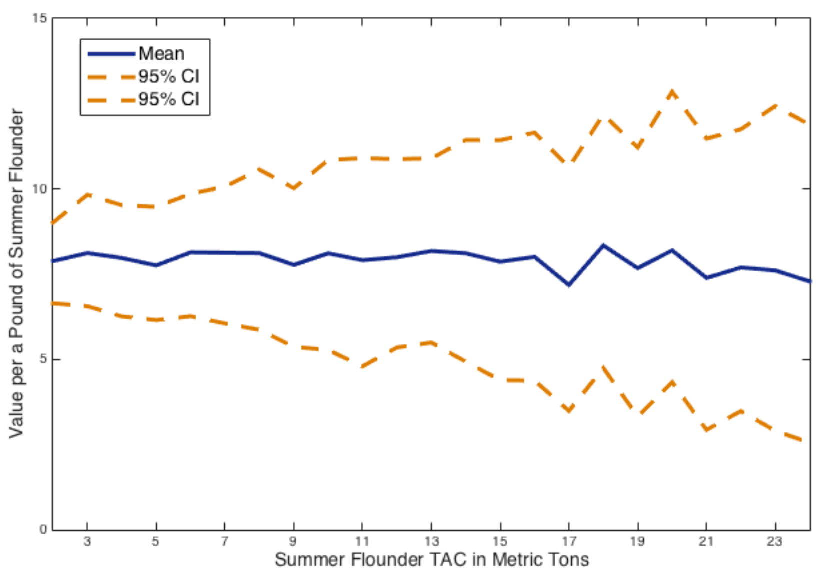
where, Marginal Value$_k$ is the marginal value when one increases the allocation of summer flounder to allocation level k, $Profit_k$ is our estimate of fleet profits when the allocation is k and $Profit_{k-1}$ is the estimated profit prior to the increase in the allocation from level $k-1$ to k. Given that our unit of increase is 1,000 metric tons, we divide the difference in the change in profits by the incremental change in pounds landed to get a marginal value per a pound of summer flounder. Since we have 40 different simulations for each level of k, through the convolution of all 40 at one level of k with the 40 observed at level $k-1$ we obtain 1,600 different comparisons. These 1,600 comparisons allow us to construct 95% confidence intervals by dropping the top and bottom 40 estimates of Marginal Value$_k$.

One important feature of the marginal value calculations is that they are derived from the total profits that a vessel earns while fishing. This is the sum of all species landed and not just summer flounder. Therefore, although the ex-vessel price for summer flounder ranges between two and four dollars it is possible that the marginal value for summer flounder can exceed this value. This is because summer flounder is a complement in production. When a vessel targets summer flounder they also catch other species that have market value. Therefore, the marginal value of summer flounder is not only the value they derive from summer flounder but also the additional value they derive from the other species that are caught in conjunction with targeting summer flounder. This is an important feature of the simulation because if one reduces the allocation of summer flounder to the commercial fleet it will also impact the revenue flows that they derive from the other species that they would have caught if they were able to target more summer flounder. The following subsections discuss the results from the three different models estimated.

4.4.1 Marginal Values - Model 1

Model 1 is the simplest of the models we estimate. This model does not utilize state limits for summer flounder, black sea bass or scup and it does not invoke any seasonality. This model only uses the allocations of the three different species as the binding constraints on the simulation. The mean marginal value for each incremental increase in the allocation of summer flounder as well as the 95% confidence intervals are illustrated in Table 4.4 and graphically illustrated in Figure 4.4.

Figure 4.4: Marginal Value Estimates for Model 1



The results from *Model 1* illustrate that the average marginal value for summer flounder ranges from around $7.2 to $8.2 a pound. The confidence intervals for the estimates increase as the quota allocation increases. At the lowest quota allocation,

Table 4.4: Marginal Values for Model 1

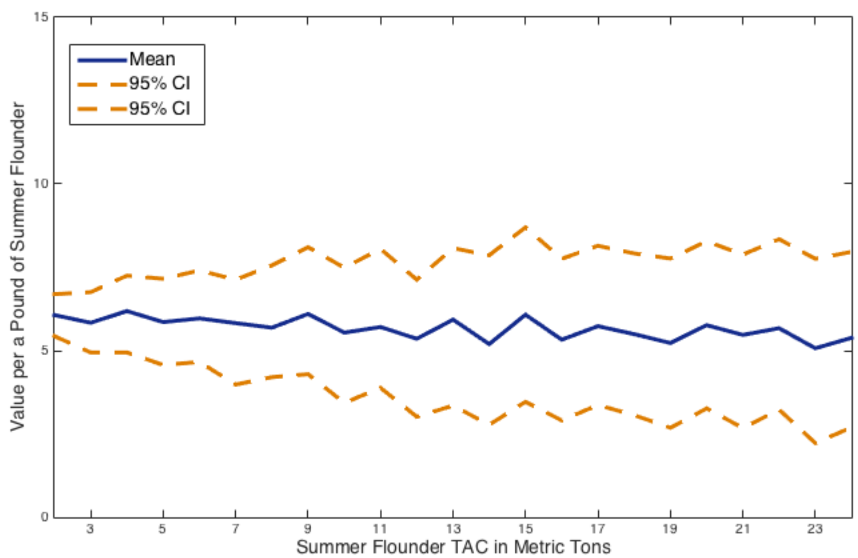
Allocation (MT)	Mean	Lower 95% CI	Upper 95% CI
2,000	7.8851	6.6453	9.0162
3,000	8.1204	6.5616	9.8310
4,000	7.9752	6.2604	9.5245
5,000	7.7581	6.1539	9.4760
6,000	8.1402	6.2661	9.8561
7,000	8.1273	6.0551	10.0714
8,000	8.1179	5.8691	10.5694
9,000	7.7738	5.3696	10.0241
10,000	8.1125	5.2754	10.8474
11,000	7.9104	4.7984	10.9040
12,000	7.9971	5.3515	10.8735
13,000	8.1800	5.4952	10.8989
14,000	8.1137	4.9322	11.4363
15,000	7.8664	4.3919	11.4297
16,000	8.0085	4.3781	11.6515
17,000	7.1833	3.4895	10.6389
18,000	8.3415	4.7475	12.1810
19,000	7.6772	3.3215	11.2153
20,000	8.1974	4.3329	12.8512
21,000	7.3900	2.9345	11.4773
22,000	7.6961	3.4828	11.7511
23,000	7.6107	2.9050	12..4311
24,000	7.2882	2.5568	11.8850

2,000 metric tons, the 95% confidence interval is between \$6.65 and \$9.02. At the highest quota level, 24,000 metric tons, the 95% confidence interval is between \$2.56 and \$11.89. The current allocation to commercial sector has been hovering between 8,000 and 13,000 metric tons. In this range the average marginal value is between \$7.8 and \$8.1 and the 95% confidence intervals are between \$5.89 and \$10.57 at 8,000 metric tons and \$5.50 and \$10.90 at 13,000 metric tons.

4.4.2 Marginal Values - Model 2

Model 2 augments *Model 1* by incorporating the state allocation constraints. This implies that once a given state has reached their allocation of summer flounder we no longer allowed vessels from that state to target summer flounder. If vessels reached their allocation of black sea bass and scup we did allow them to continue targeting summer flounder, but we did not allow them to retain any of the black sea bass or scup for sale (i.e., we zeroed out the revenue flow from the species). The results from this simulation are contained in Table 4.5 as well as Figure 4.5.

Figure 4.5: Marginal Value Estimates for Model 2



The results illustrate that incorporating the state allocation constraints lowered the marginal value per a pound of summer flounder by approximately 25%. Therefore, the state allocation constraints are a significant contribution to our simulation model.

