doi:10.7289/V5/TM-SWFSC-567

NOAA Technical Memorandum NMFS

DECEMBER 2016

REGULATORY IMPACTS OF RECREATIONAL FISHERY MANAGEMENT ALTERNATIVES FOR NORTH PACIFIC BLUEFIN TUNA

Stephen M. Stohs

NOAA-TM-NMFS-SWFSC-567

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center

The National Oceanic and Atmospheric Administration (NOAA), organized in 1970, has evolved into an agency that establishes national policies and manages and conserves our oceanic, coastal, and atmospheric resources. An organizational element within NOAA, the Office of Fisheries, is responsible for fisheries policy and the direction of the National Marine Fisheries Service (NMFS).

In addition to its formal publications, NMFS uses the NOAA Technical Memorandum series to issue informal scientific and technical publications when complete formal review and editorial processing are not appropriate or feasible. Documents within this series, however, reflect sound professional work and may be referenced in the formal scientific and technical literature.

SWFSC Technical Memorandums are accessible online at the SWFSC web site (http//swfsc.noaa.gov). Print copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22151 (http://www.ntis.gov).

doi:10.7289/V5/TM-SWFSC-567

NOAA Technical Memorandum NMFS
This TM series is used for documentation and timely communication of preliminary results, interim reports, or special purpose information. The TMs have not received complete formal review, editorial control, or detailed editing

DECEMBER 2016

REGULATORY IMPACTS OF RECREATIONAL FISHERY MANAGEMENT ALTERNATIVES FOR NORTH PACIFIC BLUEFIN TUNA

Stephen M. Stohs

Southwest Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
8901 La Jolla Shores Drive, La Jolla, CA 92037 USA

NOAA-TM-NMFS-SWFSC-567

Contents

Tables

Figures

Abstract

Management measures were considered at the Pacific Fishery Management Council in Fall 2013 to reduce North Pacific bluefin tuna population impacts due to U.S. west coast recreational fishing. The question of whether and how to regulate the west coast recreational fishery involves a potential tradeoff of conservation benefits to the bluefin tuna stock in exchange for negative short-run economic impacts of regulation on the west coast recreational anglers who include bluefin tuna among their catch species and affected industries and communities. Over time, if the management measures are successful and the stock rebounds, net benefits should become positive. This paper presents the results of an analysis of potential economic impacts and benefits to the North Pacific bluefin tuna stock for a range of alternatives including bag limits and other measures to manage bluefin tuna catch in the Southern California recreational commercial passenger fishing vessel fishery.

I. Introduction

Management measures were considered at the Pacific Fishery Management Council in Fall 2013 to reduce North Pacific bluefin tuna population impacts due to U.S. west coast recreational fishing. The question of whether and how to regulate the west coast recreational fishery involves a potential tradeoff of conservation benefits to the bluefin tuna stock in exchange for negative short-run economic impacts of regulation on the west coast recreational anglers who include bluefin tuna among their catch species and affected industries and communities. Over time, if the collective management measures on all international fisheries which target the North Pacific bluefin tuna stock are successful and the stock rebounds, net benefits should become positive.

Questions of interest regarding potential impacts of recreational bluefin management include the following:

1. What conservation benefits to the North Pacific bluefin tuna stock would result from various recreational CPFV management alternatives under consideration? As used in this paper, "conservation benefits" are derived from rebuilding the North Pacific bluefin tuna stock (Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006) through reductions in mortality due to regulatory measures such as recreational bag limits. Reduced mortality would potentially improve the future health of the stock, providing future benefits including existence values for conservationists, improved fishing opportunities for recreational anglers and commercial harvesters, and consumer surplus for consumers of North Pacific bluefin tuna seafood.

2. What short-term[1] impacts on angler welfare (consumer surplus, compensating variation or equivalent variation) could result due to bag limits or other recreational management measures to reduce bluefin tuna population impacts?

3. What regional economic impacts could result due to bag limits or other recreational management measures to reduce bluefin tuna population impacts?

[1] For purposes of this analysis, short-term is defined as the near-term time horizon of fisheries operation; for example, the time period needed to carry out a rebuilding plan would be included under this definition. By contrast, the long-term considers benefit streams into the distant future, including bequest values.

4. What are the expected tradeoffs between anticipated conservation benefits and economic impacts on the recreational fishery under different management measures that were under consideration?

   Section II describes recreational Commercial Passenger Fishing Vessel (CPFV) fleet effort in terms of total angler days, angler days associated with bluefin tuna, and bluefin tuna catch. Section III discusses the expected economic impact of a suite of recreational bluefin tuna management proposals. Section IV presents an analysis to compare angler welfare impacts to conservation benefits of recreational bag limits, and Section V provides estimates of the employment, expenditure and sales impacts of bag limit reductions for a range of demand loss scenarios. Section VI applies the analyses to consider anticipated benefits and costs of management alternatives for recreational bluefin bag-limits, and additionally discusses potential impacts under management alternatives for at-sea filleting. Appendices explain sources and methods and provide an alternative version of the analysis based on 2013 logbook records, only.

II. CPFV Tuna Fishing Effort

Bluefin tuna is one of several frequently caught tuna species on a subset of all CPFV trips which focus on HMS species; other tuna species caught on these trips include albacore, yellowfin and skipjack tuna. Separately identifying bluefin tuna effort within overall CPFV effort is problematic, as there is no clear distinction in the CPFV trip logs between trips which solely targeted bluefin tuna and trips which target other species. The logbook records contain a field indicating whether tuna was targeted, without regard to any particular species, and many trips catching large numbers of tunas do not indicate that tuna was the target species. A considerable number of trips show small numbers of bluefin tuna caught along with other species. Defining effort to only include trips where bluefin tuna was caught could create bias by systematically excluding trips where bluefin was targeted but did not occur.

The following approach was used to define CPFV tuna effort at locations and times of bluefin tuna availability, without biasing the sample towards the most successful bluefin tuna trips[2]:

1. Dates and California Department of Fish and Wildlife (CDFW) block locations, including blocks in Mexico waters[3], with bluefin tuna catch reported on CPFV trip logs were identified for the 2008-2013 period.

[2] Technical details of the methodology to identify bluefin tuna effort are fully explained in APPENDIX 3.

2. CPFV bluefin tuna fishing effort was defined to include all CPFV angler days where any species of tuna was either targeted or caught for the date-block combinations with reported CPFV bluefin tuna catch[4].

An analysis of the timing of tuna effort presented in September 2014 HMSMT Report 2 demonstrated that the majority of CPFV bluefin tuna landings in recent years have occurred over the months from June through September, with small amounts of additional landings in May and October. Further analysis was conducted to determine the ports where tuna effort originated, the relative share of tuna effort in overall CPFV effort, and locations of fishing.

The vast majority of CPFV trips reporting bluefin tuna catch originated in Southern California (District 1), with almost all (99.9%) bluefin tuna angler days over the 2008-2013 seasons originating out of ports in Los Angeles, Orange and San Diego Counties. For these three counties, most of the bluefin effort (97.0%) originated in San Diego County ports, while two Los Angeles ports (San Pedro and Long Beach) contributed 1.6% of angler days and two Orange County ports (Newport Beach and Dana Point) contributed 1.2% of the angler days. Tuna effort was also a relatively higher share of overall CPFV effort in San Diego County, comprising 28.1% of all angler days over the 2008-2013 period for San Diego ports where it originated compared to only 1% of angler days out of Los Angeles County ports and 0.8% of angler days out of Orange County ports which contributed tuna effort.

An analysis of fishing areas showed that 98.8% of CPFV bluefin effort over the 2008-2013 period inside U.S. waters occurred in CDFW blocks located to the west of Oceanside, California (33.2 degrees North latitude) in North San Diego County or further south, while 97.2% of CPFV bluefin effort in Mexico waters occurred in CDFW block 910, which is contiguous to the boundary with U.S. waters south of San Diego. The high concentration of CPFV tuna effort in waters near San Diego County and the very large share of effort originating in San Diego County ports suggest that any negative economic impacts due to recreational management measures on bluefin may disproportionately affect San Diego County ports.

