

2013

Factors of Different Management of Northern Atlantic Bluefin Tuna (*Thunnus Thynnus*)

Patrick Samuel
University of Rhode Island, pjsamuel@my.uri.edu

Follow this and additional works at: <https://digitalcommons.uri.edu/theses>

Terms of Use

All rights reserved under copyright.

Recommended Citation

Samuel, Patrick, "Factors of Different Management of Northern Atlantic Bluefin Tuna (*Thunnus Thynnus*)" (2013). *Open Access Master's Theses*. Paper 40.
<https://digitalcommons.uri.edu/theses/40>

This Thesis is brought to you by the University of Rhode Island. It has been accepted for inclusion in Open Access Master's Theses by an authorized administrator of DigitalCommons@URI. For more information, please contact digitalcommons-group@uri.edu. For permission to reuse copyrighted content, contact the author directly.

FACTORS OF DIFFERENT MANAGEMENT OF NORTHERN ATLANTIC
BLUEFIN TUNA (*THUNNUS THYNNUS*)

BY
PATRICK SAMUEL

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS
IN
MARINE AFFAIRS

UNIVERSITY OF RHODE ISLAND

2013

MASTER OF ARTS THESIS

OF

PATRICK SAMUEL

APPROVED:

Thesis Committee:

Major Professor Seth Macinko

Michael Rice

Richard Burroughs

Nasser H. Zawia

DEAN OF THE GRADUATE SCHOOL

UNIVERSITY OF RHODE ISLAND

2013

Abstract

The International Commission for the Conservation of Atlantic Tunas (ICCAT) is a regional fisheries management organization (RFMO) comprised of over fifty cooperating states and fishing entities. It manages Northern Atlantic bluefin tuna (*Thunnus thynnus*) in the Atlantic Ocean and Mediterranean Sea. Due to overfishing and ineffective management, the stock abundance of this species has declined to about thirty percent of its unfished biomass in the Atlantic Ocean and Mediterranean Sea. Publications point to this poor stock status as evidence of a fisheries management failure; it is commonly repeated that ICCAT's mismanagement of the resource amounts to an international disgrace. To maintain bluefin tuna stocks at a level that can support maximum sustainable yield (MSY), ICCAT has implemented unique tools to manage this important fishery, which include Total Allowable Catch (TAC) limits, tuna ranching control measures, catch documentation, and others that are not employed in other ICCAT fisheries.

In this thesis research, I examine the factors that contribute to the tools utilized to manage the fishery in the ICCAT Convention Area to shed light on why they are managed differently than other ICCAT stocks. To do this, I conducted a literature review on publicly available ICCAT reports, governmental and non-governmental documents, peer reviewed scientific literature, and other sources to understand and explain the relevant importance of each contributing factor to the management of the species. I utilized key informant interview methodology to obtain insights from twelve bluefin tuna experts representing a variety of interests that attend ICCAT

official meetings. I transcribed and collected insights from semi-structured interviews, which I used to ground-truth the findings of the literature review.

No single factor is responsible for the unique management in place to govern ICCAT's bluefin tuna fishery. Rather, a nuanced interaction of many important factors contributes to the species' poor stock status and unique management. The history and complex nature of the fishery, unique biology of the species, strong demand in the world sushi market, impact of Illegal, Unreported, and Unregulated (IUU) fishing, and political will of ICCAT member countries to enforce Recommendations and Resolutions influence which measures are adopted and implemented. This finding contrasts peer reviewed literature and other information to the contrary that attribute the unique management and poor stock status of bluefin tuna to such factors as high market value of the species' meat, ineffective ICCAT management, Hardin's "Tragedy of the Commons," or the "free riding" of non-cooperating fishing entities fully.

Based on key informant interviews, expert respondents share a high level of agreement that the special, "iconic" status that bluefin tuna have attained in popular media, scientific publications, and in general public opinion is an important factor that contributes to their management. I argue that the powerful symbol that bluefin tuna has become in the policy realm affects its management in direct and indirect ways. This thesis research provides analyses of these various forces and the management context of the species, and shares recommendations for improving management of bluefin tuna and other ICCAT stocks.

Acknowledgements

This thesis research and the opportunity for me to pursue graduate education were made possible through a Teaching Assistantship position through the College of Environment and Life Sciences. Thank you to my major Professor Seth Macinko for oversight of my research and helpful comments. Thank you to Professors Michael Rice and Richard Burroughs for helpful comments on my thesis idea and for serving on my thesis defense committee. Thank you to Professor Lawrence Juda for his input on conceptual ideas for the substance of this thesis research. Thank you Judy Palmer for her invaluable help in keeping me organized throughout my time at URI. Thank you to my friends and colleagues for their moral support through late nights studying, researching, and writing and for helping me keep my goals in sight. Thank you Nicole, Brendan, and Lauren for reviewing thesis drafts. Thank you to twelve anonymous bluefin tuna experts that provided critical insight to this research during interviews.

I would like to especially thank my parents for their constant encouragement, love, and the confidence they give me to continuously push beyond boundaries of what I think I can accomplish. Thank you Tim, Brendan, and Aislinn for your humor and encouragement throughout my graduate studies. Finally, I would like to thank Lauren for her continuous love, support, selflessness and understanding throughout graduate school and this thesis research process. Without her, I would not be here fulfilling a long-held dream to complete a Master's degree. Her patience, humor, and keen eye were critical to making this thesis a reality. Thank you.