Table 4.5: Marginal Values for Model 2

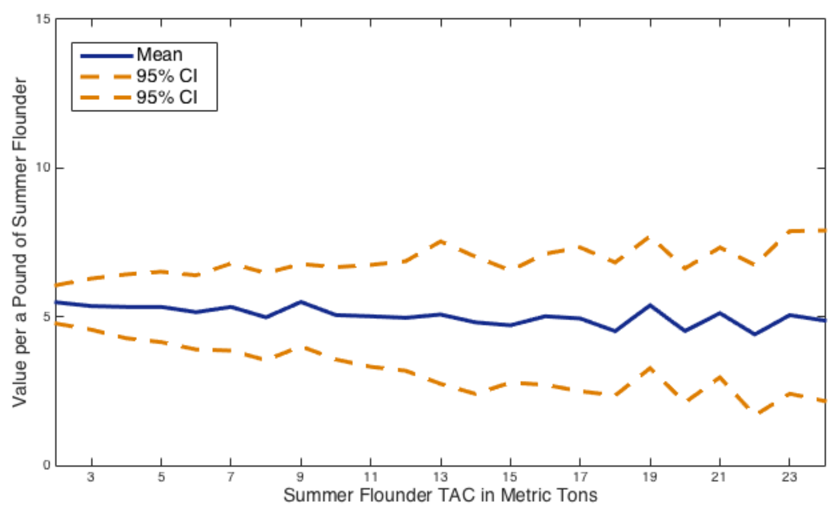
Allocation (MT)	Mean	Lower 95% CI	Upper 95% CI
2,000	6.0685	5.4347	6.6957
3,000	5.8368	4.9449	6.7553
4,000	6.1873	4.9453	7.2509
5,000	5.8575	4.5707	7.1560
6,000	5.9674	4.6613	7.4056
7,000	5.8262	3.9824	7.1283
8,000	5.6894	4.2051	7.5583
9,000	6.1013	4.2939	8.1041
10,000	5.5413	3.4329	7.4886
11,000	5.7093	3.8840	8.0508
12,000	5.3566	3.0163	7.1295
13,000	5.9295	3.3511	8.0747
14,000	5.1982	2.7767	7.8634
15,000	6.0796	3.4642	8.6992
16,000	5.3292	2.9072	7.7538
17,000	5.7339	3.3682	8.1471
18,000	5.4954	3.0646	7.9163
19,000	5.2289	2.6862	7.7639
20,000	5.7643	3.2661	8.2814
21,000	5.4730	2.6802	7.8814
22,000	5.6740	3.2282	8.3438
23,000	5.0712	2.2265	7.7550
24,000	5.3849	2.6989	7.9653

The average marginal values for *Model 2* range from slightly over \$5 to just slightly over \$6 a pound, with the values gradually decreasing as the allocation of summer flounder increases. The 95% confidence intervals range from between \$4.94 and \$6.76 at the lowest allocation, 2,000 metric tons, to between \$2.70 and \$7.97 at the highest allocation level, 24,000 metric tons. The current allocation to commercial sector has been hovering between 8,000 and 13,000 metric tons. In this range the average marginal value is between \$5.36 and \$6.10 and the 95% confidence intervals are between \$4.21 and \$7.56 at 8,000 metric tons and \$3.35 and \$8.07 at 13,000 metric tons. These are lower than the values observed under *Model 1*.

4.4.3 Marginal Values - Model 3

Model 3 builds on *Model 2* by incorporating seasonality in the execution of commercial allocation. Using the distribution of landings in Figure 3 we first randomly drew a month from this distribution and then a vessel trip as well as ensuring that the trip met the state allocation constraints. This seasonality allowed the execution of the sector allocation to mirror the actual distribution of harvest observed within the sector. The results from the simulation are illustrated in Table 4.6 and Figure 4.6.

Figure 4.6: Marginal Value Estimates for Model 3



The results from *Model 3* generate slightly lower marginal value estimates than those observed in *Model 2*. This is reasonable because we have constructed the simulation

Table 4.6: Marginal Values for Model 3

Allocation (MT)	Mean	Lower 95% CI	Upper 95% CI
2,000	5.4827	4.7681	6.0625
3,000	5.3583	4.5628	6.2845
4,000	5.3298	4.2755	6.4238
5,000	5.3301	4.1458	6.5119
6,000	5.1533	3.8970	6.3929
7,000	5.3293	3.8611	6.7917
8,000	4.9791	3.5380	6.4686
9,000	5.4968	4.0064	6.7719
10,000	5.0561	3.5626	6.6672
11,000	5.0145	3.3164	6.7422
12,000	4.9652	3.1843	6.8668
13,000	5.0733	2.7426	7.5328
14,000	4.8105	2.4053	7.0192
15,000	4.7111	2.7840	6.5570
16,000	5.0148	2.7127	7.1172
17,000	4.9404	2.4938	7.3306
18,000	4.5149	2.3536	6.8245
19,000	5.3843	3.2686	7.7050
20,000	4.5178	2.9612	7.3274
21,000	5.1218	2.9612	7.3247
22,000	4.4040	1.6833	6.7396
23,000	5.0532	2.4101	7.8775
24,000	4.8707	2.1647	7.9001

so that it mimics the seasonal inshore-offshore patterns within the fishery. The average marginal value ranges from \$5.5 to around \$4.4 per a pound of summer flounder, with the marginal values decreasing as the allocation to the sector increases. The 95% confidence intervals range from between \$4.15 and \$6.52 at the lowest allocation, 2,000 metric tons, to between \$2.16 and \$7.90 at the highest allocation level, 24,000 metric tons The current allocation to the commercial sector has been hovering between 8,000 and 13,000 metric tons. In this range the average marginal value is between \$4.97 and \$5.50 and the 95% confidence intervals are between \$3.54 and \$6.47 at 8,000 metric tons and \$2.74 and \$7.53 at 13,000 metric tons. These estimates are approximately \$0.50 lower than *Model 2* and around \$2 per a pound lower than *Model 1*. Given that *Model 3* most closely follows the seasonal harvesting trends as well as the state allocation constraints, the results from this model are our preferred estimates of the marginal value per a pound of summer flounder.

4.4.4 Caveats

As with any empirical study, there are limitations to our analysis. These limitations are a result of the modeling conducted as well as the available data we have used to conduct our analysis. Listed below are the major caveats with our work:

1. The data used in our analysis relies on the observer data set. This data set captures only a small portion of the total summer flounder landings. Although the observer data does closely align with the vessel trip reports it is important to note its limited coverage. The vessel trip report data can not be used in our analysis because it does not contain detailed and sequenced spatial behavior. Therefore, the observer data is the best available data set for our analysis.

2. Our analysis is a short run analysis of the commercial fleet. In our model the price of summer flounder is not endogenous and we do not account for the free entry and exit of fishermen within the summer flounder fishery. These factors may result in different results, but the data does not allow us to investigate these factors.

3. Our analysis does not account for the localized depletion within the fishery. As the quota increased, and more fishing occurs one might expect that the cost per a haul increases.

Chapter 5

Allocation Analysis and Recommendations

We conclude with our allocation analysis, which examines for a particular quota level the marginal benefits (or marginal willingness to pay) for each sector if an additional unit of quota was allocated to them. Following the equimarginal principle, we examine allocation levels where each sector's marginal benefit for the last quota unit allocated to them is equalized. Economists call this optimal because once we have established the optimal allocation, any other allocation necessarily lowers total economic benefits in the fishery.[1]

5.1 Allocation Analysis

The earlier chapters clearly demonstrate that both sectors benefit when quota is allocated to them. In this section, we compare these marginal benefits to examine

1. How the current allocation (60% Commercial and 40% recreational) compares to the optimal allocation
2. The quota allocation change that could increase economic benefits in the fishery

Both the commercial and recreational methodologies produce marginal value estimates that show what the sector is "willing to pay" for an additional unit of quota. We combine the marginal value estimates from Model 3 in the commercial Chapter 4

[1]This is a strong statement and we note the caveats to our work mentioned in this chapter and elsewhere in the document.

Figure 4.6 (the preferred model) with the marginal value schedule from the recreation Chapter 3 Figure 3.4 (also the preferred estimate). In order to do this, we assume a grand total allowable catch of 8,000 Metric Tons (as that was the approximate TAC level in 2014 and the last year of data included in our models) and imposed the following constraint on the commercial and recreational sectors:

$$Harvest_{Recreational} + Harvest_{Commercial} = 8000$$

This allows us to solve for one sector's harvest as a function of the other. The commercial harvest can be written as

$$Harvest_{Commercial} = 8000 - Harvest_{Recreational}$$

Using these constraints we combine the marginal value schedules for each sector in Figure 5.1. Note that in the figure, we use the preferred models from both the recreational and commercial sectors.