---

[3] CDFW blocks in Mexico waters are typically much larger and representative of greater area than those in adjoining U.S. waters off California. Thus the large amount of CPFV bluefin effort in CDFW block '910', in Mexico waters contiguous to the boundary with U.S. waters south of San Diego, could be more reflective of the large area of this block than to a more dense concentration of fishing effort compared to effort in US. waters.

[4] The definition of effort is limited to "tuna trips" on days with reported bluefin tuna catch is meant to exclude CPFV effort targeting other species where bluefin tuna catch was not likely to have occurred. Some trips where bluefin tuna catch was possible but did not occur may be omitted by this definition of bluefin tuna effort.

III. Potential Economic Impacts of Recreational Management for Bluefin Tuna

West coast recreational fishing activity on bluefin tuna and other highly migratory species is conducted from commercial passenger fishing vessels (CPFVs) and privately owned vessels fishing out of landings, marinas, and launch ramps dotting the Southern California coast from Los Angeles to San Diego (Fishery Management Plan for U.S. West Coast Fisheries for Highly Migratory Species, as amended (July 2011), Appendix A). The Sportfishing Association of California (SAC) is the major industry organization, representing nearly 200 CPFVs operating out of 23 landings from Morro Bay to San Diego. Direct expenditures in 2013 on marine recreational fishing trips from California District 1 ports, which include ports from Los Angeles south through San Diego, included roughly $119 million on CPFV trips. In 2013, this fleet provided 380,000 and 152,000 angler days of fishing effort to U.S. and Mexican fishing grounds, respectively. The contribution of these trips to employment supported about 1,537 full-time equivalent jobs in 2013 (2013 California Marine Recreational Fishing Trip Effort and Preliminary Economic Impact Estimate).

Bluefin tuna catch has sharply increased as a share of all CPFV HMS catch in recent years from levels below 10% from 2000-2007 to levels between 20% and 55% from 2011-2013 (September 2014 Agenda Item G.4.b HMSMT Report 2, Figure 7). Economic value due to recreational bluefin tuna trips is generated in the form of consumer surplus, producer surplus, and regional economic impacts[5]. Although bluefin tuna recreationally caught on west coast U.S. trips cannot legally be sold, allowing recreational anglers to catch and retain bluefin tuna for personal or community use can be an important factor in their decisions to take recreational fishing trips; conversely, depending on the level of regulation, limiting or eliminating the potential for recreational anglers to catch and retain bluefin tuna could reduce the demand (willingness to pay) for recreational fishing trips, resulting in a loss of consumer surplus. While anglers may be able to continue fishing for other species if retained bluefin catch were limited by regulation, the reduction in choice of species to catch and retain could reduce the value of the fishing experience, leading to a reduction in CPFV and private boat trip demand. A loss of producer surplus would result if reduced CPFV trip demand led to some combination of a reduction in the number of CPFV angler trips or the need for price reductions to attract anglers to continue taking trips. A decrease in the number of CPFV or private vessel recreational trips or prices is also predicted to result in a reduction in trip and durable good expenditures and attendant multiplier effects of recreational fishing, negatively impacting regional economic expenditures and jobs in supporting industries.

[5] Consumer surplus measures the aggregate amount by which the benefit of consuming a product exceeds what consumers pay to obtain it. Producer surplus is the aggregate economic value of producer profits from providing a product. Regional economic impacts consider revenue flows due to an economic activity, such as CPFV vessels providing anglers with recreational fishing trip experiences; they include direct effects on the affected industry, indirect effects on related businesses such as suppliers of services and durable goods, and induced effects on household expenditures; regional employment impacts are also considered.

The impacts of recreational management measures on bluefin would depend on both the degree to which anglers are willing and able to substitute other catch species in the event management measures reduce landings and retention of bluefin tuna, and the availability of bluefin tuna and substitute target species in the future. On one extreme is the possibility of no substitutability between species, in which case anglers who fish solely for the opportunity to catch bluefin tuna would simply not fish unless they were able to catch and retain bluefin, even if other species were available. At the other extreme, with perfect demand substitutability of other target species for bluefin tuna and equal availability of substitute target species, there would be no economic impact of restrictions on the recreational catch of bluefin tuna. Other possibilities lie somewhere in the middle. Even with perfect angler species substitutability, if substitute target species were not available, or required additional resources to target (search time, fuel, etc.), then more stringent bag or retention limits on bluefin tuna may limit the total amount of fish CPFV anglers could catch on a trip, and therefore may reduce angler sportfishing demand and total sportfisher effort. In the short run, reduced effort would negatively impact consumer surplus of anglers, producer surplus of firms engaged in the recreational fishing industry, and economic impact associated with the fishery. However, given high recent levels of bluefin tuna catch as the share of total recreational HMS catch, it is uncertain whether other close substitute species would be available in sufficient amounts to fully offset lost opportunity if regulations led to a significant reduction in allowable bluefin catch. Substitution for bluefin could lead to increased conservation impacts on other species, including other HMS, rockfish and various other CPFV target species. The degree to which substitution of other species for bluefin tuna which would occur is difficult to predict, given that recent and current management did not historically place binding limits on recreational bluefin catch and retention for all but a few trips. If bluefin tuna were locally unavailable to the fishery in future years, the losses described above could still happen for biological regions although the reductions in bag limits would not have a direct economic impact relative to a fishery without bag limits.

The U.S. west coast recreational and commercial fleets, related industries, consumers and other concerned parties could realize future benefits if current conservation measures led to improved future bluefin tuna fishing opportunities. Unless target species angler demand is perfectly substitutable and alternative target species are readily available, short run direct economic impacts of binding management restrictions on the west coast recreational bluefin tuna fishery would be negative, immediate, and potentially significant depending on the particular alternative adopted.

IV. Comparison of Estimated Angler and Bluefin Tuna Population Impacts of Bag Limit Reductions

A first step in assessing potential impacts of bluefin management measures on recreational demand is to estimate the impacts of alternative bag reductions on tuna angler experience. In addition, comparing angler impacts to anticipated reductions in bluefin tuna population impacts can provide insight on the tradeoffs for different potential bag reductions between regulatory

impacts on anglers who recreationally target bluefin tuna and conservation benefits to the bluefin stock.

For this analysis, bluefin tuna fishing effort is defined to include all CPFV angler days over the 2008-2013 seasons where any tuna species was either targeted or caught, but limited to CDFW block/date combinations in which bluefin tuna were caught on CPFV trips. This definition of effort thus includes angler days when bluefin tuna were available in the area where fishing occurred but were not caught. Appendix 2 reports comparable results for the 2013 season, only.

Table 1. Estimated Bluefin Tuna Bag Size Frequencies, 2008-2013

	2008-2013 CPFV Bag Size Frequencies	
Bag Size	U.S. Waters	Mexico Waters
0	57.9%	73.9%
1	23.6%	13.4%
2	8.0%	5.4%
3	4.3%	2.8%
4	2.2%	1.7%
5	2.4%	2.6%
6	0.5%	0.1%
7	0.5%	0.0%
8	0.4%	0.0%
9	0.2%	0.0%
10	0.0%	0.0%

Table 1 displays bluefin tuna bag size frequencies, estimated by pooling data for U.S. water trips and for Mexico water trips over the 2008-2013 periods. These frequencies were used to estimate angler and conservation impacts[6] of bag reduction alternatives, shown in Table 2 and depicted in Figures 1 and 2.

Table 2 shows the estimated impacts of potential bag reductions from current levels to numbers from 5 down to 0 bluefin tuna, where 0 represents a full moratorium on bluefin retention. The table is representative of 2008-2013 CPFV trip logs for tuna effort in Mexico and U.S. waters. The left side of the table presents estimated impacts in U.S. waters; estimated impacts due to

[6] Conservation impacts per 100 mts of U.S. recreational catch are calculated using the average EPO catch of 5,134 mts for 2008-2013, rescaled by the estimated 20% of stockwide impacts for EPO catch: 100 mts × 20% / 5,134 = 0.3895% per 100 mts. Estimated catch savings are based on average 2008-2013 bluefin tuna catch of 415 mts, allocated to U.S. waters (53 mts) and Mexico waters (362 mts) in proportion to catch counts on CPFV trip logs.

