Estimates of Recreational release Mortality for the US Commercial Passenger Vessel Fleet (2000-2019).

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ABSTRACT

Commercial catches of Pacific Bluefin tuna (PBF) has been restricted by both international management and limited interest from industry due to limited markets in the U.S. As a result, the Southern California recreational fleet, comprised of Commercial Passenger Fishing Vessels (CPFVs) and private recreational vessels, is the primary U.S. West Coast source of harvest for PBF. Catches, releases (discard) and predation events of hooked fish are recorded in California CPFV logbooks. We developed an estimate of release mortality and subsequent discard mortality numbers for this fleet. A random-effect inverse variance meta-analysis estimated the mortality rate (6%) based upon published studies. Total unseen (not landed) recreational mortality was calculated as #fish released* release mortality rate + number of predation events on hooked PBF. The number of unseen kills were small (<500 fish). Unseen kills in this fleet do not represent an important component of the total fishing mortality on the stock, but these estimates are appropriate for use in the assessment.

INTRODUCTION

The Pacific Bluefin Working Group of the International Scientific Committee of Tunas and Tuna-like species has requested that members calculate unseen kills for their respective fisheries. The recreational fishery has become the primary source of PBF removals by U.S. West Coast fisheries and the mostly likely source of unseen mortality. Recreational catches are managed using bag and possession limits. Recent reductions in the bag limit to 2 fish per angler per day (with a possession limit of 6 fish per angler for trips 3 days or longer) since August 13, 2015 were imposed to limit impacts on depleted PBF. Anecdotal information suggests that recreational encounters with PBF in the Eastern Pacific Ocean (EPO) may have increased due to commercial fisheries management improving local stock abundance. It is unknown if the combined effects of a more restrictive bag limit and potentially increasing stock abundance have resulted in increased PBF discards and discard mortality. We used records of releases (discard) of fish not landed in the CPFV logbooks (Hill and Schneider 1999) to help estimate the number of unseen fishery kills. In this paper, we summarize those release estimates and calculate a release mortality rate based on the literature to estimate a total release mortality. The paper also includes reported mortality due to predation (primarily sea lion) of hooked PBF as unseen mortality.

MATERIALS AND METHODS

CPFV fleet logbooks (Hill and Barnes 1998; Hill and Schneider 1999) include records of released (discarded) fish and predation events on hooked fish by trip. The post-release mortality rate was estimated from a meta-analysis (Borenstein et al. 2009) of studies on Bluefin tuna recreational release mortality rates (Marcek and Graves 2014; Skomal et al. 2002; Stokesbury et al. 2011: Tracey et al. 2016). Total unseen mortality (#'s) is calculated as numbers released*mortality rate + predation events. For a complete description of the meta-analysis methodology, see Appendix 1.

RESULTS AND DISCUSSION

The recreational release mortality rate for generic PBF was estimated at 6% (95%CI 0-31%). The total annual estimated unseen recreational fishery kills (release* mortality + predation) ranged from 3 - 451 fish (Table 1). Unseen kills appear to be increasing in the most recent years, although the absolute numbers are very small (Figure 1). The percentage of unseen kills relative to US recreational landings also shows an increasing pattern in the most recent years, although the percentage remains low (Figure 2).

The increasing numbers is primarily due to increasing interaction with marine mammals, and is not evidence that restrictive management and increasing stock abundance is increasing discarding. Given the magnitude of these unseen kills, they are unlikely to have material consequence to the assessment.

Additional work may be necessary to reduce the uncertainty in the estimate of unseen kills. Uncertainly exists in the logbook estimates of releases and predation events as they self-reported. Additionally, there are no published estimates of recreational release mortality for PBF, instead we relied on direct observation of recreational release mortality from other species of Bluefin tunas. Tagging experts advised us that global Bluefin tuna studies rather than other species in the EPO likely provide a better measure of PBF post-release mortality. We also note that marine mammal predation on hooked fish is both a natural mortality event as well as a fishery event. We included those kills as fishing mortality because we considered the predation event occurring only because of the fishery interaction. Because there are no estimates of the size composition of these unseen kills, we recommend representing them by the size composition of the US recreational fishery. Despite these limitations, we believe that these estimates represent the majority of all US discards (Appendix 2) and are suitable for use in the stock assessment model.