Table of Contents

Abstract.....	ii
Acknowledgements.....	iv
Table of Contents.....	v
List of Tables.....	viii
List of Figures.....	x
CHAPTER I. INTRODUCTION	
A. Research Topic.....	1
B. Research Questions and Hypotheses.....	1
C. Common Explanations for Poor Stock Status of the Species.....	3
D. Research Context.....	5
E. Status of the Species.....	10
F. ICCAT Bluefin Tuna Fishery Compared to Global Tuna Fisheries.....	14
CHAPTER II. BACKGROUND OF THE SPECIES AND THE FISHERY	
1. The Northern Atlantic Bluefin Tuna	
A. Biology.....	16
B. Life History.....	16
C. Complex Migrations.....	17
2. Description of the Fisheries for Bluefin Tuna	
A. Eastern Atlantic/Mediterranean Sea Fishery History.....	18
B. Common Methods of Capture.....	19
C. History of the Western Atlantic Fishery.....	22
D. Development of Ranching in the Mediterranean Sea.....	23
3. Demand of the Sushi Market Drives Bluefin Prices.....	24
4. Relative Stock Statuses of Eastern/Western Bluefin Tuna Stocks.....	24
5. Common Explanations for Complex Management of Bluefin Tuna.....	28

CHAPTER III. ICCAT MANAGEMENT OF BLUEFIN TUNA

1. History of ICCAT Management	
A. ICCAT History and Fisheries Management Framework.....	32
B. ICCAT Managed Species.....	33
C. Structure and Specific Responsibilities of ICCAT.....	34
2. ICCAT’s Two-Stock Hypothesis	
A. History of the 2-Stock Hypothesis.....	35
B. Eastern or Western Stock? Why does it Matter?	36
3. ICCAT Management Context	
A. Managing a Migratory Species.....	37
B. Stock Management Measures.....	38
4. Politics Surrounding Bluefin Tuna	
A. Political Pressure Affects Bluefin Tuna Management.....	40
B. Bluefin Tuna as a Special Status Species.....	41

CHAPTER IV. THESIS METHODOLOGY

1. Literature Review Methodology to Test Six Hypotheses	
A. ICCAT Management Regime Comparison.....	44
B. Comparing Relative Market Value of ICCAT-Managed Fisheries.....	45
C. Assessing Effects of Bluefin Tuna’s Special Status on its Management....	47
2. Key Informant Semi-Structured Interview Methodology	
A. Background.....	48
B. Choosing Key Informants.....	49
C. Conducting Key Informant Interviews, Compiling Results.....	50
D. Comparing Respondents’ Input with Literature Review Results.....	52

CHAPTER V. RESULTS

1. Hypothesis Testing	
A. Hypotheses 1, 2: Market Value, Fleet Size, and Scale of Bluefin Fishery..	53
B. Hypotheses 3, 4: “Iconic” Status of Bluefin Tuna.....	57
C. Hypothesis 4: “Iconic” Status Contributes to ICCAT Management.....	60
D. Hypothesis 5: Political Pressure Affects ICCAT Management.....	60
E. Hypothesis 6: Status Affects ICCAT’s Management of Bluefin Tuna.....	61

2. Respondent Interview Results	
A. The Respondents.....	64
B. Fishery Management Tools Employed in Bluefin Tuna Fishery.....	65
C. Factors Leading to Adoption of These Tools.....	66
D. Management Tools Not Effectively Used in Bluefin Fishery.....	66
E. Iconic Status of Bluefin and Implications for Management.....	67
F. Impacts of Iconic Status of Bluefin on Resource, Industry.....	68
G. Future Priorities for ICCAT.....	68
CHAPTER VI: DISCUSSION AND CONCLUSION	
1. Discussion of Literature Review Results	
A. Bluefin Tuna Fishery is Not Most Valuable under ICCAT.....	70
B. Bluefin Tuna are a Popular, Special Status Species.....	71
C. Special Status of Bluefin Tuna Affects its Management.....	72
D. Summary.....	73
2. Discussion of Key Informant Interview Results	
A. Concordance of Literature Review and Respondent Insights.....	74
B. Outlook for ICCAT-Managed Bluefin Tuna.....	77
3. Recommendations and Future Research	
A. Specific Recommendations for ICCAT Management of Bluefin Tuna.....	77
B. Future Research.....	81
4. Conclusion.....	82
APPENDICES	
Appendix I. Email to Potential Key Informants for Interview Request.....	84
Appendix II. Copy of Consent to Participate Form.....	85
Appendix III. List of Questions Posed to Interview Respondents.....	87
BIBLIOGRAPHY.....	88

List of Tables

Table 1. Bluefin Tuna Management Tool Overview.....	6
Table 2. Bigeye Tuna Management Tool Overview.....	7
Table 3. Swordfish Management Tool Overview.....	7
Table 4. Yellowfin Tuna Management Tool Overview.....	8
Table 5. Master List of Bluefin Tuna Management Tools Examined, Effectiveness, and Peculiarities of Fishery Affect their Success or Failure.....	12
Table 6. Summary of ICCAT-Managed Species' Stock Status.....	27
Table 7. CPCs and Cooperating Fishing Entities Involved in ICCAT.....	33
Table 8. Major ICCAT Managed Species.....	34
Table 9. Overview of Western Atlantic Management Tools.....	38
Table 10. Overview of Eastern Atlantic Management Tools.....	39
Table 11. Summary of Registered Vessels in Four ICCAT Fisheries.....	53
Table 12. Average Market Prices of ICCAT-Managed Species in \$US/kg.....	54
Table 13. MSY of Bigeye Tuna, Bluefin Tuna, Swordfish, and Yellowfin Tuna and Average Price of Meat in \$US/kg.....	55
Table 14. Estimate Summary of Total Market Value of Four ICCAT Fisheries.....	56
Table 15. Results of Peer-Reviewed, Published Literature Search Queries for “Northern Bluefin Tuna”	58
Table 16. Table 15. Combined Results of Peer-Reviewed, Published Literature Database Search Queries for “Bigeye Tuna” and “Yellowfin Tuna”	58
Table 17. Shared Characteristics of “Charismatic” and “Iconic” Species and Northern Atlantic Bluefin Tuna Compiled from Conservation Biology Literature.....	59
Table 18. Attempts to Secure Legal Protection for Bluefin Tuna.....	61
Table 19. SCRS TAC Recommendation and TAC Set for Eastern Atlantic/Mediterranean Sea Bluefin Tuna by Year.....	63

Table 20. Management Tool Categories Used by ICCAT to Manage Bluefin Tuna as Identified by Respondents in Order of Response Frequency.....	65
Table 21. Factors Identified by Respondents as Important to Adoption of Management Tools for Bluefin Tuna in Order of Response Frequency.....	66
Table 22. Management Tools Not Effectively Used to Manage Bluefin Tuna in Order of Response Frequency.....	67
Table 23. Impacts and Attributes of “Iconic” or “Charismatic” Status of Bluefin Tuna on Their Management in Order of Response Frequency.....	67
Table 24. Impact Themes of “Iconic” or “Charismatic” Status of Bluefin Tuna on the Resource and Fishing Industry in Order of Response Frequency.....	68
Table 25. Summary of Respondents’ Responses.....	69