This figure shows, that once the 95% confidence intervals are included, there is no clear-cut difference in marginal value schedules for a wide swath of quota allocation levels between 2000 and 6000 metric tons. Once the uncertainty is factored into the equimarginal analysis,

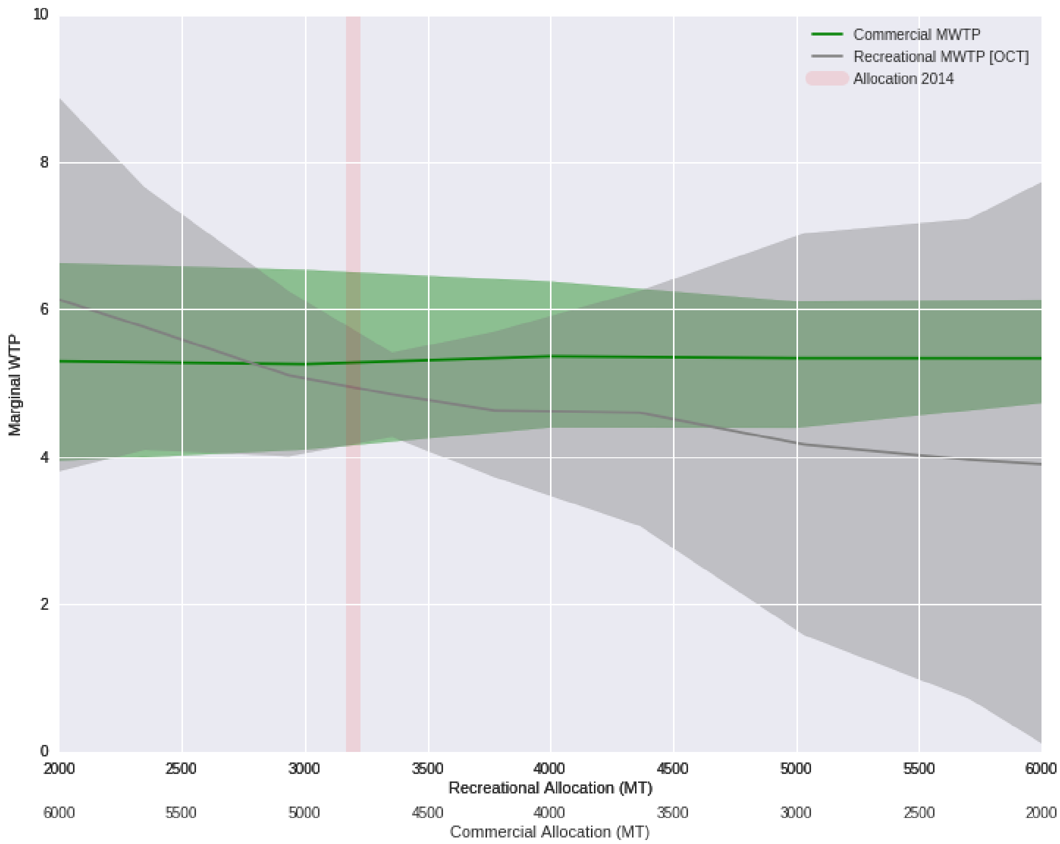
- The current allocation can't be said to be sub-optimal since stakeholders directly engaged in summer flounder fishing have very similar "Willingness to Pay" for an additional pound of fish in the neighborhood of the current allocation.
- Modest changes from the current allocation would most likely not lower benefits in the fishery.
- Large changes severely limiting one sector over another would most likely lower benefits in the fishery.

5.1.1 Caveats

The aforementioned analysis hinges on a number of key assumptions and we want to make clear some that we think are quite important to note alongside our main results.

Recreation Caveats

Figure 5.1: Marginal Benefits of Quota by Sector



1. By focusing on angler behavior, we ignore any other changes in consumer or producer surplus in the recreation sector that is *due to quota changes in the summer flounder fishery* such as losses/gains in profits at bait shops and boating repair and supply businesses. This means we are tending to underestimate the marginal value schedule for the recreation sector.

2. Our adjustment above in Figure 5.1 to account for the opportunity cost of time is an estimate of what the complete model might look like. In a sense, we are performing a benefits transfer with all of the issues that accompany it. We think it is a reasonable approximation since, both studies examine the same resource, use the same data, and employ similar methods.

3. Our methods do not account for changes in participation and numbers of trips due to policy changes. Consequently, we are tending to underestimate the marginal

value schedule for the recreational sector.

Commercial Caveats

1. The benefits accruing to commercial anglers occur in the *short-run*, since an extensive literature (see Grafton et al. (2006) for a brief overview) has shown that exogenous changes in profitability in regulated open access fisheries are often driven to low levels as commercial vessels try to out-compete each other to catch the fleet quota. Consequently, we would expect the marginal value schedule in 5.1 to decline over time.

2. Like the recreation analysis, this study only focuses on at-sea commercial behavior and ignores any changes in consumer and produce surplus in the commerical sector *solely due to quota changes* such as boating and dock services, and losses in consumer surplus for consumers of summer flounder. Consequently, we are tending to underestimate the marginal value schedule for the commercial sector.

3. Our work ignores any localized depletion due to fishing. As quota is increased, and more fishing occurs one might expect the cost per haul to increase.

5.1.2 Recommendations

Deciding the sector allocation of summer flounder between the commercial and recreational sectors, is an impactful policy decision that alters the welfare of these respective sectors. In our analysis we have focused on making conservative recommendations regarding sector allocation because each of the models developed in our analysis possess important caveats and limitations that are relevant to policy. Although, the methods and data used are the best available we have made a concerted effort to acknowledge the limitations of our efforts and its efficacy for public policy. Given our results, there are a number of short-run implications of our analysis.

In the short-run, we don't see any statistical difference between the marginal value schedules of the two sectors using the preferred set of results. This suggests that the current sector allocations conform with our results. Although the mean estimates for the commercial sectors marginal valuation lie below those within the recreational sector when the recreational allocation is below approximately 2,700 metric tons, the confidence intervals for both sectors overlap. This indicates that our results provide little empirical support for altering the current allocation. Our results also suggest that modest changes in allocation *in either direction* would most likely not lower the economic benefits in the fishery. Large changes that severely restricted one sector over another would most likely lower the economic benefits in the fishery.

Our results can not be used to inform any long-run policy analysis as both sectors are likely to change their behavior should the existing allocation change. On the recreational side our results ignore any changes that may arise in related sectors (i.e., party/charter owners, bait and tackle shops, etc..) and changes in recreational effort that could impact their marginal valuation. On the commercial side our results do not address any changes in the prevailing market (i.e, ex-vessel prices), fleet behavior (i.e, entry and exit), or in related sectors should the allocation to the commercial sector change. Consequently, based solely on the equimarginal analysis performed here with accompanying caveats, we do not recommend changing the quota allocation as the marginal value schedules (Figure 5.1) are nearly equalized at the current allocation level.

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Appendix

Table 5.1: Total Recreational Summer Flounder Catch by State (2010-2015)

		2010	2011	2012	2013	2014	2015
Connecticut	Catch	408103.0	391627.0	368752.0	1135976.0	757270.0	522428.0
	% SE	23.1	29.7	22.8	14.6	20.7	22.2
Delaware	Catch	672223.0	682321.0	298917.0	296722.0	385462.0	207777.0
	% SE	14.6	16.6	16.6	12.2	12.2	14.1
Maryland	Catch	1250666.0	487883.0	236175.0	333283.0	710356.0	288387.0
	% SE	33.9	22.8	33.2	14.4	32.6	24.3
Massachusetts	Catch	259869.0	240958.0	326079.0	93176.0	449391.0	168620.0
	% SE	56.3	22.6	24.1	19.1	47.0	20.7
New Jersey	Catch	11117078.0	8832808.0	8111333.0	7705212.0	10688470.0	5174878.0
	% SE	8.9	10.1	10.9	12.3	11.8	9.0
New York	catch	6905742.0	7671293.0	5521735.0	5184731.0	5033970.0	4732687.0
	% SE	11.6	10.4	11.8	13.0	10.4	11.5
North Carolina	Catch	79184.0	61629.0	63505.0	45469.0	47026.0	40561.0
	% SE	13.0	16.3	17.0	17.0	19.7	23.1
Rhode Island	Catch	348766.0	885522.0	484903.0	654975.0	601986.0	576822.0
	% SE	17.3	23.8	17.2	35.1	21.3	20.9
Virginia	Catch	2679889.0	2304658.0	1116641.0	701788.0	781730.0	773296.0
	% SE	13.4	17.6	15.3	14.9	10.7	23.7

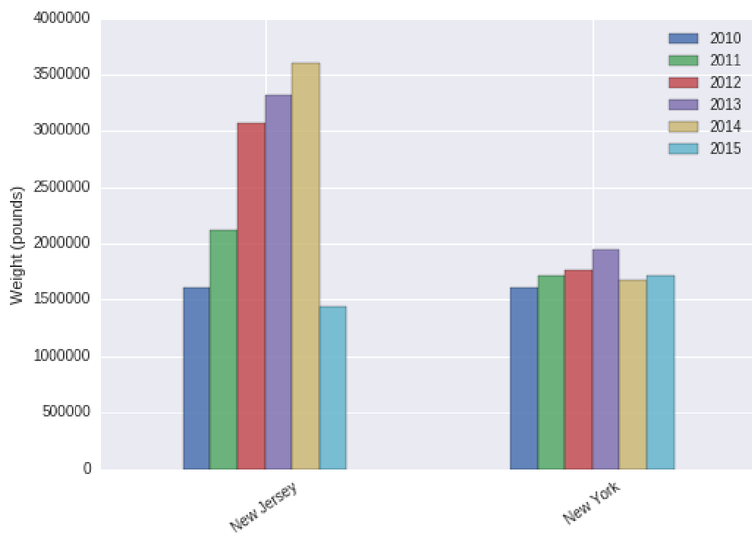
Table 5.2: Total Recreational Summer Flounder Harvest by State (2010-2015)