CPFV fishing in Mexico waters are presented on the right side. For each fishing area (U.S. or Mexico) and potential bag reduction, the leftmost three columns show angler impacts as estimated percentages of bags that would be reduced, average reductions in bag size for impacted anglers (those with bag reductions), and average bag reductions for all bluefin tuna trip anglers[7].

The rightmost two columns for each fishing area translate the estimated reduction in catch weight presented in September 2014 Agenda Item G.4.b HMSMT Report 2, Figure 7 into an estimate of the decrease in the U.S. recreational fishery share of population impacts by all fisheries on the Pacific bluefin tuna stock.

Table 2. Estimated CPFV Angler and Bluefin Tuna Population Impacts of Reduced Bag Limits

	U.S. Waters					Mexico Waters				
Potential Bag Reductions	Percent of Bags Reduced	Average Bag Reduction for Impacted Anglers	Average Bag Reduction for All Bluefin Tuna Trip Anglers	Estimated Catch Savings (mts)	Estimated Reduction in Total Population Impacts	Percent of Bags Reduced	Average Bag Reduction for Impacted Anglers	Average Bag Reduction for All Bluefin Tuna Trip Anglers	Estimated Catch Savings (mts)	Estimated Reduction in Total Population Impacts
10 fish to 5 fish	1.5%	2.23	0.03	2	0.0%	0.2%	1.75	0.00	2	0.0%
10 fish to 4 fish	4.0%	1.85	0.07	5	0.0%	2.8%	1.12	0.03	21	0.1%
10 fish to 3 fish	6.2%	2.18	0.13	8	0.0%	4.5%	1.69	0.08	52	0.2%
10 fish to 2 fish	10.4%	2.29	0.24	15	0.1%	7.4%	2.04	0.15	101	0.4%
10 fish to 1 fish	18.5%	2.30	0.42	27	0.1%	12.7%	2.18	0.28	187	0.7%
10 fish to 0 fish	42.1%	2.01	0.84	53	0.2%	26.1%	2.06	0.54	362	1.4%

Figure 1 shows a comparison of the estimated percentage of bags that would be reduced (horizontal scale) to the estimated reduction in total population impacts under different proposed bag limit reductions for fishing in U.S. waters (vertical scale), comparing the second and sixth columns of Table 1. Proposed reduced bag limits are displayed as labels on data points. A change from a bag limit of 2 to a full moratorium would increase the percent of U.S. water angler bags reduced from 10.4% to 42.1%; the associated reduction in total bluefin tuna population impacts would increase from 0.1% to 0.2%.

[7] Using terminology from the literature on the econometrics of treatment effects, the average reduction for impacted anglers can be described as the "average treatment effect for the treated group" while the average reduction for all bluefin tuna trip anglers can be described as the "average treatment effect" (Imbens, 2004).

Figure 1. Angler and Total Population Impacts for Reduced Bag Limits in U.S. Waters

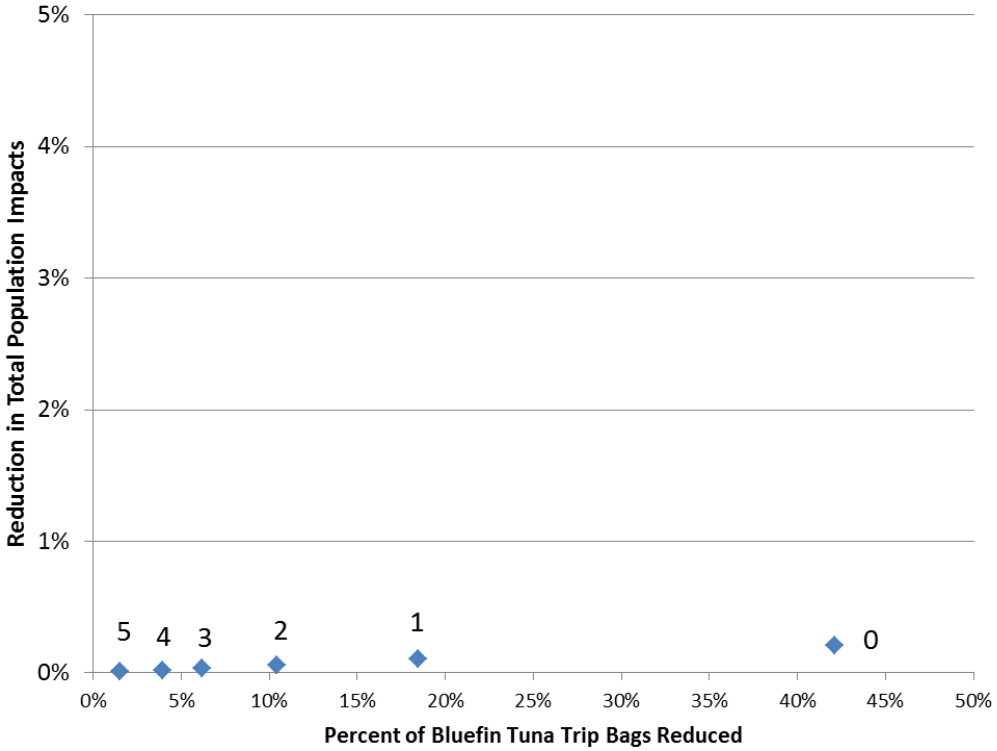
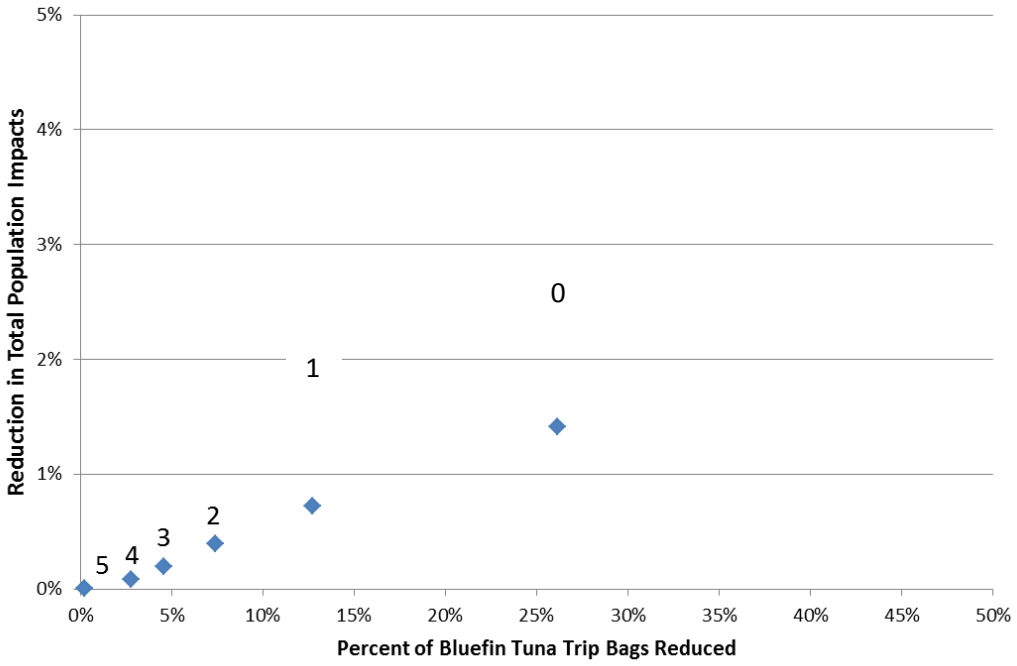


Figure 2 displays the comparable information for bag limits applied to fishing in Mexico waters, based on columns seven and eleven of Table 1. For example, with a bag limit of 1, an estimated 12.7% of U.S. bluefin tuna bags for fishing in Mexico waters would be reduced in exchange for a 0.7% reduction in total bluefin tuna population impacts.