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Table 1. Unseen mortality (#fish) by year and quarter.

Year	Qtr	released	Predation	Unseen mortality[1]
2000	1	37	0	2.22
2000	2	145	0	8.7
2000	3	40	0	2.4
2000	4	3	0	0.18
2001	1	7	0	0.42
2001	2	240	0	14.4
2001	3	191	26	37.46
2001	4	10	0	0.6
2002	1	0	0	0
2002	2	36	0	2.16
2002	3	131	27	34.86
2002	4	0	3	3
2003	1	0	0	0
2003	2	12	0	0.72
2003	3	368	24	46.08
2003	4	2	0	0.12
2004	1	0	0	0
2004	2	1	0	0.06
2004	3	19	48	49.14
2004	4	0	1	1
2005	1	0	0	0
2005	2	0	0	0
2005	3	30	2	3.8
2005	4	0	0	0
2006	1	0	3	3
2006	2	7	0	0.42
2006	3	16	2	2.96
2006	4	0	0	0
2007	1	0	0	0
2007	2	0	0	0
2007	3	1	3	3.06
2007	4	0	0	0
2008	1	35	0	2.1
2008	2	33	56	57.98
2008	3	23	53	54.38
2008	4	0	2	2
2009	1			0
2009	2	1	0	0.06
2009	3	6	8	8.36
2009	4	0	0	0
2010	1	0	0	0
2010	2	136	4	12.16
2010	3	14	33	33.84
2010	4	0	0	0
2011	1	0	0	0
2011	2	3	0	0.18
2011	3	73	11	15.38
2011	4	0	0	0
2012	1	0	0	0
2012	2	0	0	0
2012	3	144	22	30.64
2012	4	270	0	16.2
2013	1			0
2013	2	2	0	0.12
2013	3	194	44	55.64
2013	4	10	0	0.6
2014	1	0	9	9
2014	2	0	3	3
2014	3	329	91	110.74
2014	4	1	117	117.06
2015	1	0	13	13
2015	2	28	39	40.68
2015	3	125	286	293.5
2015	4	3	5	5.18
2016	1	0	0	0
2016	2	21	57	58.26
2016	3	34	243	245.04
2016	4	0	18	18
2017	1	0	0	0
2017	2	24	2	3.44
2017	3	23	315	316.38
2017	4	16	117	117.96
2018	1	3	3	3.18
2018	2	3	0	0.18
2018	3	6	374	374.36
2018	4	16	73	73.96
2019	1	1	0	0.06
2019	2	12	41	41.72
2019	3	32	43	44.92
2019	4	0	3	3

1. Estimates provided to the PBFWG data steward prior to Jan 1st 2020. Note that the assessment model inputs these as 000's of fish (#/1000).

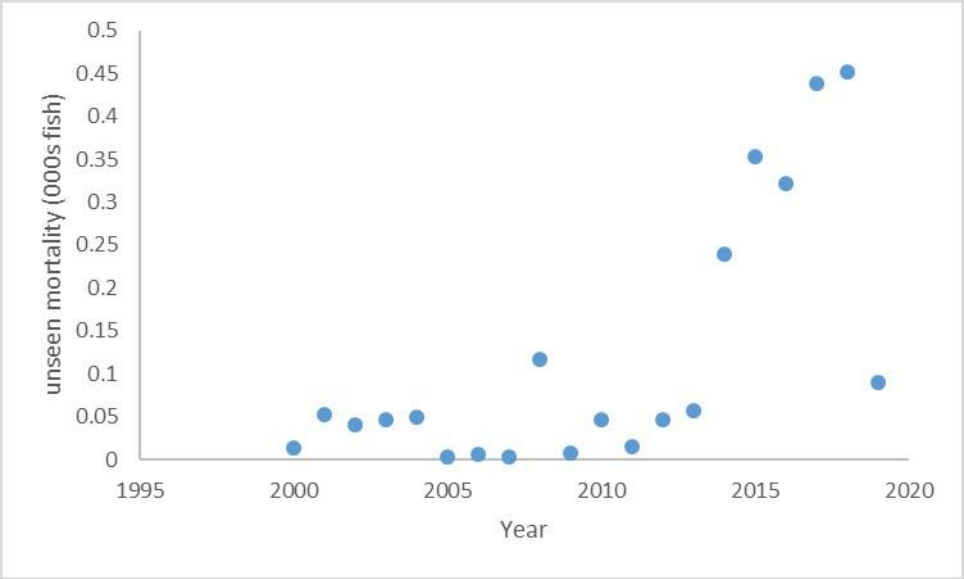

Figure 1. Annual estimates of unseen mortality in numbers of fish (000's fish).