		2010	2011	2012	2013	2014	2015
Connecticut	Harvest	35028.0	47071.0	62501.0	269650.0	119502.0	97215.0
	% SE	30.7	33.9	41.5	18.7	21.1	28.9
Delaware	Harvest	53512.0	66820.0	45474.0	58279.0	93029.0	51450.0
	% SE	18.2	21.9	23.7	13.7	15.8	13.9
Maryland	Harvest	25215.0	15347.0	22617.0	53180.0	79513.0	44437.0
	% SE	35.7	44.8	32.2	22.1	56.1	27.9
Massachusetts	Harvest	45156.0	58372.0	75803.0	31228.0	112840.0	79109.0
	% SE	48.0	36.8	34.1	26.1	41.1	34.5
New Jersey	Harvest	552401.0	736848.0	1130407.0	1244432.0	1175383.0	497482.0
	% SE	13.7	13.0	11.8	14.6	11.7	11.1
New York	Harvest	334491.0	376198.0	509123.0	518016.0	509131.0	543278.0
	% SE	16.8	16.3	17.2	16.0	14.7	11.2
North Carolina	Harvest	77157.0	60422.0	63135.0	44941.0	45708.0	40561.0
	% SE	13.2	16.6	17.1	17.2	20.2	23.1
Rhode Island	Harvest	118455.0	161125.0	103102.0	127713.0	184668.0	164028.0
	% SE	33.0	31.3	32.9	25.8	22.5	24.9
Virginia	Harvest	260050.0	317674.0	259973.0	186916.0	139431.0	159234.0
	% SE	15.2	19.0	16.9	31.7	15.3	25.0

Table 5.3: Total Summer Flounder Harvested Weight (Pounds) for Atlantic States (2010-2015)

		2010	2011	2012	2013	2014	2015
Connecticut	Pounds	132013.0	186834.0	191119.0	888906.0	391168.0	346179.0
	% SE	31.3	35.0	39.2	18.5	20.1	29.4
Delaware	Pounds	159976.0	182733.0	141935.0	159185.0	227913.0	114638.0
	% SE	18.1	22.4	24.6	13.9	16.5	14.7
Maryland	Pounds	91834.0	55686.0	61514.0	108690.0	179313.0	103613.0
	% SE	38.3	46.7	33.1	21.7	56.0	31.7
Massachusetts	Pounds	137611.0	202665.0	175110.0	64365.0	238604.0	146532.0
	% SE	44.4	51.6	32.6	27.9	36.0	27.5
New Jersey	Pounds	1614357.0	2116951.0	3063723.0	3316971.0	3608939.0	1442827.0
	% SE	14.0	13.2	11.8	14.3	12.1	11.0
New York	Pounds	1612298.0	1718121.0	1760650.0	1954821.0	1677717.0	1708882.0
	% SE	16.8	17.4	17.3	17.2	16.1	11.7
North Carolina	Pounds	111539.0	100543.0	101642.0	70874.0	67791.0	64065.0
	% SE	13.4	16.0	17.0	17.3	22.1	23.5
Rhode Island	Pounds	458873.0	511544.0	335506.0	371948.0	636207.0	600597.0
	% SE	31.3	29.0	36.7	24.8	22.7	27.9
Virginia	Pounds	789856.0	880639.0	658476.0	450884.0	370906.0	342841.0
	% SE	15.0	18.8	17.2	31.2	17.0	23.9

(a) New York and New Jersey



(b) Other Atlantic States

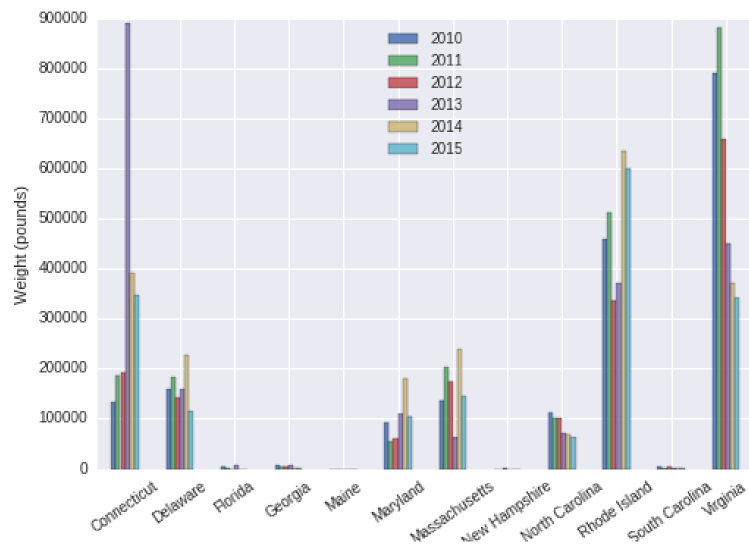


Figure 5.2: Total Recreational Harvested Weight (Pounds) (2010-2014)

Findings of the Mid-Atlantic Fishery Management Council Expert Review Panel of the Project Report "Commercial and Recreational Allocation for Summer Flounder"

Introduction and Acknowledgement

This report is a consensus report of an Expert Review Panel created to conduct a scientific peer review of the Mid-Atlantic Fishery Management Council (MAFMC) contracted research paper "Commercial and Recreational Allocation for Summer Flounder." The views expressed are those of the individual members and do not represent official positions of their employing agency or institution.

The panel expresses its gratitude to MAFMC staff Dr. José Montañez and Ms. Kiley Dancy for providing the review materials to the panel and managing the meeting logistics and to Mr. Kirby Rootes-Murdy from the Atlantic States Marine Fisheries Commission for his assistance throughout the process.

Background

The MAFMC and the Atlantic States Marine Fisheries Commission (ASMFC) are developing an amendment to the Fishery Management Plan (FMP) for Summer Flounder, Scup, and Black Sea Bass, to include a comprehensive review of all aspects of the FMP relating to summer flounder. One major issue that the MAFMC and ASMFC plan to address through the amendment is the current quota allocation between the commercial and recreational sectors of the fishery.

The MAFMC and ASMFC are interested in using an empirical basis to help evaluate allocation decisions in the summer flounder fisheries. The MAFMC contracted Dr. Kurt Schnier (University of California, Merced) and Dr. Rob Hicks (College of William & Mary) to develop a model to examine the economic efficiency of the current allocation system.

This project includes the development of two separate models, one for the commercial sector and one for the recreational sector. Each of these models is used to construct a behavioral simulation, calibrated using existing data. The simulation model is used to estimate the marginal value for summer flounder in the recreational and commercial fisheries under alternative sector allocations.

Because of the importance of allocation decisions the MAFMC convened an Expert Panel to conduct a scientific peer review of the analytical framework and empirical application of recreational and commercial models developed by Drs. Schnier and Hicks. The Panel included members from the MAFMC's Scientific and Statistical Committee (Dr. Doug Lipton, NOAA Fisheries Senior Economist; Dr. David Tomberlin, NOAA Fisheries Office of Science and Technology; Dr. Mark Holliday, NOAA Fisheries Policy Office, retired; and Dr. Lee Anderson, University of Delaware, Professor Emeritus), and an outside expert Dr. Jorge Holzer (University of Maryland). The panel was moderated by Dr. Eric Thunberg (NOAA Fisheries Northeast Fisheries Science Center). Other attendees included Kiley Dancy (MAFMC staff), Kirby Rootes-Murdy (ASMFC staff), Michael Luisi (Maryland DNR/MAFMC chairman), José Montañez (MAFMC staff, via webinar), Brandon Muffley (MAFMC staff, via webinar), Annie Hawkins (Kelley Drye & Warren), and Greg DiDomenico (Garden State Seafood Association).

The Review Panel met on November 18, 2016, in Baltimore, MD (meeting agenda attached). Review materials, including the report prepared by Drs. Schnier and Hicks were provided to the panel approximately one month prior to the meeting. During the meeting, the report authors provided a detailed presentation of both the recreational and commercial allocation models. The

Review Panel commends both Drs. Schnier and Hicks for the clarity and openness of their presentations.

The following provides comments from the Expert Panel on each of the five Terms of Reference (TORs) provided by the MAFMC. This report summarizes the Panel deliberations that occurred during the Review Panel meeting. Each panel member was also asked to provide written comments on the report. These comments are included as attachments to this consensus report.

