Catch-and-Release Recreational Angling Mortality of Bluefish (*Pomatomus saltatrix*): Updated Analysis for 2022

Jessica Valenti
National Science Foundation Postdoctoral Fellow
Rutgers University Affiliate
National Oceanic and Atmospheric Administration Affiliate
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Abstract

Estimating recreational catch-and-release mortality of bluefish (*Pomatomus saltatrix*) is an important component in the stock assessment process given the popularity of catch-and-release angling in this fishery and the direct influence of release mortality on the total allowable catch. The objectives of this study were to update the literature reviews and meta-analysis completed for the 60th Stock Assessment Workshop (SAW) in 2015 and to re-assess the appropriateness of the 15% bluefish recreational release mortality estimate used in bluefish assessments since 1997. Two systematic literature reviews were performed to determine if any additional bluefish-specific catch-and-release angling mortality papers had been published since SAW 60 and to determine if any additional catch-and-release angling mortality review papers had been published since SAW 60. From the literature reviews, no additional bluefish-specific release mortality papers were discovered, and one additional release mortality review paper was discovered. Eleven exclusion criteria were applied to each bluefish-specific study and each study within the literature tables of the review papers to determine which studies were suitable for inclusion in the analyses. Three bluefish-specific studies passed the exclusion criteria. The individual mortality estimates from these three studies were used to calculate the mean (± standard error) bluefish-specific release mortality estimate, which was 9.4% ± 0.6%. From the review paper literature tables, 19 studies passed the exclusion criteria. The 22 individual mortality estimates from these 19 studies were used to calculate the mean (± standard error) meta-analysis release mortality estimate, which was 9.7% ± 1.9%. The Working Group approved the bluefish-specific release mortality estimate of 9.4% for use in the 2022 assessment.

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Introduction

Catch-and-release angling is popular in the recreational bluefish (*Pomatomus saltatrix*) fishery. The weight of bluefish caught and released annually (i.e. discarded) has exceeded 50% of the total annual recreational landings in most years since 1998 (Northeast Fisheries Science Center 2020). Estimating recreational release mortality of bluefish is an important component in the stock assessment process as it directly influences the total allowable catch. During the 18th Stock Assessment Workshop (SAW) in 1994, recreational release mortality for bluefish was estimated to be 25% (Northeast Fisheries Science Center 1994). Since the 23rd SAW in 1997, a 15% recreational release mortality estimate has been used for bluefish (Northeast Fisheries Science Center 1997). For the 60th SAW held in 2015, an extensive literature review and meta-analysis of release mortality estimates was undertaken to assess the appropriateness of the 15% bluefish recreational release mortality estimate (see the Gottschall 2015 working paper for more details). Based on the literature review and meta-analysis, the 15% estimate was accepted by the SAW 60 Working Group and Bluefish Technical Committee (Northeast Fisheries Science Center 2015).

The objectives of this study were to update the literature review and meta-analysis completed for SAW 60 and to re-assess the appropriateness of the 15% bluefish recreational release mortality estimate. The specific objectives were to:

1. Perform a literature review to determine if any additional bluefish-specific catch-and-release angling mortality papers had been published since SAW 60
2. Perform a literature review to determine if any additional catch-and-release angling mortality review papers had been published since SAW 60
3. Update the analyses from SAW 60

Methods

Literature Reviews

Systematic review guidelines and reporting standards provided by the Collaboration for the Environmental Evidence (CEE) were followed during the literature review process where applicable (Collaboration for the Environmental Evidence 2018). The basic steps in conducting a CEE review start with developing a question the review should answer (Figure 1). The question driving both of the literature reviews in this study was:

"What is the bluefish catch-and-release angling mortality rate?"

The next step was to develop a search protocol for the literature reviews including what databases to search, what search terms to use, what sections of the literature to search, and the literature screening criteria. For both literature reviews, three main databases (Web of Science, Scopus, and ProQuest Dissertations and Theses) were searched via access through the Rutgers University Libraries. Web of Science includes journals, books, proceedings, reports, and other formats of information. Available records started in 1864. Access to this database included the

Web of Science Core Collection, which is comprised of ten databases that have over 20,000 journals and over 1 billion cited references, and ten additional regional and subject specific databases (Rutgers University Libraries 2022a). Scopus includes journals, book series, conference proceedings, trade publications, and patents starting in 1823. This database has over 75 million items, including articles from greater than 24,000 journals by over 5,000 international publishers (Rutgers University Libraries 2022b). ProQuest Dissertations and Theses includes international dissertations and theses beginning in 1637 and U.S. dissertations and theses beginning in 1861 (the year the first doctoral dissertation was accepted at a U.S. institution) (Rutgers University Libraries 2022c).