These results are representative of the operation of the fishery in 2008-2013, before the prohibition of the recreational bluefin fishery for the remainder of the 2013 season in Mexico waters after the commercial quota was reached. In case Mexico continues to take this approach of disallowing recreational bluefin catch when the commercial quota is reached, Mexico water impacts may occur regardless of the proposed action on bag limits. However, a closure of the Mexico recreational bluefin tuna fishery to U.S. anglers could also result in a shift in CPFV effort on bluefin tuna to areas inside the U.S. EEZ west of San Diego, where the vast majority of CPFV tuna effort in U.S. waters occurs.

Figure 2. Angler and Total Population Impacts for Reduced Bag Limits in Mexico Waters



V. Potential Employment Impacts of Bluefin Tuna Bag Limits

A possible consequence of reduced bag and retention limits for bluefin tuna is a loss of employment in the CPFV fishing industry, due to a drop in demand for trips if a significant number of CPFV anglers are impacted. Because in most years, anglers can catch other highly migratory species if bluefin tuna are unavailable, it is possible that a smaller number of anglers will forego trips than the percent of anglers who would experience bluefin tuna bag size reductions. However there are also reasons the drop in trip demand could exceed the percent of anglers reaching bag or retention limits. For instance, in years similar to recent ones where bluefin tuna were locally abundant off Southern California and comprised the most important component of CPFV tuna catch, angler demand for trips may depend more heavily on the potential amount of bluefin tuna they can catch and retain than the likely actual amount. A bag limit reduction from 10 down to 2 may be interpreted by anglers as a likely reduction of 8 fish per day for a trip, possibly resulting in a much larger decline in trip demand than suggested by relatively smaller estimated average bag size reductions.

Tables 3-5 provide baseline employment, expenditure and sales contributions, based on estimated average bluefin tuna angler days of 5,275 in U.S. waters and 56,338 in Mexico waters over the 2008-2013 seasons. The baseline employment contribution of CPFV tuna effort for

District 1 may be calculated directly from the bluefin tuna angler days and employment multipliers[8], as shown below in Table 3:

Table 3. Baseline 2008-2013 Employment Contribution of CPFV Tuna Effort

Fishing Location	U.S. Waters	Mexico Waters
1) Annual Average Bluefin Tuna Trip Angler Days	5,275	56,338
2) Employment Multiplier	0.002889	0.002889
3) Bluefin Tuna Trip Employment Contribution: (1) X (2)	15	163

The baseline contributions of CPFV tuna effort to expenditures and sales[9] were similarly calculated from the expenditure and sales multipliers as shown in Table 4 and Table 5:

Table 4. Baseline 2008-2013 Expenditure Contribution of CPFV Tuna Effort

Fishing Location	U.S. Waters	Mexico Waters
1) Annual Average Bluefin Tuna Trip Angler Days	5,275	56,338
2) Expenditure Multiplier	$224.44	$224.44
3) Bluefin Tuna Trip Expenditures Contribution: (1) X (2)	$1,184,000	$12,644,000

Table 5. Baseline 2008-2013 Sales Contribution of CPFV Tuna Effort

Fishing Location	U.S. Waters	Mexico Waters
1) Annual Average Bluefin Tuna Trip Angler Days	5,275	56,338
2) Sales Multiplier	$418.62	$418.62
3) Bluefin Tuna Trip Sales Contribution: (1) X (2)	$2,208,000	$23,584,000

Since the actual demand response to bag limits is unknown, a scenario analysis was employed to estimate potential industry job loss, using demand loss multiples of 0.25, 0.5, 1 and 1.5 times the anticipated percent of bags reduced to estimate the decline in numbers of CPFV trips of all types[10]. A demand loss multiple of 0.25 reflects a case where the proportional reduction in CPFV trips is only one fourth as large as the percentage of angler bags that are reduced due to regulation; at the other extreme, a demand loss multiple of 1.5 would result if the percentage reduction in CPFV trips exceeded the percentage of angler bags reduced, perhaps reflecting perceived loss of bluefin tuna fishing opportunity in excess of the actual effect of the regulation.

[8] Employment multipliers convert bluefin tuna trip angler days into an estimate of the number of full-time jobs needed to support this amount of fishing. They are based on "2013 California Marine Recreational Fishing Trip Effort and Preliminary Economic Impact Estimates", James Hilger, Southwest Fisheries Science Center, La Jolla, CA, September 2014.

[9] **Expenditures** are direct trip costs. **Sales** are gross sales generated by CPFV bluefin tuna trips, which include District 1 expenditures plus indirect sales due to bluefin trips net of expenditures generated outside District 1.

[10] This analysis assumes away the "perfect substitution" scenario described above.

Baseline employment contributions were used to estimate employment impacts under this range of scenarios, as shown in Table 6, subject to the assumption of job loss in proportion to decline in numbers of CPFV trips, with fractional jobs reflecting part-time equivalent employment.

Based on the limited share of bluefin tuna angler days as a proportion of all 2008-2013 CPFV effort in U.S. waters out of District 1 ports, loss of 10 or more full-time equivalent jobs is not predicted to occur for reduced bag limits in U.S. waters unless a full moratorium on bluefin tuna retention is passed. However, due to the much greater bluefin tuna angler day share of CPFV effort in non-U.S. waters, U.S.-based job loss exceeding 10 is predicted to occur beginning at a bag limit reduction of 4, assuming a demand loss multiplier of 1, with a potential full-time equivalent job loss exceeding 100 in the case of a moratorium on retained bluefin tuna catch and retention for bluefin tuna caught in non-U.S. waters. For example, assuming a demand loss multiplier of 1.5, a full bag limit reduction to 0 in non-U.S. waters would result in an estimated reduction of 1.5 × 26.1% = 39.15% in the number of CPFV trips, resulting in an estimated loss of 39.15% × 163 = 63.8 full-time equivalent U.S.-based CPFV industry jobs.

Table 6. Estimated Job Loss under a Range of Bluefin Tuna Bag Reduction Scenarios

	U.S. Waters					Mexico Waters				
Potential Bag	Percent of	Demand Loss Multiplier for Scenario				Percent of	Demand Loss Multiplier for Scenario			
Reductions	Bags	0.25	0.5	1	1.5	Bags	0.25	0.5	1	1.5
10 fish to 5 fish	1.5%	0.1	0.1	0.2	0.3	0.2%	0.1	0.2	0.3	0.5
10 fish to 4 fish	4.0%	0.2	0.3	0.6	0.9	2.8%	1.1	2.3	4.5	6.8
10 fish to 3 fish	6.2%	0.2	0.5	0.9	1.4	4.5%	1.8	3.7	7.4	11.1
10 fish to 2 fish	10.4%	0.4	0.8	1.6	2.4	7.4%	3.0	6.0	12.0	18.0
10 fish to 1 fish	18.5%	0.7	1.4	2.8	4.2	12.7%	5.2	10.4	20.7	31.1
10 fish to 0 fish	42.1%	1.6	3.2	6.4	9.6	26.1%	10.6	21.3	42.5	63.8

The demand loss scenarios presented in Table 6 for employment were applied to expenditures and sales contributions to obtain estimated expenditure loss (Table 7) and sales loss (Table 8) impacts under the various bag reduction alternatives and demand loss scenarios:

Table 7. 2008-2013 Estimated Expenditure Impacts under a Range of Bag Reduction Scenarios (2013 $1,000s)

	U.S. Waters					Mexico Waters				
Potential Bag	Percent of	Demand Loss Multiplier for Scenario				Percent of	Demand Loss Multiplier for Scenario			
Reductions	Bags	0.25	0.5	1	1.5	Bags	0.25	0.5	1	1.5
10 fish to 5 fish	1.5%	$4	$9	$18	$27	0.2%	$6	$12	$25	$37
10 fish to 4 fish	4.0%	$12	$23	$47	$70	2.8%	$88	$176	$353	$529
10 fish to 3 fish	6.2%	$18	$37	$73	$110	4.5%	$144	$287	$574	$861
10 fish to 2 fish	10.4%	$31	$62	$124	$185	7.4%	$233	$466	$931	$1,397
10 fish to 1 fish	18.5%	$55	$109	$218	$328	12.7%	$402	$805	$1,610	$2,415
10 fish to 0 fish	42.1%	$125	$249	$498	$748	26.1%	$826	$1,652	$3,304	$4,955