TOR 1: Were the theoretical and statistical model specifications for the recreational valuation module done in a manner consistent with professional standards?

a. **Are the statistical methods themselves compliant with theory?**
b. **Are the statistical methods appropriate for the problem being addressed?**
c. **How appropriate were the data used in the analysis? Are the data sufficient to estimate the model? Do missing data pose a risk of biasing the parameter estimates or the model results? Are appropriate reasons listed for not including specific data sets? What proxy data are used and was it the most appropriate data to use?**
d. **Were alternative model specifications investigated and tested? Were assumptions underlying the statistical analysis of the models clearly stated?**

Findings – The Review Panel finds that the recreational valuation module was consistent with economic theory and the statistical methods applied were consistent with professional standards. The Random Utility Model (RUM) is appropriate for estimating marginal recreation values based on the available data. The Review Panel found that the data were used appropriately and that alternative data were either not available or would not have resulted in improved estimates of recreational fishing values. Alternative model specifications were investigated. The Review Panel did raise several issues that need to be considered.

- The Marine Recreational Information Program (MRIP) data were the appropriate data to use for this purpose. However, these data were not scrutinized nor adjusted by the authors for outliers or anomalies that could influence the estimated parameters either up or down. Statistical information on the properties of the data used is provided in the report but only at aggregated levels. Given high interest and skepticism surrounding MRIP data the authors should be prepared to document in detail which, how, and when these data were used and any steps taken to minimize MRIP quality impacts on the model.

- The report is written at a fairly general level, which omits a substantial amount of technical detail. However, omitting this information makes it difficult to replicate the study. A technical appendix would be appropriate to more thoroughly document the data and procedures.

- The recreational valuation model was based on a single year (2014) yet the site-specific catch rates were based on a multi-year average pooled across multiple intercept sites within a county. One limitation is assuming that the mean of pooled catch rates, over a number years with ever-changing stock and regulatory conditions, accurately reflects angler expected catch rates in 2014. It is also important to note that the choice of model year (i.e., 2014) affects the estimated total valuation since it depends on the number of trips that targeted or caught summer flounder as well as the total number of recreational fishing trips in that year.

- In addition to trips that targeted and caught summer flounder, the model included both angler trips that targeted summer flounder but did not succeed in catching any summer flounder as well as trips that take place within the management unit that didn’t target summer flounder but still caught summer flounder incidentally. That these latter two sets of anglers derive value from summer flounder quota is a valid assumption of the research. However, this will need to be more clearly explained as attributing value to anglers that did not catch any summer flounder will be hard for a lay audience to understand.

- Although attributing value to trips that did not catch or target summer flounder is a valid assumption, the model does not evaluate any angler entry-exit or opt-out decisions to link recreational choices to the level of quota. Instead, the number of trips is fixed regardless of how large or small the allocated quota is. This is a strong assumption that needs to be further evaluated for its influence on the model outcome.

- In the absence of a trip response there is nothing that would drive a change in the number of trips or recreational expenditures. This means that the caveat noted by the authors that the recreational values do not include producer surplus from related industries (e.g. bait/tackle, food, beverages, etc.) is *not* a limitation of the model at least as it was constructed and estimated. By contrast, the commercial valuation model is based on simulating a change in the number of commercial fishing trips that would be necessary to harvest the commercial quota. This means that omission of profits from related industries (e.g., purchases of gear, repairs, fuel, ice, bait etc.) is a limitation of the commercial module.

TOR 2 Were the theoretical and statistical model specifications for the commercial module done in a manner consistent with professional standards?

a. **Are the statistical methods themselves compliant with theory?**
b. **Are the statistical methods appropriate for the problem being addressed?**
c. **How appropriate were the data used in the analysis? Are the data sufficient to estimate the model? Do missing data pose a risk of biasing the parameter estimates or the model results? Are appropriate reasons listed for not including specific data sets? What proxy data are used and was it the most appropriate data to use?**
d. **Were alternative model specifications investigated and tested? Were assumptions underlying the statistical analysis of the models clearly stated?**

Findings - The Review Panel finds that one aspect of the RUM model as it was applied to the commercial fishing module was not compliant with economic theory. Specifically, the revenue-based RUM model implies that the marginal utility of profit depends on the different sources of species revenue is inconsistent with professional standards that holds that the marginal utility of profit does not depend on the source of revenue. The Review Panel recommends re-estimating the commercial RUM model in terms of catch, which would be consistent with professional standards. In all other respects the statistical methods were compliant with theory and were consistent with the problem being addressed. The available data were used appropriately although the Review Panel raised several issues that may need to be further explored or at least noted in the report. These issues as well other comments on the commercial valuation module are noted below.

- The observer data is appropriate for the purposes of the commercial valuation model, however, relatively little attention has been paid to the statistical properties of these data and their limitations. These limitations include:

- The selection of observed trips is not random. Trip selection is based on a mixture of requirements guided by protected species interactions and the Standardized Bycatch Reporting Methodology policy. Moreover, the priorities between these two purposes has changed over the years that have been included in the commercial RUM model.
- Certain vessel classes are underrepresented (e.g. smaller vessels, vessels without a valid Coast Guard safety inspection, or vessels in remote ports).
- Vessel operator fishing choices are known to differ while carrying an observer as compared to trips when an observer is not present.

- The RUM model uses data over a 15-year period from 2000 to 2014. These years reflect: many changes in the summer flounder stock size and distribution both in time and space; regulatory changes (including trip limits); changes in species jointly landed with summer flounder; changes in input prices, as well as technological change. These changes confound the estimation of the RUM model parameters and resulting valuation. These limitations need to be noted in the report.

- The commercial model takes into account state-by-state summer flounder allocations as well as quota limits on black sea bass and scup. This does reflect the management of these species but as quota limits for black sea bass and scup are reached revenue from these species no longer contributes to net return, which for marginal trips could result in negative profit. The commercial model still retains these trips and would continue to select from these trips as long as the summer flounder quota for the state is not exceeded. This process needs to be noted.

- The mean marginal valuation (MV) is flat no matter how little or large the commercial quota is. This is because (1) The marginal productivity is unchanged and there are no price effects that would tend to drive MV up at low quotas or down at high quotas, and (2) Every trip in the dataset is assumed equally likely to be drawn. Note that the lower confidence interval of the commercial valuation module does decline but this is driven by trips that become constrained by the black sea bass or scup quota or by a state summer flounder quota being reached rather than economic or technical factors.

TOR 3: Was the link between the commercial module and recreational module done in a manner consistent with professional standards?

Findings: The Review Panel finds that the link between the commercial and recreational modules was done in a manner that was consistent with professional standards and that was internally consistent within the theoretical and empirical methods used in the recreational and commercial modules. The Review Panel raised several concerns related to the stated recreational and commercial caveats and the synthesis of the two modules. These concerns include:

Recreational Module

- The opportunity cost of time was the only thing for which an adjustment beyond the model result has been made. The inability of the RUM model (given the available data) to account for the opportunity cost of time was a significant omission cited by the authors. The Review Panel accepted the authors' use of benefits transfer to remedy this omission to be a practice consistent with professional standards as its use is well documented in the literature. However, in terms of where and how the application of benefits transfer was presented in the report (in the draft reviewed by the Panel it appears after the initial comparison of estimates of commercial and recreational benefits) it gives the appearance as being a justification after the fact. Further explanation of the conceptual basis and uncertainties associated with applying benefits transfer in this case is needed.

- In this research, the absence of an economic add-on survey to MRIP for 2014 meant that the opportunity cost of time, as well as other recreational fishing costs were underestimated. While the direction of bias is known its magnitude is not. The benefits transfer adjustment for the opportunity cost of time was based on some but not all of the results shown in Gentner et al 2010. Consideration of the full range of estimates would be appropriate.

- The potential impact of assuming no localized depletion was noted as a caveat in the commercial module but the potential for reduced recreational values due to congestion effects associated with high recreational allocation was not noted. Increased recreational participation may adversely impact catch rates in some geographic areas, and competition and congestion at fishing sites may diminish the value of a recreational fishing day. These effects would not be captured in the RUM model.

- The recreational module does not take into account potential behavioral changes associated with anglers that may have stronger recreational preferences than others. Instead, all trips are selected with equal probability. This is a strong assumption that should be noted by the authors.

Commercial Module

- The procedures used to estimate the commercial values result in flat marginal values. In the modeling context lower total values are driven by constraints on black sea bass and/or scup and not by any economic factors such as declining marginal productivity or price effects.

- Benefits transfer was applied to the opportunity cost of time for recreational anglers but was not applied to the consumer surplus (CS) associated with consumer demand for summer flounder. While an estimate of CS may not be available for summer flounder there may be other studies where CS has been estimated that could be referenced. If the application of benefits transfer conceptually is inappropriate in this circumstance, then it should be documented why.

- The data used to estimate commercial profit do not result, strictly speaking, in an estimate of economic surplus commensurate with that of the recreational values. The methods used to estimate net return are consistent with common practice but it should be noted that these estimates are accounting profit and not producer surplus. It would be correct and less confusing to simply refer to the commercial values as profit rather than producer surplus.