The search terms used for the literature review targeting bluefish-specific recreational release mortality papers (Review 1) were:

((“Pomatomus saltatrix” OR “bluefish”) AND (“mortalit*” OR “surviv*”))

The asterisks after words in the search string tell the system to search for all forms of that word, so for example, “mortalit*” should find literature with “mortality” or “mortalities” creating a more inclusive search. The search terms used for the literature review targeting recreational release mortality review papers (Review 2) were:

((“review” OR “synthes*” OR “analys*”) AND (“mortalit*” OR “surviv*”) AND (“recreation*”) AND (“releas*” OR “angl*” OR “hook*”))

Both reviews were implemented in all Web of Science databases and collections, and the “Topic” was searched (using the provided search terms) which includes the title, abstract, author keywords, and Keywords Plus (search date: 1/29/22). In Scopus, for both reviews, the article title, abstract, and keywords were searched using the provided search terms (search date: 1/29/22). For the ProQuest Dissertations and Theses database, both reviews searched for the provided terms “anywhere except full text – NOFT” (search date: 2/2/22).

The results of the respective literature reviews were exported and combined into two separate spreadsheets. Duplicate records were removed and the abstracts and titles from the remaining records were screened. Records from Review 1 were excluded if they were clearly not a bluefish catch-and-release mortality study or if they were already included in the SAW 60 analysis. Records from Review 2 were excluded if they were clearly not a review of catch-and-release mortality studies or if they were already included in the SAW 60 analysis. The records that passed the initial screening process went through full text screening for a final determination of their relevance to the initial question driving the literature reviews. The results of the screening process were documented using the ROSES Flow Diagram for Systematic Reviews (Haddaway et al. 2018).

Release Mortality Estimates

For SAW 60, the literature tables within the catch-and-release angling mortality review papers were used to find relevant studies for the meta-analysis (Gottschall 2015). For this updated meta-analysis, the review papers were used in the same manner, but a formal list of

exclusion criteria were established (based on thoughts from SAW 60) to explicitly guide decisions on whether papers should be included or excluded (see Appendix 1 for exclusion criteria). The same exclusion criteria were applied to the bluefish-specific papers to ensure all studies used in the updated analyses were held to the same standards.

An overall mortality estimate (i.e. total number of fish that died/total number of fish in the study) was calculated (or verified if it was provided) for each study that passed the exclusion criteria, which differed from the SAW 60 method of using multiple mortality estimates from the same study if they were provided. The overall release mortality estimates from each study were used to compute two unweighted mean release mortality estimates: one based solely on the bluefish-specific studies and one based solely on the meta-analysis studies. The source spreadsheet listing all the considered studies and final calculations for both mean mortality estimates is available on the Bluefish Working Group's Google Drive.

Results

Review 1: Bluefish-Specific Literature Search

For Review 1, a total of 225 records were identified from the literature search (Figure 2). After the 57 duplicate records were removed, 168 records went through the abstract and title screening process. Seventeen records remained after the initial screening process and underwent full text screening. After full text screening, Review 1 found zero bluefish-specific recreational release mortality papers that were not already included in SAW 60 (Figure 2).

The bluefish-specific release mortality papers that were included in the SAW 60 analysis are listed in Table 1. Three of those five papers (Malchoff 1995; Williams 1995; Broadhurst et al. 2012) passed the exclusion criteria (Appendix 1) and were included in the updated analysis (Table 1). The three studies encompassed a range of variables (e.g. fish lengths, hook types, handling methods, etc.) encountered in the recreational bluefish fishery (Table 2). The individual mortality estimates from these three studies (which are listed in Table 1) were used to calculate the mean (± standard error) bluefish-specific release mortality estimate, which was 9.4% ± 0.6% (Table 3).

Review 2: Review Paper Literature Search

For Review 2, a total of 660 records were identified from the literature search (Figure 3). After the 145 duplicate records were removed, 515 records went through the abstract and title screening process. Twenty-nine records remained after the initial screening process and underwent full text screening. After full text screening, Review 2 found one additional catch-and-release angling mortality review paper that was not included in SAW 60 (Figure 3).

The two review papers that were included in the SAW 60 analysis (Muoneke and Childress 1994; Bartholomew and Bohnsack 2005) and the additional review paper identified through the 2022 literature review (Cooke and Suski 2004) are listed in Table 4. Within the review papers, the literature tables used for the meta-analysis were Table 1 in Muoneke and Childress 1994, Table 1 in Cooke and Suski 2004, and Appendix A in Bartholomew and Bohnsack 2005. From the literature tables, 19 studies passed the exclusion criteria (Appendix 1)

and were included in the updated meta-analysis (Table 5). The studies encompassed a range of variables (e.g. fish lengths, hook types, handling methods, etc.) encountered in the recreational bluefish fishery (Table 6). The 22 individual mortality estimates from these 19 studies (which are listed in Table 5) were used to calculate the mean (± standard error) meta-analysis release mortality estimate, which was 9.7% ± 1.9% (Table 3). Certain studies focused on more than one relevant species and therefore had multiple individual release mortality estimates.

Working Group Decision

The Working Group discussed whether the bluefish-specific release mortality estimate (9.4%), the meta-analysis release mortality estimate (9.7%), or an average of the two prior estimates (9.6%) was most appropriate for use in the 2022 updated assessment. The majority of the Working Group favored the bluefish-specific release mortality estimate of 9.4%, so this was the estimate approved for use in the 2022 assessment.

Discussion

The bluefish-specific literature search and the review paper literature search resulted in nearly identical catch-and-release mean mortality estimates of 9.4% and 9.7%, respectively. The closeness of these two estimates supported the decision by the Working Group to use the bluefish-specific release mortality estimate (9.4%) in the 2022 assessment. Although estimates used in other species assessments are generally whole numbers, the Working Group elected not to round the calculated release mortality estimate to a whole number since there is no requirement to do so and since precedent was set for using a real number by the tautog (*Tautoga onitis*) assessment (Table 7).