List of Figures

Figure 1. Northern Atlantic Bluefin Tuna (<i>Thunnus thynnus</i>) Image.....	5
Figure 2. Contribution of Bluefin Tuna to World Tuna Catch in 2010.....	14
Figure 3. Horizontal and Vertical Distribution of Tunas in Water Column.....	16
Figure 4. Satellite Tagging Migration Map of Adult Bluefin Tuna.....	18
Figure 5. Diagram of a Traditional <i>tonnara</i> or Fish Trap.....	19
Figure 6. Common Fishing Methods Employed around Atlantic Ocean.....	20
Figure 7. Map of ICCAT Jurisdictions.....	22
Figure 8. A Tow-Cage Transferring Bluefin Tuna to a Net Pen for Fattening.....	23
Figure 9. Eastern Atlantic/Mediterranean Sea Bluefin Stock Biomass.....	25
Figure 10. Estimates of Western Atlantic Bluefin Tuna Spawning Stock Biomass.....	26
Figure 11. Diagram Showing Theoretical Maximum Sustainable Yield.....	32
Figure 12. Illustration of ICCAT’s East-West Management Boundary Line.....	36
Figure 13. Results of Respondents’ Opinions on What ICCAT Should Prioritize to Maintain Healthy Bluefin Tuna Stocks Over the Next Five Years.....	69

CHAPTER I. INTRODUCTION

A. Research Topic

The International Commission for the Conservation of Atlantic Tunas (ICCAT) is the regional fisheries management organization (RFMO) tasked with the conservation and management of fisheries for highly migratory tuna and tuna-like species in the Atlantic Ocean and Mediterranean Sea, including the Northern Atlantic bluefin tuna (*Thunnus thynnus*). For the remainder of this thesis, I will use the term “bluefin tuna” to refer to *Thunnus thynnus* unless otherwise noted. Through an international agreement with nearly fifty member parties, ICCAT sets harvest policies to ensure the long-term sustainable yield, called Maximum Sustainable Yield (MSY) in fisheries literature, from stocks of the species under their management (ICCAT 2011c). For several decades, the stocks of this species have not been managed at MSY (ICCAT 2008). In the following chapters, I provide evidence that bluefin tuna attract a majority of the management capacity and effort of ICCAT, and that this species is managed differently than other ICCAT stocks due to a variety of factors. The main focus of this thesis is finding out why this is the case.

B. Research Questions and Hypotheses

In this thesis, I explore ICCAT’s different management of bluefin tuna compared to other stocks through a two-part research question:

Why are bluefin tuna managed differently than other species under ICCAT’s purview?

What factors (such as stock status, market value, complex biology of the species, nature of the fishery, and intense media attention, etc.) contribute to this unique management?

I rely on a literature review of publicly available information and key informant experiences to explore this question and to test six hypotheses that are grounded in conventional wisdom on bluefin tuna management:

1. High market value of bluefin tuna meat does not fully account for the unique management of this species.
2. Individual market value, fleet size, and scale of the bluefin tuna fishing industry are not greater in proportion to the management tools employed in this fishery to other ICCAT-managed fisheries.
3. Bluefin tuna have achieved an “iconic” or “charismatic” status in popular media, peer-reviewed literature, and in non-governmental group publications that other ICCAT-managed stocks have not.
4. This “iconic” status contributes to the management approaches adopted by ICCAT to manage this species differently than others, and has important implications for both the resource and the fishing industry.
5. Non-scientific information and political pressure play a major role in influencing which management tools are adopted at ICCAT meetings, and a disproportionate amount of management attention and focus is afforded to bluefin tuna.
6. Media scrutiny and heightened status of bluefin tuna affects ICCAT’s ability to effectively manage the species.

For this research, I define market value as the sum of the average market price paid per unit of weight over the MSY estimate provided by ICCAT’s scientific body, the Standing Committee on Research and Statistics. An “iconic” species is one that embodies cultural or societal values, and often has for extended periods of time. A “charismatic” species is similar to an “iconic” one but has physical attributes such as large size, great speed, perceived intelligence, or exceeding rarity that help humans identify with them more so than with other organisms that do not share these traits.

I test these hypotheses through a comparison of the findings of a literature review with responses of one dozen key informants that have an in-depth knowledge of ICCAT management. I provide evidence to support the idea that the current paradigms used to frame and understand the bluefin tuna management regime in the Atlantic Ocean, namely the “Tragedy of the Commons,” the high market value of the fish, and the failure of the weak international governance regime of ICCAT masks the complexity and true nature of the structure in place to manage bluefin tuna.

C. Common Explanations for Poor Stock Status of the Species

In published fisheries, economics, conservation biology, and political science literature, ICCAT’s management of bluefin tuna is pointed to as a failure, but authors cite a variety of causes (Fromentin and Fonteneau 2001, Magnuson et al. 2001, ICCAT 2008, MacKenzie et al. 2008, Aranda et al. 2010, Longo and Clausen 2011, Conathan 2012). I developed my hypotheses to test these ideas. Public media often cite Garrett Hardin’s “Tragedy of the Commons” as the cause of the decline of the species, wherein Hardin argues that individuals acting in their own self-interest eventually cause the degradation of open-access resources (Hardin 1968, Nickler 1999, McWhinnie 2006, *The Economist* 2008, Revkin 2008, Sumaila and Huang 2012). Internet searches reveal articles with a similar thrust:

If EVER there were a graphic illustration of the tragedy of the commons, it is the plummeting of the world's stocks of bluefin tuna (*The Economist* 2008).

I used this line of thinking to develop Hypotheses 1 and 2. I link Hypotheses 1 and 2 with the “Tragedy of the Commons” common explanation found in the literature based on the fact that bluefin tuna is the most valuable individual fish in the world

(Porch 2005). Due to the very high value of the fish, it is commonly perceived that catching a single fish is like “winning the lottery.” This seems to fuel the misperception that bluefin tuna fishers race to catch every last fish and that this drives the overexploitation of the resource (Ruais 2012). This is simply untrue; the average bluefin tuna fisher never obtains the very high exvessel prices that are paid for outstanding specimens on Tsukiji Fish Market’s auction floors (Ruais 2012).