TOR 4: Were the results of the analysis (synthesis of the two modules) clearly interpreted? Can the model be used to map out a benefit curve given changes in allocation across commercial and recreational fisheries and can the results be used for management purposes? Can the model be used to consider allocation alternatives that were not specifically analyzed? Is it possible to make modifications to the current model that would allow for the measurement of benefits (both total and marginal) in situations where allocations are not binding?

Findings - The Review Panel finds that: 1) The synthesis of the two modules was clearly interpreted; 2) The model can be used to trace out a marginal benefit curve given changes in allocation across commercial and recreational fisheries; 3) The model can be used to consider allocation alternatives that were not specifically analyzed, and 4) Modifications to the current model would be unnecessary to measure marginal or total benefits when quota allocations are not binding.

With respect to whether or not the model results can be used for management purposes the Review Panel found that the model is considered best available science and can be used to inform a management decision.

The Review Panel found that the model results do not suggest that the existing allocation is inefficient, or that a reallocation would result in an increase in net benefits based on equi-marginal principles. Moreover, the model results do not provide a strong basis for arguing for or against any specific allocation. With the exception of very large changes in allocation, the confidence intervals for both the estimated recreational and commercial marginal benefits overlap. This means that for a wide range of summer flounder allocation options, the sector and total economic value to commercial fishermen and recreational anglers would be largely unchanged, based on the models and their associated data.

The Review Panel notes that the authors adopted an equi-marginal principle to formulate their recommendation on allocation of quota between sectors. This mean that the optimal allocation occurs when the value of the last pound of quota allocated to the commercial and recreational sectors results in the greatest combined economic value of the fishery, all else equal. The Review Panel found the equi-marginal principle to be consistent with professional standards as a useful approach to assessing allocations. However, this is not the only factor Councils may take into consideration: the relative risk of overages in one sector or another; the relative likelihood of quota not being taken by one sector or another; uncertainties not captured explicitly in the model that might affect sectors differentially, such as changes in fuel costs; transferability of quota within/between sectors, and relative economic impacts beyond the fishery itself (e.g., processing for commercial, tourist infrastructure for recreational). The synthesis of the two modules does not investigate how these additional factors might deviate the Council from the equi-marginal/economically efficient outcome derived by the models.

The Review Panel provided several additional comments.

- The recreational and commercial modules were primarily constructed based on 2014 conditions to evaluate whether or not the existing 60/40 allocation is optimal. This means that commercial and recreational values are conditioned on 2014 summer flounder stock size and availability, stock size and availability of alternative target species, recreational participation, and commercial fleet size and structure. The model results and its utility for projecting forward to allocation decisions under future biological, environmental, social, and economic conditions has to be understood within this context.

- The differences in estimated commercial values between the results for model 1 and model 3 suggests that state by state allocations in the commercial sector may be introducing much larger allocative inefficiencies compared with current levels of commercial-recreational allocations (i.e., within sector reallocations could result in higher benefits to the nation, as the modeled value of summer flounder quota was much higher in some states than others).

- Given the lack of information on the probabilities of accessing the quota by the heterogeneous harvesters in each sector, the results should be used with caution. The study currently assumes that, within each sector, every harvester is equally likely to access the quota. However, this may not hold in practice.

- The authors' included a recommendation in the report the Panel reviewed to use the lower bound estimates, as this would be a more conservative approach. The Review Panel believes the authors should not imposes their own risk factor on behalf of the MAFMC. This is best left to the MAFMC to decide. The Review Panel notes that the model results are reported showing the full confidence interval so there is no need to make any statements regarding preference for any particular upper or lower bound estimate.

TOR 5: Can this model be used to assess allocation in other fisheries? Could future models be run by other individuals without major modifications (e.g., Council and/or ASMFC staff)? Can the model be easily updated to support new MRIP estimates?

Findings – The Review Panel finds that the theory and methods to assess summer flounder allocations would be applicable to other fisheries. These methods would still be applicable to the revised MRIP estimates but the values would need to be adjusted to accommodate the new sample frame for trips. In general, applying the model to other fisheries would likely be limited to species with high encounter rates in the MRIP intercept survey. This is because application of the RUM model requires a reasonably high number of trips that targeted and/or caught the species of interest. The panel notes that even under these circumstances, an economic add-on to the MRIP intercept survey would be highly advisable, for example, to obtain necessary data to compute opportunity costs. Allocation models for species with low encounter rates would likely require employing a different method such as a "stated preference" survey.

With respect to whether the summer flounder allocation model or similar models for other species could be run by other individuals (e.g., MAFMC and/or ASMFC staff)**,** the Review Panel finds that the software and computational requirements demand specialized expertise. The model would not be able to be run by other individuals without major modifications.

ATTACHMENT

AGENDA and BACKGROUND

Summer Flounder Allocation Model Peer Review

Friday, November 18, 2016, 9:00 AM-5:00 PM

DoubleTree Baltimore-BWI Airport
890 Elkridge Landing Rd., Linthicum Heights, MD 21090
(410) 859-8400

http://www.mafmc.org/council-events/2016/nov-18-sf-allocation-peer-review-meeting

Agenda

Friday, November 18, 2016

9:00- 9:20	Introductions; Overview of Meeting Objectives and Agenda
9:20 - 10:00	Presentation: recreational module (Kurt Schnier/Rob Hicks)
10:00-10:30	Discussion, Q&A, and response to recreational module terms of reference
10:30 - 10:45	Break
10:45 - 12:00	*Continued:* Discussion, Q&A, and response to recreational module terms of reference
12:00 - 1:00	*Working Lunch:* Presentation: commercial module (Kurt Schnier/Rob Hicks); begin Q&A and discussion
1:00 - 3:30	Discussion, Q&A, and response to commercial module terms of reference
3:30 – 3:45	Break
3:45 - 5:00	Presentation: synthesis of model results; discussion and response to remaining terms of reference
5:00	Adjourn

Note: The meeting will be treated as a working meeting. The agenda reflects approximate times. Questions from the review panel may be entertained at any time during presentations.

Comments from Mark C. Holliday, Ph.D. (NOAA Fisheries Service, Retired)
Mid-Atlantic Council Scientific and Statistical Committee
November 21, 2016

O**verall:**

The research meets or exceeds the standards for a scientifically-based and statistically defensible modeling of marginal economic benefits of the allocation of the summer flounder catch between commercial and recreational sectors. The specifications are sufficiently supported by the stated assumptions and the documented caveats in the paper such that it is consistent with professional standards. The theory has been well tested previously for the recreational model and the commercial model is well documented. There are significant limits to the economic data collected by management authorities to conduct such research, and the authors did not conduct any additional primary data collection. Nonetheless, the information set used is considered to be the best available. The research result satisfactorily documents that the current 60/40 allocation is not sub-optimal, from an economic efficiency perspective based on an accounting of marginal benefits of those with direct engagement in fishing. Moreover, the authors' models of commercial and recreational fishing behavior showed clearly that modest reallocations between the two sectors would not produce substantial changes in overall benefits from the fishery.

From a public policy view the two behavioral models are by definition a limited (i.e., economic efficiency) specification of the full suite of issues facing angler and fishermen choices, as well as the Council's factors going into the allocation decision. This affects the broader utility of the models for decision-making. It is a very useful tool that takes a static look at confirming whether the 1993 allocation was the best one or not, all else being equal.

The research did not target looking forward to what should be the optimal allocation in the future given projected or hypothetical conditions with respect to stock productivity, stock availability, changes in fishing effort (trips) by existing fishermen (as well as entry and exit into the commercial and recreational fisheries), and changes in the summer flounder markets/prices through product competition/substitution, trade and aquaculture. The paper acknowledges the shortcomings of a static view, stating all else being equal, and discounts the distributional and social impacts of allocation important not only to decision makers but to angler and fishermen choice sets. The Council's long term interest is a tool to project an optimal allocation for the future under changing conditions (whether that is an annual specification, one that is revisited every x years, or in perpetuity). These considerations were presumably beyond the scope of work.

It is noted that the research was extremely data-intensive, computationally complex, and it pushed the limits of currently available statistical software and hardware. There are few analysts who could undertake this type of work successfully. These factors may limit the model's broader application to other species. Moreover, besides summer flounder (one of the most commonly observed species in the recreational data set), there may be an insufficient number of data observations for other species to satisfy the requirements of the model.