Contrary to the SAW 60 analyses, the 2022 Working Group elected to use only one overall mortality estimate from each study because using multiple release mortality estimates from a single study could bias the calculated mean mortality estimate towards those studies with multiple estimates. Additionally, the calculated mean mortality estimates were unweighted since there was no justifiable or objective reason to give more or less weight to certain studies' mortality estimates (e.g. a study with a large sample size does not guarantee a "better" release mortality estimate than a study with a small sample size).

The studies included in the bluefish-specific release mortality estimate and the meta-analysis release mortality estimate encompassed a wide range of study variables (e.g. fish lengths, hook types, handling methods, etc.). The inclusion of a wide range of study variables ensures the release mortality estimates calculated from these studies are representative of the diversity of angling strategies and catch-and-release scenarios that likely take place in the recreational bluefish fishery. Although there was interest in calculating separate release mortality estimates for subgroups within study variables (e.g. adults versus juveniles, etc.), the Working Group felt there was insufficient data to do so.

Ayvazian et al. 2002 and Fabrizio et al. 2008 were the two bluefish-specific studies included in SAW 60 that were excluded from the updated 2022 analysis. Ayvazian et al. 2002 was excluded due to the short holding and observation time (2 hours) of the hooked fish. Studies with observation times shorter than 24 hours are unlikely to capture delayed release mortality

and could provide biased release mortality estimates. Fabrizio et al. 2008 was excluded because there was mention of study factors that may have severely confounded the reported release mortality estimate (e.g. abrasions on fish, fish with external infections, long transport of fish possibly without adequate space/oxygenation, etc.). As such, the reported release mortality estimate may have been heavily influenced by those study factors, which could have inappropriately biased the resulting bluefish-specific mean release mortality estimate. For details on why studies were excluded from the meta-analysis release mortality estimate, see the source spreadsheet available on the Bluefish Working Group's Google Drive.

Future updates to this analysis could include (1) repeating the above literature searches to find any new bluefish-specific papers or review recreational release mortality papers and incorporating the studies into the analyses if they pass the exclusion criteria, (2) tracking down studies from the review papers' literature tables that were not found during the 2022 update, but that may provide additional release mortality estimates for the meta-analysis, (3) searching additional databases for bluefish-specific and review recreational release mortality papers, and (4) expanding the meta-analysis to include non-bluefish recreational release mortality studies that were not listed in a review paper literature table.

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Figures

Figure 1

The basic steps in conducting a Collaboration for Environmental Evidence (CEE) systematic review (figure extracted from CEE 2013). The peer review by CEE staff steps were omitted in this study since the reviews are not being published in peer-reviewed journals and the Working Group provided feedback on the reviews throughout the process.