Others argue that the degraded bluefin fishery results from the sum of individual greed of fishers from each ICCAT nation, which drives the over exploitation of this valuable ICCAT fishery (Nickler 1999, Fromentin and Fonteneau 2001, Fromentin and Powers 2005, Revkin 2008, MacKenzie et al. 2008, Greenberg 2010). Conventional wisdom in literature confounds the high individual value of a bluefin tuna with high market value of the fishery as a whole (Magnuson et al. 2001, McWhinnie 2006, MacKenzie et al. 2008, Conathan 2012). It is a commonly-held belief that the high market value of the species drives its degradation by encouraging overfishing for individual gain and illegal, unreported, and unregulated (IUU) fishing that drive a “Tragedy of the Commons” scenario (Magnuson et al. 2001, Fromentin and Powers 2005, MacKenzie et al. 2008). This led me to develop Hypothesis 2.

Next, some authors point to weaknesses in the regimes of RFMOs in general and lack of collective political will to effectively regulate resources as major drivers of the degradation of the world’s tuna fisheries (Aranda et al. 2010, Collette et al. 2011). Several sources attribute this lack of political will to effectively manage bluefin tuna to the prevalence of non-scientific information and elevated, “iconic” or “charismatic” status of the species, which led me to develop Hypotheses 3, 4, 5, and 6 to shed light

on the management of the species (Whynott 1995, Weber 2002, Fromentin and Ravier 2005, Porch 2005, ICCAT 2008, Safina and Klinger 2008, ICIJ 2010, Ruais 2011).

D. Research Context

Bluefin tuna are the largest, widest ranging, and most valuable of all bony fishes, and have been actively pursued by humans for millennia (Mather et al. 1995, See Figure 1).

Figure 1. Northern Atlantic bluefin tuna (*Thunnus thynnus*) image.



Photo from NMFS Photo Library: Web: <<http://www.photolib.noaa.gov/bluefin>>. Accessed 28 September 2012.

These facts are important to keep in mind when considering that ICCAT has consistently set harvest recommendations that are far above the best scientific evidence and the recommendations of their scientific experts, and that they have used different tools to manage this fishery (ICCAT 2008, Pew 2010, ICIJ 2010, NMFS 2012a). As a result of overfishing, stocks of this species, or fish populations that have been divided up for management purposes, have steadily declined in the western and eastern Atlantic Ocean/Mediterranean Sea for decades (ICIJ 2010, Pew 2010, Boustany 2011, Collette et al. 2011, Sumaila and Huang 2012). ICCAT manages bluefin tuna more intensely and differently than any other species. The number,

variety, and attributes of management tools ICCAT employs to regulate bluefin tuna make their governance unique among ICCAT stocks (See Tables 1, 2, 3, and 4).

Table 1. ICCAT fishery management tools in the form of legally binding Recommendations and voluntary Resolutions, used for bluefin tuna since 1972. Note: **Bolded** tools are unique to the bluefin fishery.

BLUEFIN TUNA MANAGEMENT TOOL OVERVIEW

Fishery Management Tool	Year and Recommendation / Resolution Identification #	Type of Tool
Minimum Size Limit	1974-01	Output
Total Allowable Catch (TAC) Percentage Shares	1981-01	Output
Research Quota Set-Aside	1991-01	Input
Bluefin Certification/Documentation	1993-05	Output
Closed Season/Area for Longlining	1993-07	Input
Spotter Plane Ban	1995-07	Input
Management Boundary Line	1996-05	Input
Mandatory Observer Coverage	1997-03	Output
Recovery Plan Implementation for Western Stock, Effort Reduction	1998-07	Input
Vessel Registration	2000-08	Input
Regulations Governing At-Sea Transfers to Farming Operations	2000-10	Input
IUU Vessel Blacklist	2003-08	Input
Recovery Plan Implementation for Eastern/Mediterranean Stock, Effort Reduction	2006-05	Input
Capacity Reduction Program	2006-08	Input
Catch Documentation Scheme	2007-04	Output
Multilateral Trade Sanctions against CPCs	2008-06	Input
Atlantic-Wide Research Programme for Bluefin Tuna (GBYP)	2011-06	Input
TOTAL ACTIVE MEASURES:	14	

Data from ICCAT 2012b.

For comparison, Tables 2, 3, and 4 summarize the ICCAT Recommendations and Resolutions taken to date in the bigeye tuna, swordfish, and yellowfin tuna fisheries in that order. Note that there were 21, 38, and 4 ICCAT management measures implemented, in that order, for these fisheries since 1979 (ICCAT 2012b).

Table 2. Summary of management tools used by ICCAT to manage bigeye tuna.

BIGEYE TUNA MANAGEMENT TOOL OVERVIEW

Fishery Management Tool	ICCAT Recommendation/ Resolution Identification # and Year	Type of Tool
Minimum Size Limit	1997-01	Output
Capacity Reduction	1997-13	Input
Monitoring/ Enforcement Sanctions	1997-15	Output
Vessel Registration	1998-02	Input
TAC Percentage Shares	2000-01	Output
Implementation of a Multi-Year Conservation Plan	2004-01	Input
TOTAL ACTIVE MEASURES:	2	

Data from ICCAT 2012b.

Table 3. Summary of fishery management tools used by ICCAT to manage swordfish.

SWORDFISH MANAGEMENT TOOL OVERVIEW

Fishery Management Tool	ICCAT Recommendation/ Resolution Identification # and Year	Type of Tool
Minimum Size Limit	1990-02	Output
TAC Percentage Shares	1995-11	Output
Management Boundary Split	1996-07	Input
Rebuilding Plan Implementation for Swordfish	1999-02	Input
Time/Area Closures and Gear Restrictions	1999-04	Input
Gear Restrictions for Bycatch Reduction	2000-03	Input
Gear Restrictions for Fishing Mortality Reduction on Juvenile Swordfish	2009-04	Input
TOTAL ACTIVE MEASURES:	13	

Data from ICCAT 2012b.

Table 4. Summary of management tools used by ICCAT to manage yellowfin tuna.

YELLOWFIN TUNA MANAGEMENT TOOL OVERVIEW

Fishery Management Tool	ICCAT Recommendation/ Resolution Identification # and Year	Type of Tool
Minimum Size Limit	1972-01	Output
Effort Reduction Program	1993-04	Input
Request for CPC Implementation and Compliance with Rules	1995-06	Input
Repealing Minimum Size Limit	2005-01	Output
TOTAL ACTIVE MEASURES:	0	

Data from ICCAT 2012b.