Specific Comments:

1. With respect to the recreational model, the site-specific mean catch rates per wave appear to be based on a multi-year average and computed across multiple locations in the MRIP site register at the county level, yet the allocation decision modeled was for a single year (2014). Two issues stand out: 1. How well do the means, representing a changing catch rate over a period of years, reflect the catch rate choice in 2014? The fact that there are differing regulations by State, and within a State, different regulations over time, indicates that summer flounder management is facing ever-changing conditions. The different

states value quantity of fish, size of fish, and access to fish (seasonality) differently. However, the site-specific quality measure is mean catch per wave. How did modeling 2014 accurately represent the dynamics of catch rates over time, particularly as a function of stock abundance and regulatory measures we've seen over the last 5-10 years? Was the 2014 catch rate choice to be modeled more likely a probability range versus a mean?; 2. How aggregation of sites within a county was handled is not discussed in any detail. The catch rates are not likely normally distributed. While sites in the register are weighted in proportion to their likelihood of producing a fishing trip (angler avidity) the probability of encountering summer flounder catch at a site and its computed catch rate (# fish/trip) will have different probabilities. How does this affect the angler choice set of selecting a county? Was catch rate distribution across sites within counties looked at, and how would calculation of means be affected? Inclusion of some of the statistical properties of the catch rate computation (n's, means, range, etc.) and discussion within the paper would document whether this had any effect.

2. The use of MRIP data does qualify for the "best available data" but that does not mean it has received sufficient attention by the authors. Very often no information is provided on the sample sizes used to calculate the parameters nor are their statistical properties documented. In addition, the authors do not indicate whether they subjected the raw data to any form of quality control. What is presented are tables or figures of estimates at the aggregate level (the finest detail being State estimates of catch and trips). Biases in the underlying raw data (e.g., digit bias), small sample sizes and coding errors can manifest themselves in anomalous results. From a credibility standpoint, examination of these data is critical as many participants have already viewed the raw and estimated data for States like New Jersey and New York and are skeptical of their validity. Because of the context in which this research was conducted it was suggested it needed to spend extra effort to anticipate criticism of the outcomes if the data were not sufficiently reviewed. The paper makes no mention of this issue; it should at least document what was/was not done to the raw data to assess outliers and their treatment (e.g. MRIP data showing summer flounder in Puerto Rico as cited by one of the authors in the November 18th meeting).

3. Similarly, the utility of observer data as the commercial source of data is given short attention by the authors. Its use is also justified as the only set meeting the model's criteria yet little time is spent discussing any actual evaluation of the data set. There is some uncertainty in the behavior of fishermen on observed versus unobserved trips, and this would be useful to evaluate in the context of how they data set is used in the current model. Moreover, the selection of trips to observe is not random: certain fisheries and gears were targeted for inclusion because that was where funding or regulatory requirements directed effort to be undertaken (e.g., Marine Mammal Protection Act funding; Standard Bycatch Reduction Methodology litigation outcomes). In addition, certain classes of vessels may be underrepresented (e.g., vessels too small to carry an observer; vessels in ports too remote or costly to get observers to; vessels excluded because they did not have a valid USCG safety inspection). This could affect calculation of trip costs, statistical areas fished and calculation of success rates, and/or revenue functions.

To investigate and mitigate the potential bias, comparisons of variables on trip data and tow data from other sources such as the NEFSC study fleet or other State and federal research could reveal some statistical differences. Even if there were differences identified, sensitivity analysis of the final estimated value per pound of summer flounder to the input data could find they had no impact but this type of analysis is not discussed. It would be valuable to know more about the data used including sample fraction, distribution by state, the statistical properties of the data set, and for example, the comparison of the author's cost, revenue and profit models to other researcher's work on the same topic. One could look at how representative were the sampled observer trips to the overall fleet, i.e., in terms of vessel size, number of trips, total revenue, trip location, home port, etc. Moreover, at the November 18th meeting a new NEFSC data set for weighting observer trips was revealed, and that might be useful to investigate if additional funds were made available. Comparing the author's results to other published estimates was used in the paper's recreational section when model results were presented, for example. And attention to the question about confidence in the underlying data will be essential to the Council's ability to apply this work.

4. The use of opportunity cost estimates from Gentner to fill out a hole in the available data/model output is defensible and common in the economics literature, but the rationale and explanation in the paper is given very short treatment and justification. The authors do ascribe the positive use as a "benefits transfer" approach for opportunity costs, but they didn't propose to use this approach for any other missing information listed in their string of caveats. For example, would this technique be appropriate for the "missing" consumer surplus component on the commercial model side, why or why not? Instead they direct the reader to do their own reading of cited literature if they wish to better understand the applicability of this approach to the subject model's outcomes.

5. An additional caveat not discussed that could impact the utility of the model is that it does not account for changes in fishery availability over time as a result of climate changes impacts. If the center of the range of summer flounder is moving northward then historical catch areas will shift in the future and the models based on historical distributions of catch will become less representative of fishermen’s true choices. The current costs to reach the more productive sites will be invalid. The authors might minimally describe the direction of any change in value based on distribution of fleet or fishing trips by State/port (albeit fishermen may continue to relocate in the long term).

6. Comments on Section 4.4.5 were discussed at length on November 18th; the principle is that the author's should not project their risk aversion profile on behalf of the Council. The risk policy decision is reserved for the Council to consider.

7. Several additional recreational and commercial caveats are worth noting:

- My comments and rationale for benefits transfer accounting in Figure 5.2 occurring elsewhere were discussed in detail at the November 18th meeting.
- Countering the potential for underestimating the marginal value schedule for the recreational sector caused by increases in participation and number of trips is the negative effect of such increased participation on the value of the recreational experience. Congestion in the form of crowed fishing sites, increased competition and impacts on catch rates (localized depletion) may occur with increased trips, lowering the marginal benefits value.
- Commercial caveats about dissipating value benefits over time as a result of open access was not tested or evaluated empirically for this specific fishery, and may be countered if additional forms of catch shares (as in Maryland) or sector separation tools are employed. Commercial caveats about costs per haul to increase as a result of localized depletion due to increased fishing could just as well be offset through economies of scale; it is impossible to say without any data or analysis what the net result will be.

Minor Comments/Editorial Suggestions (Needs a strong copyediting)

Search on "patter" replace with "pattern" or "patterns"; search on Massachussetts and replace with Massachusetts; search on "graphical" and replace with "graphically" (as appropriate)

P6 Para1: The range listed is not correct for summer flounder, which is east coast of Florida to Nova Scotia. What is cited appears to be the range for southern flounder *Paralichthys lethostigma*.

P6 Para 2: "Federal regulations" not "Official policies" are established by NMFS

P7 Para1: "...perception of overall health." unclear what has undergone a transition; declining stock health change is not a perception but a reality

p7 Para 3: Define/cite equimarginal principle (not principal)

P8 Para 1: Edwards (1990) not cited in reference section; using the term economic *impact* in first sentence is confounding efficiency vs. impact; *Maximizing total welfare*...to whom, accounting stance of producer and consumer surplus outside this analysis.

P8 Para 3: ...traditional*ly*

P9 Para 2: ...*motivate*??? "Inform"? "Provide a context"?

P8 Para 3: after "(Chapter 4)" add "*sectors";* in line 5 "...to develop *a"*

P10 Para 1: "...annual *ex vessel value*"; line 3: Are prices throughout paper expressed in constant dollars when evaluating trends?

P10 Para 2: "...is similar *to* the percentage"

P10 Para 3: Reference is made to comparing observer data to VTR data to investigate robustness of observer data - is this Table 2.4 on place where this is done/discussed? Why only 3 years (2012-2014) used in the table analysis, would like to see # observed trips vs. all trips, trips with VTRs, trips with VTRs AND observers. What analytical tests were run to evaluate differences (text says "for the most part" spatial data were similar -- were any statistical comparisons made? Only see one correlation coefficient mentioned. The validity of the observer data is foundational to the successful use of the model - expected to see more analysis.

P15 Figure 2.2: In B&W, figure could be misleading; legend has Observer data on top vertically whereas data line for observers is below VTR -- use dashed line or symbols in-line in addition to color as not many photocopies of paper will be in color. If the intent is to show seasonality then perhaps put observers on Y2 scale to better reveal monthly differences in values.

P16 Para 1: More documentation of the data range of the queries run for Section 2.3 should be included - heard to reproduce what you did. Suggest moving footnote 5 into first paragraph of Section 2.3 text - mapping MRIP and other conventions used for catch, harvest, landings, etc. is very confusing.

P16 Para 2: Last sentence incomplete...

P16 Para 3: line 3 "...except that ~~the~~"

P17 Para1: Table 2.7 shows 6 years of data but 7,398,558 is not the mean of those years but the point estimate for 2014. Same comment for Para 2 re: it is estimated catch, not mean estimated catch.

P17 Para 2: What defines a "sizable" amount of uncertainty -- a value-judgment being made here. The CV's for NY and NJ are under 20 percent, which for recreational survey results is almost the gold standard. If they are "sizable," what did you do to account for this uncertainty in your model/analysis?