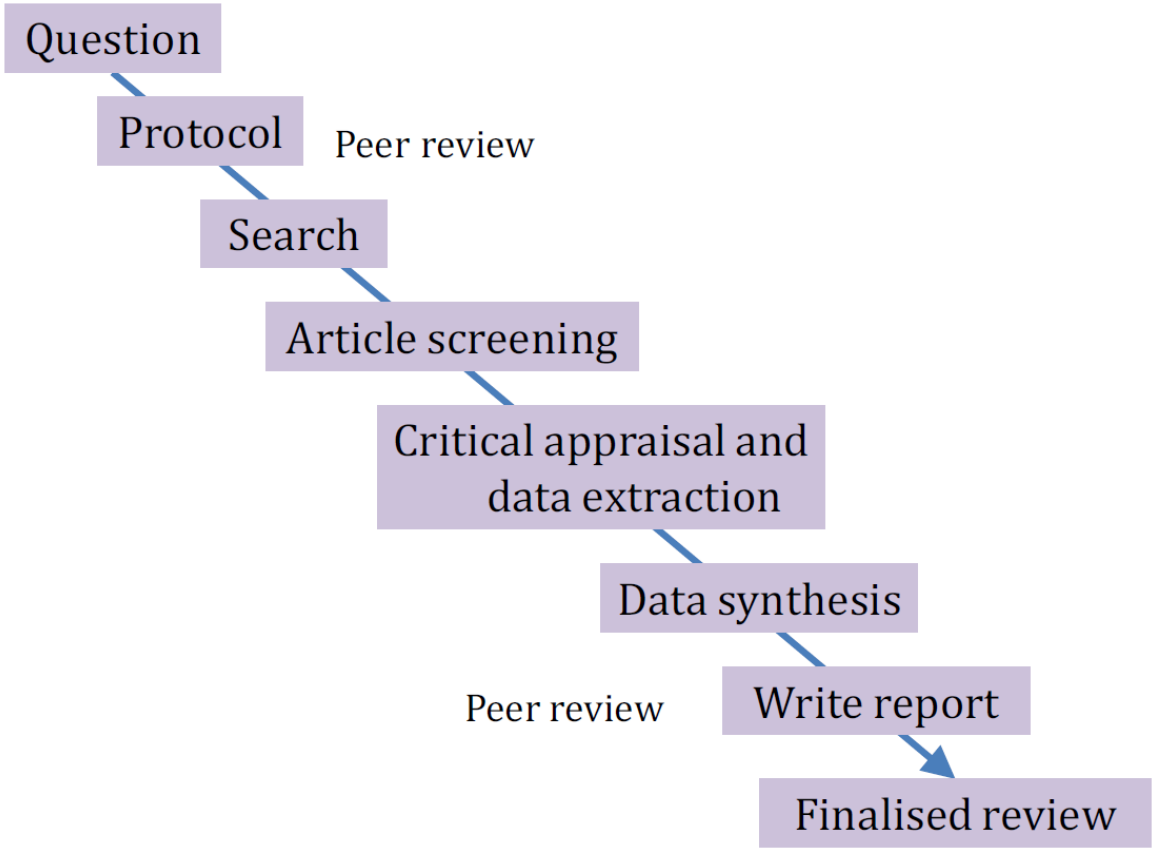


Figure 2

Results of the bluefish-specific literature search and screening process (Review 