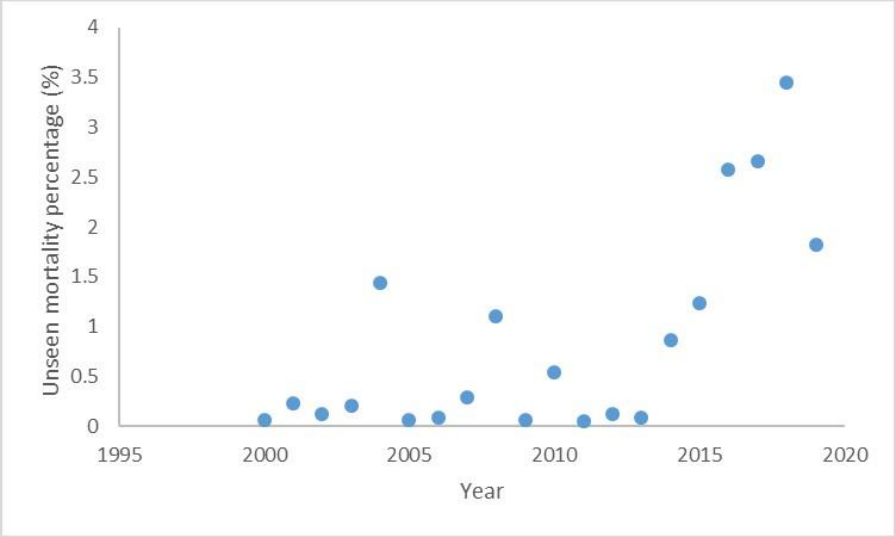

Figure 2. Annual unseen mortality expressed as a percentage of total recreational landings.

APPENDIX 1. Meta-analysis of recreational release mortality

We derived our recreational discard mortality rates and variance based on published observations of recreational discard mortality (Appendix Table A1.1). We chose only those studies with tagging based discard mortality for Bluefin tunas (Appendix Table A1.2). The final estimate of discard mortality was random effects inverse variance weighted mean across all methods (Table A1.2). The methods of estimation of the weighted mean are taken from Borenstein et al. (2009):

Total variance (Q) is:

$$Q = \sum w_i (X_i - \bar{X})^2$$

Where w_i is the 1/ within method variance and X_i is the method mean and $\bar{X}$ is the weighted mean across methods and i is an index of the methods.
The between methods variance (t) is:
if $Q>df$

$$t = (Q - df)/C$$

or, if $Q<df$ $t=0$
Where df is the number of methods -1 (8) and C is a scaling factor and w_i is inverse variance of the method (1/variance).

$$C = \sum w_i - \frac{\sum w_i}{\sum w_i}^2$$

The weight given to a method (w^*_i) is given by:

$$w_{i*} = 1/v_{i*}$$

Where v^*_i is the within component of total variance:

$$v_{i^*} = v_i + t$$

Where v_i is the within method variance.

The weighted mean is calculated as:

$$weighted\ mean^{(M)} = \sum w_i^* x_i / \sum w_{i^*}$$

The variance $(V)^*$ of the weighted *Mean (M)* is also given by (Borenstein et al. 2009):

$$V^* = 1/\sum w_{i^*}$$

We chose a random effect approach because no single study likely represents the U.S. West Coast recreational fleet. The estimate comes from a wide range of ocean basins, fishing methods, hook style and fish sizes. There is likely considerable variation among studies about how fish were handled prior to release. Treating each study as coming from a distribution of possible outcomes seemed more appropriate. The uncertainty in the estimate of release mortality (6%) is reflected in the wide Confidence Interval (0-31%).

Appendix Table A1.1. Post release tagging mortality studies and their characteristics.