ICCAT employs a variety of input and output fishery controls in the bigeye, bluefin, yellowfin tuna and swordfish fisheries. While no discernable trend emerges in preference for specific usage of tools over time in each fishery, bluefin tuna have had significantly more and varied management measures implemented for them. The total number of active management measures in place for bluefin tuna (14) is similar to the total of the other three fisheries (15). However, there were more management measures implemented by ICCAT for bluefin tuna (64) than for these three other species combined (63) since its inception in 1969 (ICCAT 2012b). Only the bluefin tuna fishery has a catch documentation/certification scheme, IUU vessel blacklist, multilateral trade sanctions against countries, TAC set-asides for research, mandatory observer coverage for the purse seine fleet and at-sea transferring of fish, or an Atlantic-wide research program in place (ICCAT 2012b). Also, ICCAT seems as though it has been willing to implement more intensive management measures for its bluefin tuna fishery that require significant cooperation for monitoring and enforcement by CPCs than those used in other fisheries.

ICCAT uses input measures such as time/area closures in the Gulf of Mexico and the banning of longlining in the Mediterranean Sea to protect spawning aggregations of bluefin tuna and to reduce bycatch of juvenile ICCAT-managed stocks, respectively (ICCAT 2010b). Gear restrictions that ban the use of driftnets and spotter planes also ensure that planes do not guide purse seiners to find and capture entire schools of bluefin tuna, which is how that fishery rapidly developed in the past (ICCAT 2010b). ICCAT also uses output controls that focus on helping to accurately constrain total catch in the fishery (Pope 2012). The percentage share TACs for CPCs under ICCAT's management, certification schemes such as the bluefin catch documentation scheme, and mandatory observer coverage are examples of output controls. These tools contrast with typical input fisheries management tools used to reduce fishing effort and intensity (Pope 2012).

A second group of management measures unique to the bluefin tuna fishery relate to research and statistics. Research set-asides of the overall TAC for each stock of bluefin tuna allow scientists to implement the Atlantic-Wide Research Program for Bluefin Tuna, or "Grande". Grande is funded by CPCs and implemented in various CPC countries through tagging programs and aerial surveys to estimate relative abundance of bluefin tuna (ICCAT 2012a).

Third, multilateral trade sanctions have been used against countries that flag vessels that have been found out of compliance with ICCAT requirements for participating in fisheries under their jurisdiction (Pew 2010, ICCAT 2012a). This mechanism effectively removes the major buyers in the world bluefin tuna market from trade such as Japan, USA, and EU (Pew 2010, ICCAT 2012a). Finally, measures

regarding the at-sea-transfer of live bluefin tuna to tow cages and net-pens for fattening only apply in the Mediterranean Sea. The mandatory observer coverage of such transfers seeks to reduce uncertainties over total catch of the Eastern/Mediterranean stock of bluefin tuna (ICCAT 2010b).

E. Status of the Species

Current estimates suggest that Northern bluefin tuna stocks in the Atlantic Ocean and Mediterranean Sea represent about 30% of the 1970s population, which is when large-scale industrial fishing for the species began in earnest (Boustany 2011, Fromentin and Powers 2005, Safina and Klinger 2008, Aranda et al. 2010, ICCAT 2010b). This depleted status of the species in the Convention Area represents a failure, in biological terms, of ICCAT as a whole. These stock levels are not sufficient to support MSY, which is ICCAT's stated management goal for every stock under its jurisdiction. The governments of Sweden, Kenya, and Monaco each sponsored motions to list the Atlantic bluefin tuna as "endangered" under Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in order to halt their sale worldwide (ICCAT 2010b, IUCN Redlist 2011, CITES 2012). Such protection would liken sale of bluefin tuna meat to trade in elephant ivory: an illegal act internationally. The poor spawning stock biomass of both bluefin tuna stocks in the Convention Area, coupled with various attempts to secure legal protection for the species in international fora strongly suggest that ICCAT is failing its management mandate to sustain stocks at MSY levels (Aranda et al. 2010).

In light of this failure, I assessed the difference in management of the bluefin tuna fishery versus other ICCAT fisheries and their relative effectiveness according to whether or not they have helped ICCAT to reach its management goal of sustaining stocks at levels that sustain MSY according to ICCAT reports and other publications. As both bluefin tuna stocks are currently overfished, it seems as though every management tool has failed, but this is not necessarily the case. Some tools, such as those that address the ranching of bluefin tuna that is unique to that fishery, have had a positive impact on the illegal transfer of live bluefin from catching vessels to net pens (ICIJ 2010, Pew 2010). However, other tools that are not unique to the bluefin fishery have largely failed to curtail fishing effort or total mortality in the fishery (Sumaila and Huang 2012). I provide a master list of management tools evaluated in this thesis research with some indication of the success or failure of each and some context to lay the groundwork for the unique management in place in the bluefin tuna fishery (See Table 5).

Table 5. Master list of bluefin tuna management tools examined, effectiveness, and peculiarities of bluefin tuna fishery that affect their success or failure.

ICCAT Management Tool	Success/Failure	Bluefin Fishery Context
Minimum size limits	Failure	Immature bluefin tuna are still captured by purse seines for tuna ranching operations in the Mediterranean Sea, which undermines rebuilding spawning stock
Time/area closures	Failure	Closures in the Gulf of Mexico and Tyrrhenian Sea have not measurably affected stock status
Effort reduction	Uncertain	Effort reduced across Convention Area in aggregate, but bluefin tuna stocks remain overfished
Total Allowable Catches (TACs)	Success	Countries share TAC allocations that have been set within scientific recommendations; 2012 estimates show both stocks are increasing in abundance
Gear restrictions	Failure	Have not reduced total catch or mortality
Mandatory observer coverage	Failure	Have not reduced IUU fishing overall
Catch documentation	Failure	Have not significantly reduced IUU fishing, currently being replaced by ICCAT for 2013 fishing year with electronic program
Vessel blacklist	Failure	Have not succeeded in permanently removing offending vessels from fishery
Research set-asides	Uncertain	Led to increased scientific understanding of bluefin tuna life history, but not have not informed management changes as hoped
Management units for stocks	Failure	Splitting bluefin tuna into two stocks has not reduced fishing effort or mortality on the whole
Recovery plans	Success	Agreed-upon management frameworks with scientifically based reference points and timelines for rebuilding have helped stocks
Capacity reduction	Uncertain	Capacity reduced in some of the Convention Area, but in aggregate have not reduced fishing effort
Vessel registration	Failure	Unregistered vessels continue to pursue bluefin tuna every fishing year

Data from ICCAT 2012b, ICCAT 2008.