Table 8. 2008-2013 Estimated Sales Impacts under a Range of Bag Reduction Scenarios (2013 $1,000s)

	U.S. Waters					Mexico Waters				
Potential Bag	Percent of	Demand Loss Multiplier for Scenario				Percent of	Demand Loss Multiplier for Scenario			
Reductions	Bags	0.25	0.5	1	1.5	Bags	0.25	0.5	1	1.5
10 fish to 5 fish	1.7%	$9	$19	$38	$56	0.2%	$12	$23	$46	$70
10 fish to 4 fish	6.7%	$37	$74	$149	$223	2.8%	$165	$329	$658	$988
10 fish to 3 fish	10.7%	$59	$118	$237	$355	4.5%	$268	$535	$1,071	$1,606
10 fish to 2 fish	17.8%	$98	$197	$393	$590	7.4%	$434	$869	$1,737	$2,606
10 fish to 1 fish	31.2%	$172	$344	$689	$1,033	12.7%	$751	$1,501	$3,003	$4,504
10 fish to 0 fish	42.1%	$232	$465	$930	$1,394	26.1%	$1,540	$3,081	$6,162	$9,243

Estimated impacts are stated in thousands of 2013 dollars. For example, assuming a demand loss multiplier of 1, a moratorium on U.S. west coast bluefin tuna retention (bag reduction to 0) would result in a loss of $3.8 million in direct expenditures on bluefin tuna CPFV trips and a loss of $7.1 million in gross sales within District 1.

VI. Anticipated Benefits and Costs of Potential Management Alternatives

The following discusses anticipated benefits and costs of potential management alternatives under consideration by the Pacific Fishery Management Council, using quantitative information where available to strengthen the comparison.

Management Alternatives for Bag and Possession Limits

Alternative 1 (No Action): Continue daily bag limit of 10 bluefin and possession limit of 30 bluefin

This alternative would avoid imposing any immediate regulatory costs on the west coast recreational fleet due to more stringent bluefin tuna management measures. However it would fail to address conservation concerns regarding recent levels of bluefin tuna mortality due to west coast recreational fishing.

Alternative 2: Reduce bag limit to two fish per day and the possession limit to six fish for multi-day trips (Preliminary Preferred Alternative)

With a bag limit reduction to 2 fish, an estimated 17.0% of bags in U.S. waters and 13.0% of bags in Mexico waters would be limited to below current allowable levels. The average retained catch per angler who reaches the new limit would decrease by 2.26 fish in U.S. waters and 2.02 fish in Mexico waters compared to fishing under current management. Under the PPA, between 8 and 51 jobs could be lost compared to the No Action Alternative, depending on the demand loss multiplier and the degree to which restrictions in U.S. waters affects fishing in non-US waters.

Alternative 3: Harmonize U.S. daily bag and possession limits for federal waters off California with Mexico's current regulations for bluefin tuna.

This alternative would affect anglers who catch more than five bluefin tuna on one day of a trip or more than 15 bluefin tuna over three days. Direct conservation benefits to the stock would be realized due to bluefin tuna mortality reductions stemming from the bag limit reduction. Only effort inside the U.S. EEZ would be affected. Anticipated impacts on angler experience and the regional economy would be quite limited under this alternative, as seen in the top rows of Table 1 and Tables 6., 7. and 8.

Alternative 4: Reduce daily bag and possession limits to below 5 fish per day and 15 fish in possession for federal waters off California, and as a potential suboption, limit possession of fish caught in Mexico to no more than the corresponding U.S. possession limits.

The bottom five rows of Table 1 show impacts of bag reductions to below 5 fish per day on angler experience and U.S. recreational bluefin mortality; the bottom 5 rows of Tables 6, 7 and 8 show employment and other economic impacts for bag reductions below 5. The percentage of angler bags that would face a reduction increases steeply while the reduction in U.S. recreational mortality increases by small amounts, particularly for fishing in U.S. waters. Estimated economic impacts also increase sharply with lower bag limits; for instance, US-based job loss in the CPFV industry on the range from 14 to 85 is expected with a bag reduction to 1 fish per day.

Alternative 5: Prohibit retention of bluefin tuna by recreational fisheries.

This alternative could potentially impose severe economic impacts on the west coast U.S. recreational fishery. The degree of severity would depend the degree of angler substitution between species which would impact the angler consumer surplus loss due to excluding bluefin tuna from the species they were allowed to catch, the loss of producer surplus to the recreational fleet if angler demand for trips significantly declined, and the potential for the fleet to cease normal operations in the face of a bluefin tuna moratorium. Upwards of 40 percent of anglers would face bag size reductions, with anticipated employment loss on the range from 26 to upwards of 150 jobs.

Management Alternatives for At-sea Filleting

Adopting bag limits for PBF that differ from other tunas caught in recreational fisheries (principally yellowfin and albacore tuna) requires that the different species can be distinguished for monitoring and enforcement purposes. This raises a concern regarding at-sea filleting, in case this practice makes it difficult to determine how many of each species of fish were caught on a trip. However, filleting at sea provides income in the form of tips for CPFV crew and facilitates the storage and transport of fish. Average angler per day expenditures on crew tips for California based CPFV trips are $17.03 (2011$) (Lovell et al, 2013). On-shore processing services are available at prices from $0.60 a pound for basic gill, gut, and head removal (e.g., $24 for processing two 20-pound fish) up to $2.25 a pound for fish jerky; since on-board processing services provided by crew members are generally less expensive and are completed upon arrival

to the landing, there are benefits to the angler if at-sea processing is allowed. The alternatives under consideration are listed below, with discussion of policy implications and potential economic impacts. They would only apply to processing of tuna at sea by recreational harvesters fishing south of Point Conception.

No Action Alternative: Current state requirements, which allow filleting as long as a 1-inch square patch of skin is left on the fillet.

The current requirement, which allows filleting at sea, does not allow species identification necessary to enforce bag limit reductions because several key diagnostic characteristics (e.g., pectoral fin) are removed during the filleting process.

Alternative 2: Preliminary Preferred Alternative: Filleting of tuna at sea would be authorized in a manner that allows for both the species and the quantity of tuna taken aboard a vessel to be determined.

If a technique can be developed to enable filleting at sea while allowing species identification and quantity of tuna taken aboard a vessel to be determined, this could allow the current practice of filleting at sea to continue under reduced bag limits. Crew members who currently earn significant tip revenue from at-sea filleting could continue to do so.

Alternative 3: Filleting of tuna at sea would be prohibited, while continuing to allow processing to remove organs and viscera (i.e., allowing only gilling and/or gutting).

In case it proves infeasible to identify species or retained catch counts while continuing to allow filleting at sea, this approach could provide an intermediate option between filleting and an outright ban on processing at sea. This alternative would reduce tip revenues for fish that would otherwise have been filleted and potentially imposes additional costs on anglers who would have to make arrangements for onshore processing in lieu of at-sea filleting.

Alternative 4: Filleting of tuna at-sea would be prohibited, while continuing to allow processing to remove the head and organs and viscera (i.e., allowing only heading or gilling/gutting).

This measure would similarly reduce fish processing revenues from filleting at-sea, while imposing additional costs and inconvenience on anglers who would need to make arrangements and incur added costs for processing their catch on shore.

Alternative 5: Prohibit any processing of tuna at sea.

This alternative would eliminate potential filleting revenue to crew members who currently offer at-sea filleting services. Additional effort and expense would be incurred by anglers required to land their catch whole. Industry representatives have also expressed a potential public health concern if a requirement for anglers to land their catch whole leads to an increase in the inappropriate disposal of fish waste products on shore.