Study[1]	species	location	bait	Hook	Size	year
Goldsmith et al.	Atlantic	E. Coast US	bait	J, treble	114-201cm	2015-16
Tracey et al.[2]	Southern	Tasmania, NSW	bait/lures	J, circle, treble	78-188cm	2012-14
Marcek and Graves	Atlantic	E. Coast US	bait/lures	J	69-119cm	2012
Stokesbury et al.	Atlantic	Canada	bait	circle	114-455kg	

1. To be considered for this analysis the study must have been conducted on a Bluefin tuna species, captured using recreational gear and postrelease mortality evaluated using direct observations (e.g. pop-up satellite tagging).
2. Study contains two estimates: one for J and circle hooks and a separate estimate for treble hooks. Those estimates were treated as separate studies.

Appendix Table A1.2. Study-specific estimates of discard mortality, variance, meta-analysis weight (w_i) and study sample size (n).

Study	Estimate	Variance	w_i	n
Goldsmith et al.	0.00	0.0673[1]	14.8511	15
Tracey et al.	0.17	0.1411	7.0872	54
Tracey et al.	0.40	0.2400	4.1667	5
Marcek and Graves	0.00	0.1900[1]	5.2632	19
Stokesbury et al.	0.03	0.0328	30.4470	59
	Weighted mean (M)	Variance (V*)		
	0.06	**0.0161**		

1. Variances were reported by authors as derived from boostrapping simulations (Goodyear 2002).

APPENDIX 2. Commercial catches and prospects for commercial catch discarding

Annual catches of PBF by US fisheries have been primarily from the Recreational fleets in the since 2013 (Appendix table A2.1). Commercial catches are overwhelmingly from purse seine operations that target PBF with limited incidental take by other coastal gears (e.g. gillnet etc). Targeting occurs sporadically do to a number of factors including: when oceanic conditions makes them available in US territorial waters, availability of coastal pelagic species and local market factors. PBF commercial catches are subject to domestic management limits set in accordance with IATTC resolutions. Annual US commercial catches generally do not come within 20% of annual limits (Appendix Table A2.1) and are at or below the biennial specifications. The only instance of attaining the biennial specification occurred in 2017-18 when 2017 catches exceeded the annual limit resulting in a smaller 2018 annual limit to meeting the biennial specification (for a full description of why the annual catch was exceeded see footnote below).

Currently there is no evidence of measurable discard in the commercial fleet and US regulations are designed to avoid discard of PBF. PBF are not a major commercial resource for US fleets resulting in relatively low commercial catches, which also limits the magnitude of potential discard. Recent biennial management specifications allows for overages, which is generally thought to reduce potential discarding. In addition, individual trip limits of <2mt are imposed as Commercial catches approach (within 50mt) the annual limit which eliminates PBF fishing by the purse seine fleet but allows for incidental catches to be retained by the other commercial gears (limiting discarding). Catch monitoring of the purse seine fleet is thought to be good as California Department of Fish and Wildlife (CDFW) monitors commercial PBF landings through in-season collection and tracking of landing receipts. CDFW updates NMFS daily based on landing receipt collections as catches approached the annual catch limit. Near real-time monitoring of catches is expected after a transition to electronic reporting in July 2018.

Footnote: Management response to the 2017 overage is described here
https://www.pcouncil.org/wpcontent/uploads/2017/09/J3a_Sup_Joint_CDFW_NMFS_Rpt1_Intl_SEPT2017BB.pdf

Table A2.1. Catches (mt) of PBF by commercial and recreational sectors. For commercial sectors the annual quota limit is given and the catches for those years. We report both the commercial catches from the ISC database and those used by NOAA Region to manage the resource. For comparison the annual US recreational catches (ISC database) are also given.

year	Limit[2]	Commercial ISC database (mt)	Commercial management (mt)	Recreational ISC database (mt)
2020	356 mt	NP[1]	0	0
2019	425 mt	NP[1]	270	NP[1]
2018	114 mt	61.4	55.9	809
2017	425 mt	487.3	486	420
2016	425 mt	356.3	350.2	399
2015	425 mt	98.4	96.1	368
2014	500 mt	408	404	450
2013	500 mt	11	6	484

1 not yet produced for the ISC catch tables

2. A real-time update of this information and links to descriptions of domestic fishery rules (FR) corresponding to IATTC resolutions can be found at: https://www.fisheries.noaa.gov/west-coast/sustainable-fisheries/pacific-bluefin-tuna-commercial-harvest-status