1). Template provided by Haddaway et al. 2018.

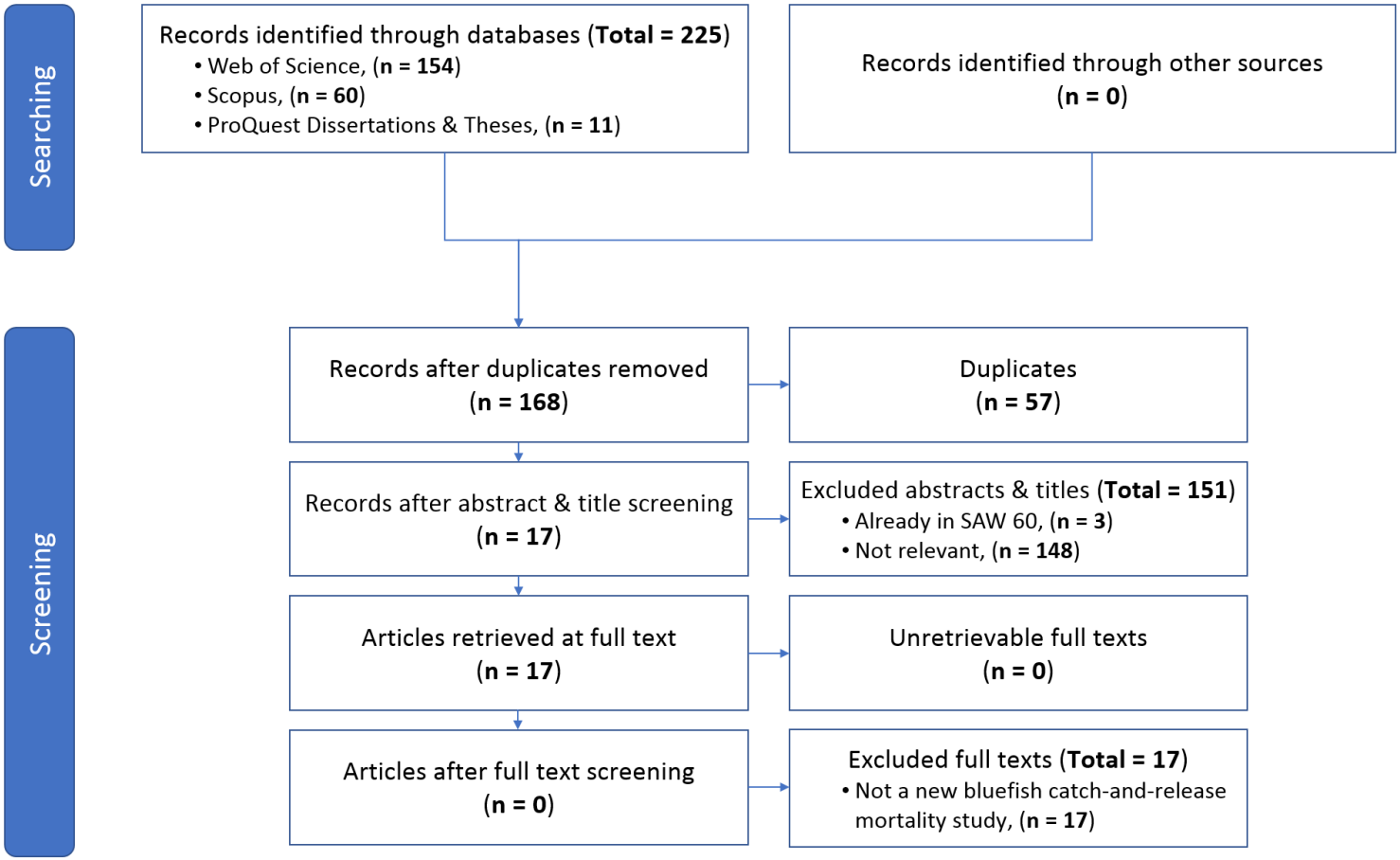
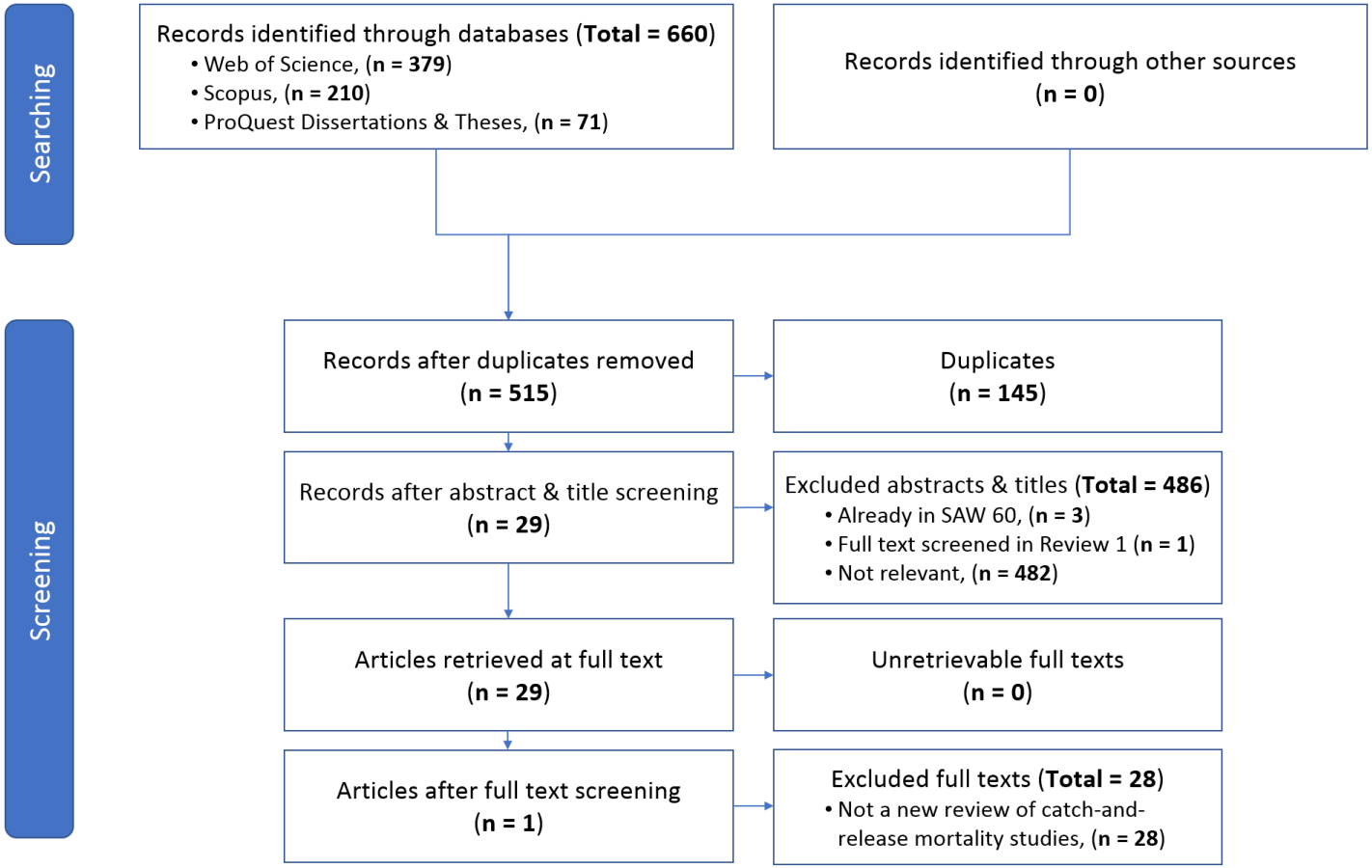