Based on my assessment of these tools, only two of thirteen major management tool categories employed in the bluefin tuna fishery have been successful to date in measurably reducing total fishing mortality (total catch) and fishing effort (amount of time spent fishing) for bluefin tuna in the ICCAT Convention Area. Effort reduction, capacity reduction, and research set-asides have all had uncertain outcomes in terms of buoying stock status to MSY-sustaining levels because their impacts are difficult to measure without reliable numbers. Two out of thirteen successful tools is a fairly bad measure by any count, but ICCAT itself may not be to blame for the failure of most of the tools it employs in the bluefin tuna fishery.

There should be some consideration of the nature and peculiarities of the bluefin tuna fishery that affect the relative effectiveness of each tool. The majority of the fishing pressure on bluefin tuna is exerted in the Mediterranean Sea by about a dozen countries from many different ports with different abilities to effectively police their waters and enforce ICCAT binding Recommendations and voluntary Resolutions. There is no ICCAT inspection team that scans the Mediterranean to enforce their rules. Rather, monitoring and enforcement of minimum size limits, gear restrictions, time/area closures, vessel blacklists, accurate registration, and catch documentation are up to each individual Contracting Party Country. Therefore, it is perhaps not surprising that many of these tools have failed in the ICCAT Convention Area, but not for lack of trying. ICCAT is only as strong as its CPCs, and political will, funding, and resources must be allocated by each respective country to ensure that tools are effective in sustaining stocks at MSY-sustaining levels. It is through this lens of the failure of various management tools that we must consider the factors that

contribute to their adoption and success or failure over time for the remainder of this thesis research. Failure of specific management tools and in an aggregate failure of ICCAT to sustain healthy bluefin tuna stocks under its management are strong drivers for the specific management framework in place currently (Aranda et al. 2010).

F. ICCAT Bluefin Tuna Fishery Compared to Global Tuna Fisheries

While a large amount of information has been published on the management of Northern Atlantic bluefin tuna in the past several decades, harvest of this species accounted for less than 10% of tuna catch in the world’s oceans by weight in 2010 (FAO 2011, See Figure 2).

Figure 2. Contributions of commercial tuna species to world tuna catch in 2010.

Approximate contributions of individual principal market tuna species to their 2010 total catch is given below.







Principal market tunas		
	Albacore (ALB)	5.9%
	Atlantic bluefin tuna (BFT)	less than 1%
	Bigeye tuna (BET)	8.2%
	Pacific bluefin tuna (PBF)	less than 1%
	Southern bluefin tuna (SBF)	less than 1%
	Skipjack tuna (SKJ)	58.1%
	Yellowfin tuna (YFT)	26.8%

Image from FAO 2011, pg.3

I want to explore why this is the case. I am interested in the poor stock status of the species, the popularity of ICCAT management of the stock in fisheries management literature, and the general causal statements regarding the collapse of this species in published documents. To investigate these areas of interest, I examine the

characteristics of the fishery to clarify and understand the factors that contribute to bluefin tuna management. In this thesis, I provide background information on bluefin tuna and the fisheries that developed to catch it. I explore the factors that contribute to its management in Chapters II and III. Some of the most common explanations for the specific management tools ICCAT employs in the bluefin tuna fishery are discussed in Chapter III. In Chapter IV, I discuss a literature review and key informant interview methodology used to test my six hypotheses. Chapters V and VI describe my findings and results, and provide a discussion and policy recommendations for ICCAT based on this thesis research.

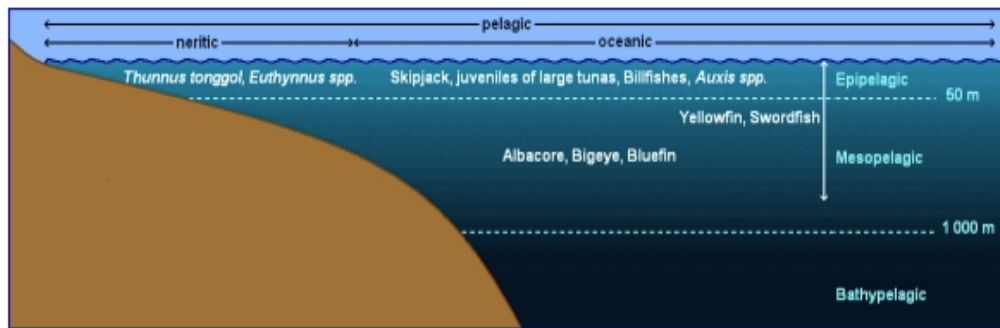
CHAPTER II. BACKGROUND OF THE SPECIES AND THE FISHERY

1. The Northern Atlantic Bluefin Tuna

A. Biology

Northern Atlantic bluefin are the largest of the three bluefin tuna species and are capable of growing to over ten feet in length and weighing nearly 1,500 pounds (Mather et al. 1995, See Figure 3).

Figure 3. Typical horizontal and vertical distribution of tunas in the water column.



FAO 2012b, pg. 4.

Bluefin tuna must swim continuously to push oxygenated water over their gills to breathe, which forces them to adopt a highly migratory lifestyle (Mather et al. 1995, Maggio 2000, Ehrenberg 2008).

B. Life History

As a result of their physiology and highly migratory lifestyle, bluefin tuna expend energy keeping themselves warm while they hunt in cold waters, and thus spend relatively less time growing large or producing eggs or milt for spawning (Porch 2005, Teo et al. 2006). Bluefin tuna stocks often fluctuate in abundance

considerably over time, which makes it difficult to reliably estimate their abundance and biomass and to manage fisheries for them (Mather et al. 1995, Porch 2005).

Without accurate estimates of biomass, it is difficult to set harvest guidelines for stock (Porch 2005). Thus, bluefin tuna have a high susceptibility to overexploitation and low resiliency of its stocks to overfishing (Porch 2005).