Acknowledgments
The author thanks California Department of Fish and Wildlife (CDF&W) for developing, maintaining and providing access to CPFV logbook data used in this analysis, and to James Hilger and other NMFS staff involved in regional economic analysis for the CPFV fishery. In addition, the author thanks several reviewers, both known and anonymous.

References

Conservation, Magnuson-Stevens Fishery. " Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006." Public Law 479 (2007).

Hilger, James. 2014. 2013 California Marine Recreational Fishing Trip Effort and Preliminary Economic Impact Estimates. https://swfsc.noaa.gov/uploadedFiles/Operating_units/FRD/Socio-Economics/SWFSC-CA_2012_Rec_Impact_by_Mode_District.pdf

Imbens, Guido. 2004. Nonparametric Estimation of Average Treatment Effects under Exogeneity: A Review. The Review of Economics and Statistics, 86(1): 4-29.

Lovell, Sabrina, Scott Steinback, and James Hilger. 2013. The Economic Contribution of Marine Angler Expenditures in the United States, 2011. U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-F/SPO-134, 188 p.

Pacific Fishery Management Council. 2011. Fishery Management Plan for U.S. West Coast Highly Migratory Species as Amended through Amendment 2, July 2011.

APPENDIX 1: Methodology for Estimating Impacts of Reduced Bag Limits

The observed frequency distribution of bag sizes for fishing in California and Mexico waters over recent years can be used to estimate the effect of a given bag limit reduction on angler experience. For each area fished, the analysis estimates the percentage of impacted bags, the average reduction in bag size for impacted anglers, and the average reduction in bag size for all bluefin tuna trip anglers. The analysis assumes the recently observed bag size distribution is a counterfactual of potential catch, so that any reduction in average bag size is due to anglers reaching the new lower limit.

Table 9. Estimated Bluefin Tuna Bag Size Frequencies in 2013

	2013 CPFV Bag Size Frequencies	
Bag Size	U.S. Waters	Mexico Waters
0	45.1%	59.6%
1	28.0%	18.7%
2	9.9%	8.8%
3	6.2%	5.0%
4	4.0%	3.3%
5	5.1%	4.4%
6	0.6%	0.2%
7	0.4%	0.0%
8	0.6%	0.0%
9	0.1%	0.0%
10	0.0%	0.0%

The data summarized in Table 9 are representative of all 2013 CPFV bluefin tuna angler days in U.S. and in Mexico. For an example of how these frequencies can be used to estimate angler impacts of a bag limit reduction, consider a limit of 2 bluefin tuna in U.S. waters. The percentage of bags affected is estimated as the sum of bag frequencies for which the bag limit would reduce the bag size, given by the sum of all entries in the applicable column of the table below the reduced limit. A limit of 2 bluefin tuna in U.S. waters would impact bags which otherwise would have contained 3 or more fish; the percentage of bags in U.S. waters which would be reduced from a potentially higher level under a limit of 2 is estimated as

$$6.2\% + 4.0\% + 5.1\% + 0.6\% + 0.4\% + 0.6\% + 0.1\% = \mathbf{17.0\%}.$$

The overall average reduction in bag size for a given limit can be calculated as the weighted average reduction based on the above frequencies. For the example, anglers who would have achieved a bag of 8 would be reduced by 6 down to 2; those who would have had a bag of 7 would be reduced by 5; and so on, down to anglers whose bags would be reduced by 1, from 3 down to 2. Bags which would have been 2 or fewer under existing policy are not expected be limited (i.e. their reduction would be 0). The average bag reduction for a limit of 2 is thus calculated as

$$1 \times 6.2\% + 2 \times 4.0\% + 3 \times 5.1\% + 4 \times 0.6\% + 5 \times 0.4\% + 6 \times 0.6\% + 7 \times 0.1\% = \mathbf{0.382}.$$

Finally, the average reduction for only the bags which would be limited can be estimated as the weighted average reduction in bag size for these bags:

$$(1 \times 6.2\% + 2 \times 4.0\% + 3 \times 5.1\% + 4 \times 0.6\% + 5 \times 0.4\% + 6 \times 0.6\% + 7 \times 0.1\%) \div (6.2\% + 4.0\% + 5.1\% + 0.6\% + 0.4\% + 0.6\% + 0.1\%) = \mathbf{2.26}.$$

The above calculations were carried out separately for U.S. waters and for Mexico waters, for potential bag size reductions down to levels on the range from 5 down to 1.

Estimating the Impacts of Bag Limit Reductions on Overall Bluefin Tuna Population Impacts

Information provided in the September 2014 HMSMT Report 2 under Council Agenda Item G.4.b may be used to estimate the impacts of alternative bag limit reductions on overall bluefin tuna population impacts. As shown in Figure 5 of the report and discussed in the accompanying text, over recent years (2007-2012) EPO fisheries have accounted for approximately 20% of the impacts of all fisheries on the Pacific bluefin spawning stock biomass (excerpted from Executive Summary to the Stock Assessment for Bluefin Tuna, 2014, by the Bluefin Tuna Working Group, ISC). Based on preliminary catch estimates for 2013 shown in Table 4 of HMSMT Report 2, U.S. recreational catch for 2013 was estimated at 984 mts out of 4,184 mts total EPO catch. Recent (2013) U.S. recreational catch thus represented approximately 984 / 4,184 = 23.5% of EPO impacts, or 23.5 % × 20% = 4.7% of impacts of all fisheries on bluefin spawning stock biomass (bottom-right cell of Table 4). The choice of 2013 to estimate recreational impacts is for consistency with the bag limit analysis in the September HMSMT Report 2, and results in a conservative measure of potential ongoing recreational impacts; for comparison, the U.S. recreational share of impacts of all fisheries on the Pacific bluefin spawning stock biomass over the entire 2008-2013 period was 1.6%.

To estimate the direct effect of potential U.S. recreational fishery bag limit reductions on overall bluefin tuna population impacts, the ratio of U.S. sport percent of all impacts for 2013 to U.S. sport catch in 2013 was rescaled to an estimated U.S. recreational population impact per 100 mts of U.S. sport catch:

$100 \times 4.7\% / 984 = 0.4882\%$ of all impacts per 100 mts of U.S. sport catch.

This ratio was multiplied by potential bluefin catch savings in total weight of fish (100s of mts) for the CPFV fishery shown in Table 7 of HMSMT Report 2 under Council Agenda Item G.4.b to estimate the percentage reduction in overall population impacts under different bag limit reductions to levels on the range from 5 down to 1. For instance, a bag limit reduction down to 1 fish in U.S. waters is estimated to result in a catch savings of 55 mts. The resulting reduction in overall Pacific bluefin fishery population impacts due to the reduction in U.S. bag limit from 10 down to 1 is estimated as $(55/100) \times 0.4882\% =$ **0.3%**. By comparison, the effect of a bag limit reduction down to 1 in Mexico waters is estimated to result in a catch savings of 477 mts, for a reduction in overall Pacific bluefin fishery population impacts of $(477/100) \times 0.4882\% =$ **2.3%**. These values and similar results are included in Table 10 and Figures 3 and 4.

APPENDIX 2: Impact Analysis based on 2013 CPFV Experience

For comparison with the results shown in the paper, a parallel analysis was carried out using data for the 2013 season, only; results are summarized below. Since 2013 was a year with unusually high levels of CPFV bluefin tuna catch and effort, results of an analysis using only 2013 data may misrepresent typical experience compared to the more representative 2008-2013 period. Table 10 provides comparable information to Table 2, but only based on 2013 angler experience.