Figure 3

Results of the review paper literature search and screening process (Review 2). Template provided by Haddaway et al. 2018.



Tables

Table 1

Bluefish-specific release mortality studies that were included in the SAW 60 analysis and the 2022 updated analysis.

Study	Release Mortality Estimate (%)	Included in SAW 60	Included in 2022 Update	Reason for Excluding Study in 2022 Update
Ayvazian et al. 2002	3.0	Yes	No	The fish were not held and observed for at least 24 hours
Broadhurst et al. 2012	8.2	Yes	Yes	N/A
Fabrizio et al. 2008	38.8	Yes	No	Study factors may have confounded the mortality estimate
Malchoff 1995	10.3	Yes	Yes	N/A
Williams 1995	9.7	Yes	Yes	N/A

Table 2

Summary of the study variables used in the three bluefish-specific studies included in the 2022 updated analysis (Malchoff 1995; Williams 1995; Broadhurst et al. 2012). For numeric variables (e.g. salinity, etc.), observed ranges are listed. Only results reported by the studies could be included. The number of studies that provided results for each study variable is listed in the last column. For example, the "3" in the last column of the "Hook Type" study variable does not mean all three studies used barbed, barbless, single, and treble, hooks. It means that between the three studies, those hook types were the only ones used.

Study Variable	**Summary/Range of Results**	**Number of Studies that provided Results**
Species Name	• Bluefish (*Pomatomus saltatrix*)	3
Number of Fish Observed	• 85 – 481	3
Observation Period (days)	• 3 – 10	3
Salinity (ppt)	• 22 – 28	1
Temperature (°C)	• 14 – 26	3
Water Depth (m)	• Not reported	0
Fish Size (cm)	• 14 – 76 FL	2
Hook Type	• Barbed • Barbless • Single • Treble	3
Bait Type	• Artificial bait • Artificial lures • Natural bait (dead)	3
Were Any Fish Deep Hooked?	• Yes • No	2
Were All Hooks Removed?	• No	2
Anatomical Hooking Site	• Esophagus • Eye • Gill • Jaw • Junction of mandible and maxillary • Lip • Mouth	2
Bleeding/Wounds	• Bleeding • Eye damage • Fin damage • Gill damage • Jaw damage • Mouth damage	2

Study Variable	Summary/Range of Results	Number of Studies that provided Results
	• Scale loss	
Handling	• Playing/landing times: less than 15 seconds to 8 minutes • Air exposure/handling times: less than 15 seconds to greater than 60 seconds • Handled with dry hands, wet hands, towels • Some were unhooked with de-hookers • Some were dropped, hit the boat, hit the ground	3
Angler Description	• Local fishing club members • Volunteers	2
Angler Experience	• Not reported	0
Method of Fishing	• Boat (party, private charter, private vessel) • Shore (surf beaches, rocks)	3

Table 3

Mean release mortality estimates from the 2022 updated analyses. In the review paper meta-analysis, some studies focused on more than one relevant species and therefore had multiple individual release mortality estimates.

Analysis	**# of Studies / # of Individual Mortality Estimates**	**Mean Mortality Estimate (%) ± Standard Error**
Bluefish-Specific	3 studies / 3 estimates	9.4 ± 0.6
Review Paper Meta-Analysis	19 studies / 22 estimates	9.7 ± 1.9

Table 4

Review studies that were included in the SAW 60 meta-analysis and the 2022 updated meta-analysis.

Study	**Included in SAW 60**	**Included in 2022 Update**	**Notes**
Bartholomew and Bohnsack 2005	Yes	Yes	N/A
Cooke and Suski 2004	No	Yes	Paper found during 2022 literature review
Muoneke and Childress 1994	Yes	Yes	N/A

Table 5

Studies from the review paper literature tables that were included in the updated meta-analysis. Studies with an asterisk were deemed suitable alternatives to the studies cited in the review papers (e.g. if a paper was cited as being in press, the published version was used here). Certain studies focused on more than one relevant species and therefore had multiple release mortality estimates.

Study	**Review Study Found In**	**Study Species**	**Release Mortality Estimate (%)**
Aalbers et al. 2004*	Cooke and Suski 2004	White seabass (*Atractoscion nobilis*)	10.0
Aguilar 2003*	Cooke and Suski 2004	Red drum (*Sciaenops ocellatus*)	6.7
Albin and Karpov 1998	Bartholomew & Bohnsack 2005	Lingcod (*Ophiodon elongatus*)	3.6
Bugley and Shepherd 1991	Muoneke and Childress 1994	Black seabass (*Centropristis striata*)	4.7
Carbines 1999	Bartholomew & Bohnsack 2005	Blue cod (*Parapercis colias*)	12.5
Caruso 2000	Cooke and Suski 2004	Striped bass (*Morone saxatilis*)	9.3
Collins et al. 1999	Bartholomew & Bohnsack 2005	Black seabass (*Centropristis striata*) Vermilion snapper (*Rhomboplites aurorubens*)	9.5 9.2
Diggles and Ernst 1997	Bartholomew & Bohnsack 2005	Yellow stripey (*Lutjanus carponotatus*)	2.2
Diodati and Richards 1996	Bartholomew & Bohnsack 2005	Striped bass (*Morone saxatilis*)	8.7
Duffy 2002	Bartholomew & Bohnsack 2005	Red drum (*Sciaenops ocellatus*) Spotted seatrout (*Cynoscion nebulosus*)	6.3 13.3
Gitschlag and Renaud 1994	Bartholomew & Bohnsack 2005	Red snapper (*Lutjanus campechanus*)	36.0
Jordan and Woodward 1992*	Muoneke and Childress 1994	Red drum (*Sciaenops ocellatus*)	17.0
Lucy and Arendt 2002	Bartholomew & Bohnsack 2005	Tautog (*Tautoga onitis*)	1.7
Malchoff and Heins 1997	Bartholomew & Bohnsack 2005	Weakfish (*Cynoscion regalis*)	3.3
Malchoff et al. 2002	Bartholomew & Bohnsack 2005	Summer flounder (*Paralichthys dentatus*)	9.5
Matlock and Dailey 1981	Muoneke and Childress 1994	Spotted seatrout (*Cynoscion nebulosus*)	31.9
Matlock et al. 1993	Muoneke and Childress 1994	Red drum (*Sciaenops ocellatus*) Spotted seatrout (*Cynoscion nebulosus*)	4.1 7.3
Murphy et al. 1995	Bartholomew & Bohnsack 2005	Spotted seatrout (*Cynoscion nebulosus*)	4.6
Taylor et al. 2001	Bartholomew & Bohnsack 2005	Common snook (*Centropomus undecimalis*)	2.1

Table 6

Summary of the study variables used in the 19 studies included in the updated meta-analysis (see Table 5 for the list of studies). For numeric variables (e.g. salinity, etc.), observed ranges are listed. Only results reported by the studies could be included. The number of studies that provided results for each study variable is listed in the last column. For example, the "18" in the last column of the "Hook Type" study variable does not mean all 18 studies used barbed, barbless, single, double, and treble, hooks. It means that between the 18 studies, those hook types were the only ones used.