P17 Para 2: More illuminating than saying total catch is declining would be to look at data and say catch is declining along with declining effort, or effort is stable of going up yet catch is going down; i.e., catch by itself is only part of the picture.

P22 Para 2: What is the conclusion being drawn here? Is there any? Where is the table /figure showing drop in trips from 2014-2015? The narrative of trends and the supporting for them in the form of tables and figures throughout 2.3.2 could be tightened up considerably with more and better cross references and stronger/clearer topic sentences for each paragraph trend.

P25 Para1: What is the rationale for choosing 2014, and would results hold if other years were chosen instead?

P25 Para2: Where is table or figure showing target species data?

P27 Para 1: "...our work ~~follows~~ uses"; You spelled out MRIP acronym twice, first use only is sufficient

P31 Para 3. "...mean catch of summer *flounder by* county per wave"

P32 Para 2: Confusing text and mixed tense from "Genter et al" onwards - rewrite please

P37 Figure 3.1: Label the different series peaks

P42: What does Footnote 14 refer to in the text?

P68 Para 3 "...produce*r* surplus"

Appendix Tables 5.1 - 5.3: Punctuate the numbers with commas (by thousands); add row and column totals as appropriate

Comments from Dr. Doug Lipton, NOAA Fisheries Senior Economist
Mid-Atlantic Council Scientific and Statistical Committee
November 30, 2016

1) Not meant as a critique of the authors, but of the process: A more iterative process for the analysis would be helpful in the future, similar to the procedures use for stock assessment. The analysts had to make many choices during the study regarding what data to use and the specific modeling approach to adopt. The review panel is asked to come in at the end of the process when there is little time to make substantive changes to the analysis. By reviewing the data and modeling choices earlier in the process, there is an opportunity to test and compare alternative approaches, and thus, lead to higher confidence in the output.

2) The RUM model as applied to the recreational sector aggregates fishing intercept sites to the county level and assigns catch rates to the county. The only travel cost considered is from the angler's home zip to the county centroid. There is no accounting for where the angler actually fishes on the water, and thus, the time spent to access better fishing grounds. This approach is necessitated by the data, but there needs to be a strong acknowledgement of the large amount of error this adds to the model results.

3) The recreational RUM model assigns average summer flounder keep and release for the county and wave as the angler expectation. Trips taken early in the wave, thus, have expectations that are formed mostly by data collected after they have taken their trip. Some examination of the data to see if this is an issue (e.g., low catches early in the wave, high catches late in the wave) impacted the results. Other approaches such as using some data from preceding wave (albeit, means losing observations in the first wave) could be explored.

4) The observed keep and release of summer flounder may be a result of either a binding bag limit on the trip, catch of undersized fish, angler preference to keep fewer than the bag limit, or some combination. Since there are variations in State bag and size limits, this may also confound the analysis. The implementation of the policy where it is assumed there will be an increase in keep may be overstating the welfare effects since it assumes all angers want to keep more fish.

5) The implementation of the 60 day lag (average catch for the 60 previous days) of catches in the commercial RUM model appears naïve given the known seasonality in the fishery. A more sophisticated spatial choice model could be explored in future work including looking at polynomial distributed lag models and combinations of annual and more recent lags.

6) The commercial RUM model of site choice, in addition to the issue discussed regarding species specific revenues, is estimated from data from 2000-2014. There should be some consideration of the fact that over this period, we observe North Carolina fishermen traveling longer distances to catch the statewide quota, and fishermen more closely located to fishing grounds, unable to make summer flounder trips due to lower state quotas. This phenomenon is demonstrated in the Model 1 simulations compared to Model 3, but how does it affect the distance parameter in the estimation and what are the implications for the simulations?

Comments from Dr. Jorge Holzer, University of Maryland
November 29, 2016

Overall, this is a well-executed project. The comments below refer to the commercial specification and the way the simulations on quota reallocation between the two sectors were conducted (due to the lack of additional data).

1. In the specification of the utility in the random utility model (RUM), it is unclear what the rationale is for assuming that the marginal utility of a dollar depends on where that dollar comes from (i.e. eq. 4.1. on p. 49, includes separate terms –and separate parameters to be estimated– for the revenues of the different species caught). It is suggested this specification is modified so that it uses total revenues, rather than individual revenues, to explain harvesters' choices. Alternatively, authors could use catch per species rather than revenues per species.

2. Note that, even if the suggestions in 1) are adopted, there is still a seeming mismatch between the computation of marginal values in p.55 and the utility, as specified in the RUM model and determining the probabilities of visiting the different sites. Indeed, while the former are based exclusively on expected profits, the latter are based on the specified utility, which does not include trip costs but includes the variable "distance".

3. In the commercial model, unlike the recreational model, constant marginal utility of the catch is assumed at the trip level. In other words, the utility associated with an additional pound of catch of summer flounder is the same, regardless of the total catch during the trip. This assumption, combined with the fact that, when drawing trips during the simulations, each trip in the dataset has identical probability of being drawn, effectively implies that, by design, the average marginal utility for the commercial sector will be a horizontal line. Similarly, when drawing recreational trips to meet the recreational allocation, it is assumed (again, due to lack of the necessary data to do otherwise) that each trip has the same probability of being drawn. These assumptions implied in the way the simulations are conducted are strong, although justified by the lack of additional data. Therefore, it is suggested that, in the list of caveats, it is explicitly stated that little is known about the probabilities of access of different harvesters/anglers. In the absence of transferable property rights in both fisheries and lacking additional data, the assumption of uniform random access (i.e. equal prob. of access) is the best the authors had to work with. However, there is no guarantee that the actual sorting of marginal values in the fishery is consistent with this assumption.

Comments from Dr. David Tomberlin, NOAA Office of Science and Technology
Mid-Atlantic Council Scientific and Statistical Committee
December 1, 2016

COMMENTS FOR COUNCIL:

The equimarginal principle is a useful approach to assessing allocations, but there are other factors for consideration: the relative risk of overages in one sector or another; the relative likelihood of quota not being taken by one sector or another; uncertainties not captured explicitly in the model that might affect sectors differentially, such as changes in fuel costs; and relative economic impacts beyond the fishery itself (e.g., processing for commercial, tourist infrastructure for rec).

COMMENTS FOR AUTHORS:

GENERAL:
Footnote 10 (ie that the model is limited to change in allocation only and not a change in TAC) is a significant limitation. Is there any way to help readers understand the likely implications of this limitation and how they might think about the case of simultaneous change?

It'd be good to explore benefits transfer from all three Gentner et al models rather than just the one preferred. Alternatively, you could look at how far the ratio of included to not-included would have to wander before it starts to look like evidence that an allocation shift might be needed (I don't have a specific method in mind for doing this, just throwing it out there as an idea that might help round out the picture).

DETAILS:

Pg. 29 point 3: does "overlap" mean geographic overlap or something else?

Pg. 31: how many observations were dropped in getting to the subset that meets the < 150 mile criterion? And was the subsetting on a) simply < 150 miles or b) jointly on <150 miles and also single day?

Pg. 32: if travel cost is the "lower bound" estimate, why not examine the upper bound too? I mean just explain why it's not as easy to do as the lower bound, not that you need to do it (unless it is in fact easy).

Section 3.2 / RUM model: any thoughts on what indexing by time might do (e.g., onshore / offshore movement of the fish suggest site productivity will vary during the season); is indexing by time irrelevant, unlikely to be informative, or just intractable?

Fig. 3.1: labeling is not clear in draft version

Section 4.1: summary stats on the data used for estimation would be nice, also an idea of what share of total fluke catch is accounted for by the observations kept in the data set

Comments from Dr. Lee G. Anderson, Professor Emeritus, University of Delaware
Mid-Atlantic Council Scientific and Statistical Committee
December 2, 2016

I made specific comments on copy editing and small issues during the meeting and in the review of the final panel report.

I think it should be acknowledged that this is the first time that the rum model was used in this way for commercial fisheries. It received high marks from the review panel during the discussion, although there were some suggestions for improvements. This is the first time I recall seeing estimates of the marginal benefit curves rather than just point estimates. I am pleased that the council supported this innovative work.

I think that it should be emphasized that although the report did not come out the way in a way that made either commercial or recreational interests happy (each would have like a report that gave them higher values), it did produce a definitive answer. Given the best information we have we cannot say that the current allocation is wrong on economic efficiency grounds. It is also important to keep in mind that these results are only applicable to this case at this time. It cannot be generalized to other fisheries.

This brings up a related point. Perhaps the report should have included a brief explanation of the equal-marginal principle and how it is to be interpreted. One important aspect has recently been made clear in the literature is that even if studies can show that the value of an extra fish allocated to a certain sector will have a higher value, this only become policy relevant if the actual way fish are allocated by regulation will send that fish to the higher value user.