Table 10. Estimated CPFV Angler and Bluefin Tuna Population Impacts of Reduced Bag Limits

	U.S. Waters					Mexico Waters				
Potential Bag Reductions	Percent of Bags Reduced	Average Bag Reduction for Impacted Anglers	Average Bag Reduction for All Bluefin Tuna Trip Anglers	Estimated Catch Savings (mts)	Estimated Reduction in Total Population Impacts	Percent of Bags Reduced	Average Bag Reduction for Impacted Anglers	Average Bag Reduction for All Bluefin Tuna Trip Anglers	Estimated Catch Savings (mts)	Estimated Reduction in Total Population Impacts
10 fish to 5 fish	1.7%	2.16	0.04	3	0.0%	0.3%	1.82	0.01	5	0.0%
10 fish to 4 fish	6.8%	1.54	0.11	9	0.0%	4.7%	1.11	0.05	52	0.3%
10 fish to 3 fish	10.8%	1.98	0.21	18	0.1%	8.0%	1.65	0.13	131	0.6%
10 fish to 2 fish	17.0%	2.26	0.38	32	0.2%	13.0%	2.02	0.26	260	1.3%
10 fish to 1 fish	26.9%	2.43	0.65	55	0.3%	21.8%	2.20	0.48	477	2.3%
10 fish to 0 fish	54.9%	2.19	1.20	93	0.4%	40.4%	2.19	0.88	891	4.3%

Figures 3 and 4 are comparable to Figures 1 and 2 in the body, except they are representative of 2013 angler experience rather than the entire 2008-2013 period. The potential reduction in total population impacts appears greater when based on 2013 angler experience, only, rather than for the full period. This reflects that CPFV bluefin tuna catch was highest in 2013 for all years in the period.

Figure 3. Angler and Total Population Impacts for Reduced Bag Limits in U.S. Waters

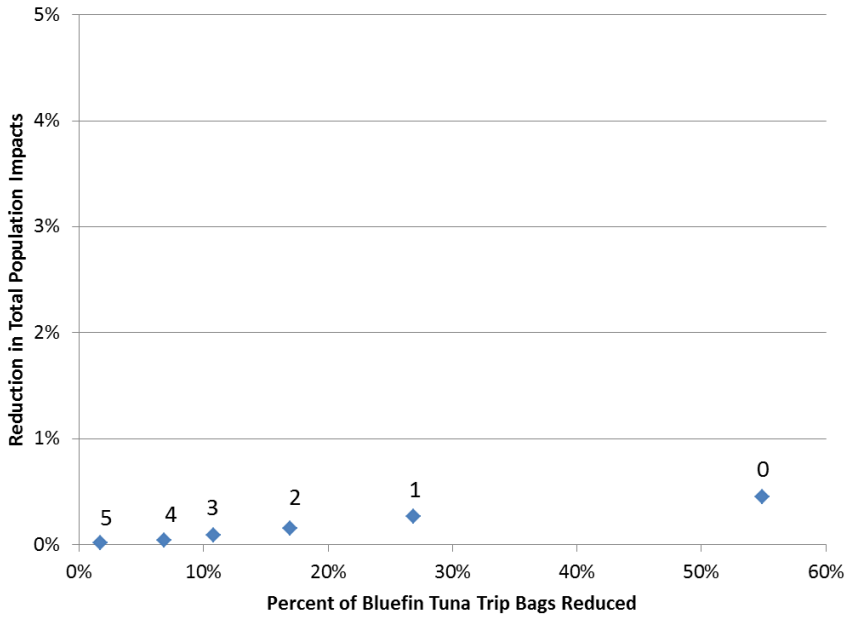
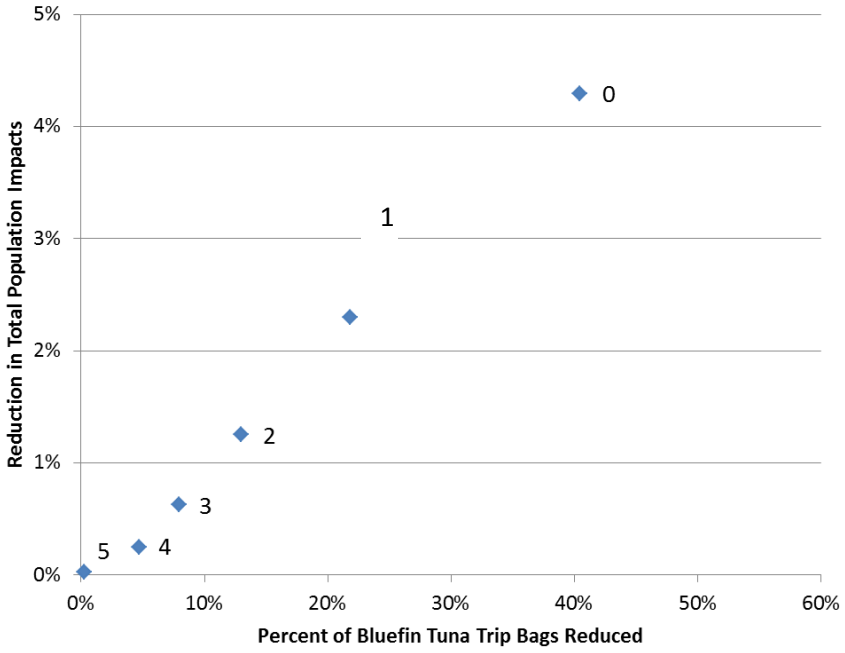


Figure 4. Angler and Total Population Impacts for Reduced Bag Limits in Mexico Waters



Tables 11-14 provide baseline employment, expenditure and sales contributions, based on estimated average bluefin tuna angler days of 6,825 in U.S. waters and 80,957 in Mexico waters during the 2013 season, and using the same multipliers as for the 2008-2013 analysis.

The contribution of CPFV fishing out of District 1 ports to regional employment roughly divide into 1,099 jobs due to fishing in U.S. waters and 438 jobs due to fishing in Mexico waters; the fishing effort which supports these jobs includes half-day trips and trips targeting other species besides tunas, such as bass and rockfish. An analysis of bluefin tuna angler days out of District 1 ports showed that 1.8% of all 2013 District 1 CPFV angler days in U.S. waters represented tuna effort, while 53.4% of District 1 CPFV angler days in Mexico waters were due to tuna effort. District 1 CPFV jobs due to U.S. and Mexico water effort were rescaled by the shares of bluefin tuna angler days to obtain baseline employment contributions of bluefin tuna fishing shown in Table 11:

Table 11. Baseline Average Employment Contributions of 2013 CPFV Tuna Fishing Effort

Fishing Location	U.S. Waters	Mexico Waters
1) All District 1 CPFV Angler Days	380,380	151,620
2) All District 1 CPFV Contribution to Employment	1,099	438
3) Bluefin Tuna Trip Share of District 1 Angler Days	1.8%	53.4%
4) Bluefin Tuna Trip Employment Contribution: (2) X (3)	20	234

Alternatively, the baseline employment contribution of CPFV tuna effort for District 1 may be calculated directly from the bluefin tuna angler days and employment multipliers[11], as shown in Table 12:

Table 12. Baseline 2013 Average Employment Contribution of CPFV Tuna Effort

Fishing Location	U.S. Waters	Mexico Waters
1) Bluefin Tuna Trip Angler Days	6,825	80,957
2) Employment Multiplier	0.002889	0.002889
3) Bluefin Tuna Trip Employment Contribution: (1) X (2)	20	234

The baseline contributions are further translated into estimated expenditure and sales contributions using the same multipliers as were for the 2008-2013 analysis, with results shown in Tables 13-14.

[11] Employment multipliers convert bluefin tuna trip angler days into an estimate of the number of full-time jobs needed to support this amount of fishing. They are based on "2013 California Marine Recreational Fishing Trip Effort and Preliminary Economic Impact Estimates", James Hilger, Southwest Fisheries Science Center, La Jolla, CA, September 2014.

Table 13. Baseline 2013 Average Expenditure Contribution of CPFV Tuna Effort

Fishing Location	U.S. Waters	Mexico Waters
1) Bluefin Tuna Trip Angler Days	6,825	80,957
2) Expenditure Multiplier	$224.44	$224.44
3) Bluefin Tuna Trip Expenditures Contribution: (1) X (2)	$1,532,000	$18,170,000

Table 14. Baseline 2013 Average Sales Contribution of CPFV Tuna Effort

Fishing Location	U.S. Waters	Mexico Waters
1) Bluefin Tuna Trip Angler Days	6,825	80,957
2) Sales Multiplier	$418.62	$418.62
3) Bluefin Tuna Trip Sales Contribution: (1) X (2)	$2,857,000	$33,890,000

The baseline contributions are translated into estimated job loss, expenditure and sales impacts under the same range of scenarios as were used for the 2008-2013 analysis, as shown in Tables 15-17.