Study Variable	**Summary/Range of Results**	**Number of Studies that provided Results**
Species Name	• Black seabass (*Centropristis striata*) • Blue cod (*Parapercis colias*) • Common snook (*Centropomus undecimalis*) • Lingcod (*Ophiodon elongatus*) • Red drum (*Sciaenops ocellatus*) • Red snapper (*Lutjanus campechanus*) • Spotted seatrout (*Cynoscion nebulosus*) • Striped bass (*Morone saxatilis*) • Summer flounder (*Paralichthys dentatus*) • Tautog (*Tautoga onitis*) • Vermilion snapper (*Rhomboplites aurorubens*) • Weakfish (*Cynoscion regalis*) • White seabass (*Atractoscion nobilis*) • Yellow stripey (*Lutjanus carponotatus*)	19
Number of Fish Observed	• 47 – 1,145	19
Observation Period (days)	• 1 – 130	19
Salinity (ppt)	• 10 – 38	8
Temperature (°C)	• 13.3 – 38	14
Water Depth (m)	• 1 – 55	8
Fish Size (cm)	• 16 – 125 FL	18
Hook Type	• Barbed • Barbless • Single (J, offset circle, non-offset circle) • Double • Treble	18
Bait Type	• Artificial bait • Artificial lures	18

Study Variable	Summary/Range of Results	Number of Studies that provided Results
	• Natural bait (live, dead)	
Were Any Fish Deep Hooked?	• Yes	12
Were All Hooks Removed?	• Yes • No	13
Anatomical Hooking Site	• Body • Esophagus • Eye • Fins • Gill • Gut • Head • Heart • Jaw • Junction of mandible and maxillary • Lip • Mouth • Operculum • Pharyngeal teeth • Snout • Stomach • Tongue	14
Bleeding/Wounds	• Bleeding • Body damage • Esophagus damage • Eye damage • Gill damage • Hardened tissue • Heart damage • Hyperbaric trauma • Inability to breathe • Intestine damage • Kidney damage • Liver damage • Mouth damage • Scale damage • Seawater in coelomic cavity • Stomach damage • Swimming issues	13

Study Variable	Summary/Range of Results	Number of Studies that provided Results
Handling	• Some were allowed to hold bait for 5-7 seconds before the hook was set • Playing/landing times: less than 20 seconds – 10.3 minutes • Landed with dip net, nylon net, no net • Air exposure/handling times: less than 1 minute to 7.12 minutes • Supported by holding the body, lip, over eyes, operculum • Unhooked by force, hand, hemostats, needle-nose pliers • Handled with bare hands, rubber gloves, wet spun-nylon gloves, wet cotton gloves, no special care • Some were: kept out of direct light, kept in direct light • Some were: dropped on the boat deck or concrete pier surface • Some were: tossed, slipped, thrown, or dropped back into the water, placed quickly and gently back into the water, never removed from the water, resuscitated when needed	14
Angler Description	• Commercial fishermen • Local fishing club members • Researchers and laboratory personnel • State biologists and personnel • Volunteers	9
Angler Experience	• Expert • Experienced • Average • Less experienced • Novice	11
Method of Fishing	• Boat (charter, research vessel) • Shore (piers)	14

Table 7

Release mortality estimates used in recreational-heavy species assessments other than bluefish (*Pomatomus saltatrix*).

Species	Release Mortality Estimate Used (%)	Year	Source
Tautog (*Tautoga onitis*)	2.5	2021	Atlantic States Marine Fisheries Commission 2021
Black drum (*Pogonias cromis*)	8	2015	Atlantic States Marine Fisheries Commission 2015a
Red drum (*Sciaenops ocellatus*)	8	2022	Atlantic States Marine Fisheries Commission 2022
Striped bass (*Morone saxatilis*)	9	2018	Northeast Fisheries Science Center 2019
Atlantic croaker (*Micropogonias undulatus*)	10	2010	Atlantic States Marine Fisheries Commission 2010
Summer flounder (*Paralichthys dentatus*)	10	2018	Northeast Fisheries Science Center 2019
Weakfish (*Cynoscion regalis*)	10	2019	Atlantic States Marine Fisheries Commission 2019
Black seabass (*Centropristis striata*)	15	2018	Northeast Fisheries Science Center 2020
Scup (*Stenotomus chrysops*)	15	2015	Atlantic States Marine Fisheries Commission 2015b

Appendix 1

Exclusion criteria for the bluefish-specific studies and for the studies listed in the literature tables within the catch-and-release angling mortality review papers.