Bluefin tuna typically spawn in large aggregations in warm waters in the Gulf of Mexico and in the Mediterranean Sea (Porch 2005). Data from multiple tagging studies suggest that western Atlantic-origin bluefin that spawn in the Gulf of Mexico have a median spawning age, or age of maturity, of nearly eleven to twelve years (Block et al. 2001). This contrasts the estimate four- to five-year median age of maturity of bluefin that spawn in the Mediterranean Sea (NMFS 2011). Reliable patterns of spawning migrations make the species susceptible to overfishing because large schools of spawning fish are easily targeted by fishers (NMFS 2011).

C. Complex Migrations

Northern Atlantic bluefin tuna were split into two stocks for management considerations based on total Atlantic Ocean catch in 1980 according to their migratory patterns across the Atlantic basin, called mixing (Powers and Porch 2004). Bluefin abundance varies in these areas based on a number of factors such as recruitment, food availability, oceanic currents, and other environmental factors (Galuardi et al. 2010, See Figure 4). The current state of the debate over the two stocks is that it is not reflective of the biology of the fish and should be replaced by another management framework in the future.

Figure 4. Estimated tracks of adult bluefin tuna tagged in the western Atlantic Ocean based on satellite data from 2005 and 2006.

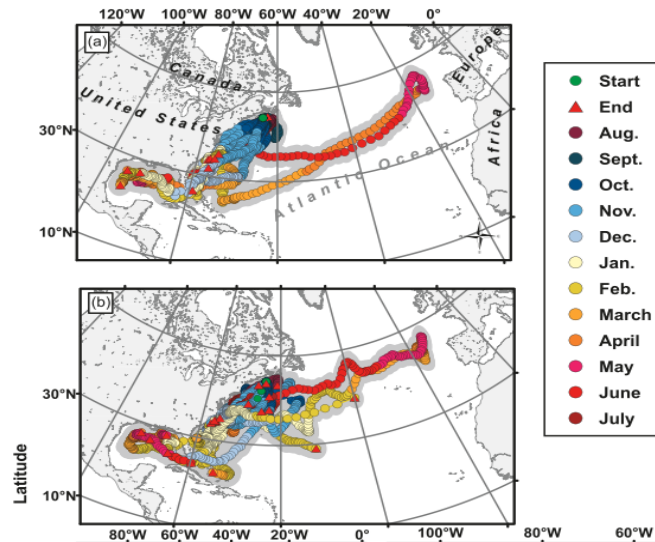


Image from Galuardi et al. 2010. Figure 3, pg. 971. Note: Individual bluefin swim from one side of the Atlantic to the other in a given year.

The extent to which mixing occurs in spawning areas and feeding grounds remains hotly-contested in the scientific literature and fishing industry publications because it affects how shares of total catch of bluefin are divided among countries by ICCAT (Lutcavage 2001, Powers and Porch 2004, Secor et al. 2011).

2. Description of the Fisheries for Bluefin Tuna

A. Eastern Atlantic/Mediterranean Sea Fishery History

The fishery for bluefin tuna in the Mediterranean Sea is one of the oldest documented fisheries in the world, as evidenced by cave paintings on the islands of Sicily that date back to circa 4000 BC (Desse and Desse-Berset 1994, Mather et al. 1995, Whynott 1995, Maggio 2000, FAO 2012). Fishers operated elaborate walled-net pen traps, called *tonnaras*, to catch out-migrating tuna that had spawned in the Mediterranean Sea as early as 2000 BC (Maggio 2000, FAO 2012, See Figure 5).

Figure 5. Diagram of a traditional *tonnara*, or fish trap made of net pens anchored to shore and the seafloor, from Sicily (Maggio 2000).

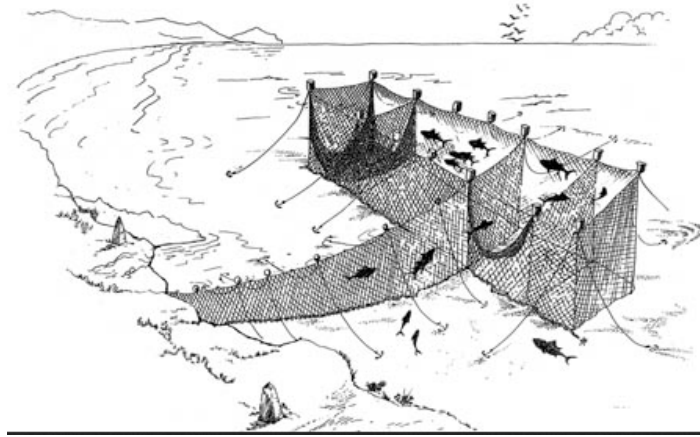


Figure from: Un Mare D'Mare. 2012.

In Maggio's ethnographic work *La Mattanza*, she highlights the symbolic and cultural importance of the annual bluefin migration:

The bluefin were to ancient Mediterranean peoples what the buffalo was to the American Plains Indian: a yearly miracle, a reliable source of protein from a giant animal they revered, one that passed in such numbers that the cooperation of an entire tribe was needed to kill them and preserve their meat. Around the Mediterranean the migrating bluefin was a staple food for entire civilizations (Maggio 2000, pg. 10).

Various Mediterranean islands had thriving tuna fishing and salting industries since the thirteenth century, and harpooning, seining, and drift netting have been commonly employed since (Mather et al. 1995, Maggio 2000). There is evidence of tuna spotting towers excavated at Cosa in modern day Italy from 100 BC (McCann et al. 1987). Despite changes in the fisheries for bluefin tuna, the species remains very important across the Mediterranean region and beyond (ICCAT 2012a).

B. Common Methods of Capture

The majority of bluefin tuna caught in the Convention Area are captured by purse seines, longlines, baitboats, and rod and reel fishers (ICCAT 2012a). These methods were developed based on the attributes of bluefin, such as their migratory patterns and aggregating habits when spawning (FAO 2012c, See Figure 6).

Figure 6. Common fishing methods around Atlantic Ocean. Clockwise from top right: 1. purse seining; 2. bottom trawling; 3. mid-water trawling; 4. drift netting; 5. longlining; 6. hook and line or trolling; 7. harpooning.