Table 15. Estimated Job Loss under a Range of Bluefin Tuna Bag Reduction Scenarios

	U.S. Waters					Mexico Waters				
	Percent of	Demand Loss Multiplier for Scenario				Percent of	Demand Loss Multiplier for Scenario			
Potential Bag Reductions	Bags Reduced	0.25	0.5	1	1.5	Bags Reduced	0.25	0.5	1	1.5
10 fish to 5 fish	1.7%	0.1	0.2	0.3	0.5	0.3%	0.2	0.3	0.7	1.0
10 fish to 4 fish	6.8%	0.3	0.7	1.4	2.1	4.7%	2.7	5.5	11.0	16.5
10 fish to 3 fish	10.8%	0.5	1.1	2.2	3.2	8.0%	4.7	9.3	18.7	28.0
10 fish to 2 fish	17.0%	0.8	1.7	3.4	5.1	13.0%	7.6	15.2	30.4	45.5
10 fish to 1 fish	26.9%	1.3	2.7	5.4	8.1	21.8%	12.7	25.5	51.0	76.5
10 fish to 0 fish	54.9%	2.7	5.5	11.0	16.5	40.4%	23.7	47.3	94.6	142.0

Table 16. Estimated Expenditure Impacts under a Range of Bag Reduction Scenarios (2013 $1000s)

	U.S. Waters					Mexico Waters				
Potential Bag	Percent of	Demand Loss Multiplier for Scenario				Percent of	Demand Loss Multiplier for Scenario			
Reductions	Bags	0.25	0.5	1	1.5	Bags	0.25	0.5	1	1.5
10 fish to 5 fish	1.7%	$7	$13	$26	$39	0.3%	$13	$26	$51	$77
10 fish to 4 fish	6.8%	$26	$52	$105	$157	4.7%	$213	$426	$852	$1,278
10 fish to 3 fish	10.8%	$41	$83	$165	$248	8.0%	$362	$724	$1,449	$2,173
10 fish to 2 fish	17.0%	$65	$130	$260	$390	13.0%	$589	$1,179	$2,358	$3,537
10 fish to 1 fish	26.9%	$103	$206	$412	$618	21.8%	$990	$1,980	$3,960	$5,939
10 fish to 0 fish	54.9%	$210	$420	$841	$1,261	40.4%	$1,837	$3,674	$7,348	$11,023

Table 17. Estimated Sales Impacts under a Range of Bag Reduction Scenarios (2013 $1000s)

Potential Bag Reductions	U.S. Waters					Mexico Waters				
	Percent of Bags	Demand Loss Multiplier for Scenario				Percent of Bags	Demand Loss Multiplier for Scenario			
		0.25	0.5	1	1.5		0.25	0.5	1	1.5
10 fish to 5 fish	1.7%	$12	$25	$49	$74	0.3%	$24	$48	$95	$143
10 fish to 4 fish	6.8%	$49	$98	$195	$293	4.7%	$397	$795	$1,590	$2,384
10 fish to 3 fish	10.8%	$77	$154	$308	$462	8.0%	$676	$1,351	$2,702	$4,054
10 fish to 2 fish	17.0%	$121	$242	$485	$727	13.0%	$1,099	$2,199	$4,398	$6,596
10 fish to 1 fish	26.9%	$192	$384	$768	$1,152	21.8%	$1,846	$3,693	$7,385	$11,078
10 fish to 0 fish	54.9%	$392	$784	$1,568	$2,352	40.4%	$3,427	$6,853	$13,706	$20,559

Comparing the analysis based on the range of seasons from 2008-2013 to the 2013 season analysis generally indicates larger potential conservation benefits and economic impacts of bag reductions for the unusually high levels of bluefin tuna catch and effort that occurred in 2013 compared to the analysis using the combined data over the 2008-2013 seasons.

APPENDIX 3: Identifying Tuna Effort in CPFV Logbook Data

The following steps were taken to identify and characterize tuna effort on the CPFV logbook data (MS Access file HMS.CPFVLogbookTripsDataCleaned90-13.mdb):

1. Distinct date-block combinations where bluefin tuna were caught in the 2008-2013 period were identified by a query ('BFT Date Block') which selected post-2007 records in the 'CPFV9013' table where either 'number kept', 'number thrown back' or 'lost to sea lions' was greater than 0 for bluefin tuna ('market' = '004'). CPFV trip logs recorded bluefin tuna catch for a total of 1860 distinct date-block combinations since 2008.

2. Tuna effort is characterized as all vessel days that targeted or caught any tuna species within a date-block combination where bluefin tuna were caught. To identify this data, the select query 'BFT Effort' was used to identify records in the 'CPFV9013' table which meet three criteria:

    a. The date-block combination matches one from the 'BFT Date Block' query

    b. Either the log indicates tuna were targeted ('target tuna' field is 'Y') or the market species code indicates tuna catch ('market' is '001' Or '002' Or '004' Or '005' Or '006' Or '008' Or '009' Or '011' Or '012')

    c. 'Number of anglers' greater than 0 (to exclude records of trips with no anglers).

3. Logbook records of bluefin tuna catch counts for days when bluefin were caught were obtained through the query 'BFT Catch GT Zero' which selects records on 'BFT Effort' with 'market' equal to '004', including 'serial_number', 'Date', 'block', 'market', 'number of anglers', 'number kept', 'number thrown back' and 'lost to sea lions', where at least one of the latter three fields is positive. A total of 7,143 vessel days since 2008 recorded bluefin tuna catch.

4. A select query, 'BFT Catch Distribution', was used to add catch counts for trips where bluefin tuna were caught to 'BFT Effort', by matching serial numbers for the 'BFT Catch GT Zero' query records to serial numbers on 'BFT Effort'. The resulting query includes all bluefin tuna vessel days after 2007 (as defined in step 2.), and pulls in 'number kept', 'number thrown back' and 'lost to sea lions' from 'BFT Catch GT Zero' for records where at least one of these values are positive. A total of 13,642 distinct bluefin tuna vessel days since 2008 were identified.

5. The 'US Catch Distribution' query was selected from the 'BFT Catch Distribution' query by selecting records for which 'block' was either '< 900' or equal to '950' or '>999'. The

'MEX Catch Distribution' query was similarly obtained from 'US Catch Distribution' by selecting records where 'block' was '> 899 and <950' and '>950 and <1000'. A total of 12,379 Mexico vessel days and 1,263 US vessel days were identified.

6. The 'BFT Effort by Port' query was created to obtain data representative of the distribution of tuna effort by port of origin. The 'BFT Effort' query was narrowed down to show distinct 'YYYY', 'port', 'serial_number', 'number of anglers', 'trip type' and 'block', providing data suitable for analysis of tuna effort by port. A total of 13,642 distinct vessel days were identified (12,379 MEX + 1,263 US), consistent with 'MEX Catch Distribution' and 'US Catch Distribution' query results.

7. The 'All CPFV Effort from BFT Ports' query selects 'YYYY', 'port', 'serial_number' and 'number of anglers' for those ports where bluefin tuna trips originated ('port' is 743 Or 748 Or 767 Or 770 Or 869 Or 880 Or 881 Or 883). A total of 85,279 vessel days were counted for the 2008-2013 period.

8. The 'All District 1 CPFV Effort' query selects 'YYYY', 'serial_number', 'port', 'number of anglers' and 'block' for all CPFV effort since 2008 out of ports in District 1 (Los Angeles, Orange and San Diego Counties). The query selects all distinct records from the CPFV9013 table with 'YYYY' > 2007 and 'port' > 699. A total of 101,783 vessel days originated out of District 1 ports over the 2008-2013 period.