Notes (read before proceeding to exclusion criteria):

1. A whole study does not need to be excluded if the data from that study that do not meet the exclusion criteria can be separated from the data that do meet the criteria. For example:
    a. In a study, if test fish were hooked but control fish were not hooked, as long as the control data can be removed from the calculation of overall release mortality the whole study does not need to be excluded
    b. If there is more than one species in a study and one meets the exclusion criteria and the other does not, the whole study does not need to be excluded, just the data for the species that does not meet the exclusion criteria
    c. If multiple sampling locations were used in a study and some meet the salinity criteria and others do not, the whole study does not need to be excluded if the data for the sampling locations that do not meet the salinity criteria can be excluded from the calculation of overall release mortality
2. Release mortality studies on species not found along the U.S. east coast are permitted for inclusion, but like all other studies, they should be reviewed on a case-by-case basis to ensure compliance with the exclusion criteria

Exclude if:

1. A physical copy of the study or a suitable alternative (e.g. different paper by the same author or group using the same data, etc.) could not be obtained

    Justification: A physical copy of the study is needed to accurately implement the exclusion criteria

2. An overall release mortality estimate (i.e. total number of fish that died/total number of fish in the study) was not provided or could not be calculated using data in the study

    Justification: Without this metric, a study is not directly comparable to other studies. Use of a different metric, even if only for a few studies, could inappropriately bias results. Further, using multiple release mortality estimates from a single study will bias the resulting mean mortality estimate towards those studies with multiple estimates.

3. The data were already included in another estimate of release mortality. That is, do not include the same data more than once (e.g. a conference abstract and a published paper with the same data should only be used once)

   Justification: Duplication of data would bias results toward the study with duplicated data

4. The fish were not held and observed for at least 24 hours

   Justification: Studies with observation times shorter than 24 hours are insufficient in capturing delayed release mortality and could provide biased release mortality estimates

5. The release mortality estimate was not based on observed mortality (i.e. exclude release mortality estimates based on hooking location, ability for the fish to swim down easily, tagging/recapture rates, etc.)

   Justification: Release mortality studies that are not based on observed mortality are reporting assumed mortality based on other factors. Assumed mortality estimates are inherently more biased than observed mortality estimates, and the two estimation methods are not directly comparable, so inclusion of assumed mortality data would be inappropriate

6. The mortality data are for fish that were caught with methods other than hooking (i.e. exclude those that were caught with nets, electrofishing, etc.)

   Justification: In the recreational fishery, most bluefish are caught with a traditional hook and line (rod and reel) (Mid-Atlantic Fishery Management Council 2022). Other collection methods (e.g. nets, electrofishing, etc.) are not well represented in the recreational fishery, so inclusion of data from these collection methods would be inappropriate

7. The study was commercial fishing focused or used commercial fishing gear (e.g. longlines, trotlines, trawls, etc.)

   Justification: This analysis is focused on recreational release mortality. In the recreational fishery, most bluefish are caught with a traditional hook and line (rod and reel) (Mid-Atlantic Fishery Management Council 2022). Other collection methods (e.g. longlines, trotlines, trawls, etc.) are not well represented in the recreational fishery. Inclusion of data from commercial fishing studies or those using commercial fishing gear would be unsuitable for the goals of this analysis

8. Salinity less than 10 ppt was recorded during the study. If it is not clear if the study was conducted in water less than 10 ppt it should be excluded (e.g. if the salinity range or

specific sampling location were not reported in a study about a species that often uses less saline waters [e.g. striped bass, red drum, etc.] it should be excluded)

Justification: Salinity is known to influence release mortality (Muoneke and Childress 1994). Bluefish prefer the polyhaline portions of estuaries, but have occasionally been observed in mesohaline environments (Shepherd and Packer 2006; Grothues and Able 2007). They are rarely observed in oligohaline environments (Shepherd and Packer 2006; Able et al. 2009). As such, the Bluefish Technical Committee indicated release mortality estimates from low salinity studies may be inappropriate for inclusion in the analysis (Gottschall 2015). Anything less than 10 ppt was excluded from the SAW 60 analysis (personal communication with K. Gottschall)

9. The release mortality estimate is for salmonids or freshwater species

   Justification: Salinity is known to influence release mortality (Muoneke and Childress 1994). Bluefish prefer the polyhaline portions of estuaries, but have occasionally been observed in mesohaline environments (Shepherd and Packer 2006; Grothues and Able 2007). They are rarely observed in oligohaline environments (Shepherd and Packer 2006; Able et al. 2009). As such, the Bluefish Technical Committee indicated release mortality estimates for salmonids and freshwater species may be inappropriate for inclusion in the analysis (Gottschall 2015)

10. The release mortality estimate is for tunas, billfish, or groupers

    Justification: The recreational fisheries for tunas, billfish, and groupers differ from bluefish (National Marine Fisheries Service 2021; South Atlantic Fishery Management Council 2022), and many species in these groups have unique life history parameters bluefish do not share (International Commission for the Conservation of Atlantic Tunas 2016; South Atlantic Fishery Management Council 2022). As such, the Bluefish Technical Committee indicated release mortality estimates for tunas, billfish, and groupers may be inappropriate for inclusion in the analysis (Gottschall 2015)

11. There was mention of study factors that may have severely confounded the reported release mortality estimate (e.g. abrasions on fish, fish with infections, parasites present in/on fish, transport of fish without adequate space/oxygenation, etc.)

    Justification: The reported release mortality estimate may be heavily influenced by those study factors, which could inappropriately bias the results