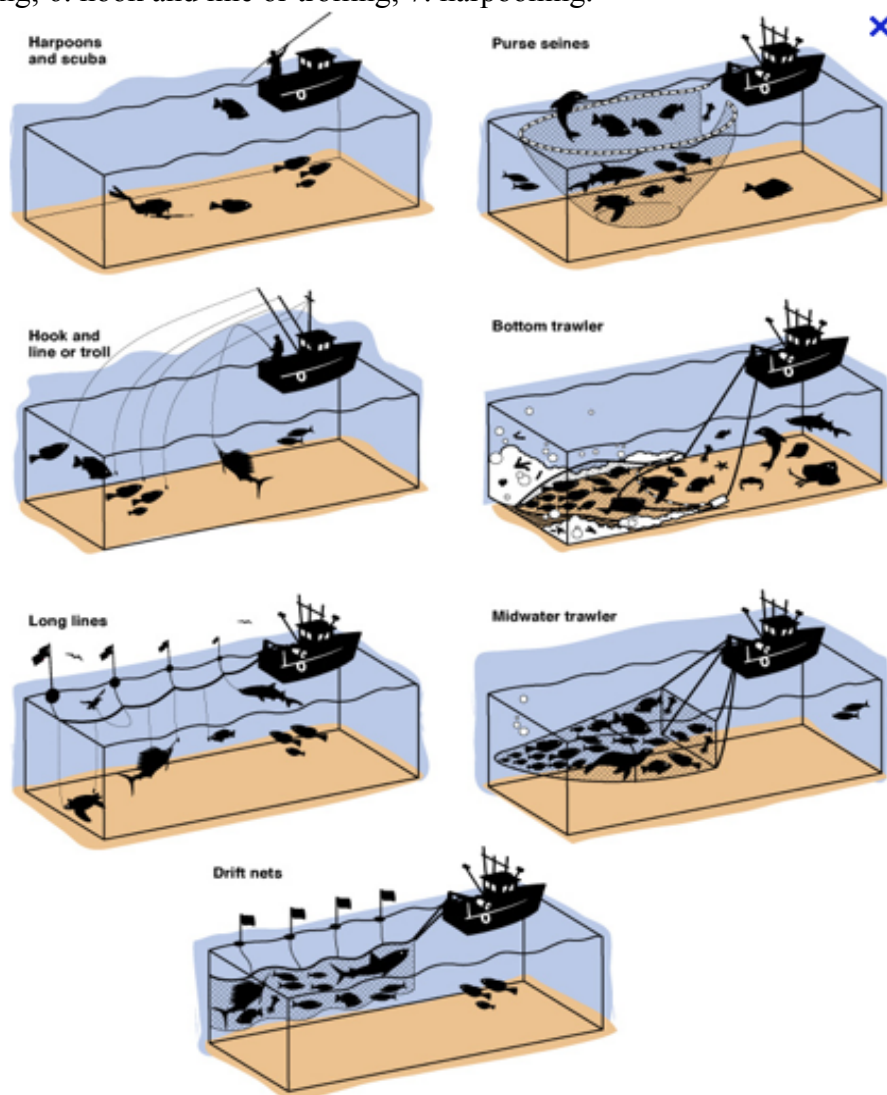


Image from: Joseph Shoulak Illustrations, WSJ Graphics, in: *The Wall Street Journal* “The Slippery Business of Picking Fish”. 2 March 2011.

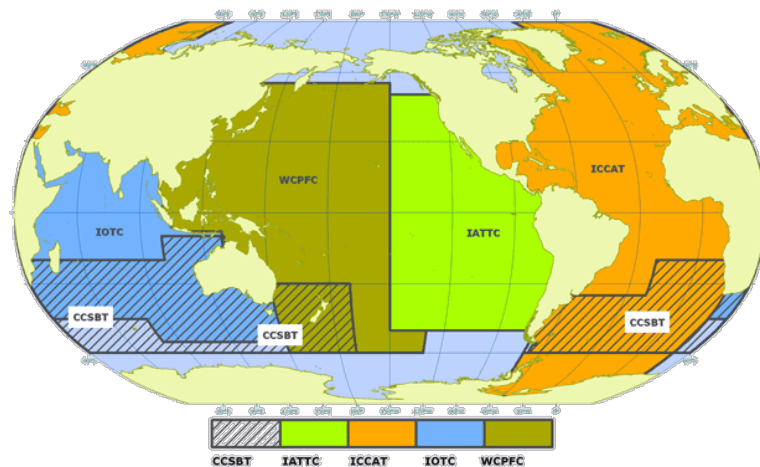
Purse seining is a common bluefin tuna fishing method and works by encircling a school of bluefin with a large net and then pulling the bottom of the net closed with a running line, like closing a purse. This method is used almost exclusively in the Mediterranean to supply tuna fattening operations (Pew 2010, ICCAT 2010a). Bottom trawling and mid-water trawling and drift netting are unselective methods of capture and have been banned in the ICCAT Convention Area due to high incidence of killing non-target species, called bycatch (ICCAT 2010a, Pew 2010). Longlines are fishing lines with many baited hooks that capture fish by hooking and holding them until they are pulled in, and are used extensively throughout the Atlantic Ocean (Mather et al. 1995, Tudela 2004).

Hook and line fishers and trollers pull lines with baited hooks through the water column on small boats with machinery or rods and reels (Mather et al. 1995). Bluefin fishers off the coast of North America typically “chunk” or “chum” dead, cut up baitfish to create “slicks” of blood that attract them to baited hooks (Whynott 1995). This method is very selective, as species captured are precisely targeted and undersized or undesirable fish can be released alive, unlike many of the other methods described here (Ravier and Fromentin 2001, Tudela 2004). Harpoon fishing is employed in select regions of the Atlantic and Mediterranean Sea, especially in the Gulf of Maine off the coast of North America. This method specifically targets “giant” –bluefin tuna larger than 73 inches near the surface of the water. This method is highly selective because the harpooner must physically see and judge the size of the fish before the throw is made to secure the tuna to a line and pull it aboard the vessel (Whynott 1995, ABTA 2012).

C. History of the Western Atlantic Fishery

The western Atlantic fishery for bluefin tuna is significantly younger and decidedly different than the Mediterranean fishery. Trophy sportfishing for giant (> 1,000 pounds) bluefin tuna along “Tuna Alley” near Nova Scotia started in earnest in the 1930s, and by the 1940s a small market emerged for their meat (Mather et al. 1995). In the 1950s, trolling and trapping methods for smaller fish developed using more efficient methods such as live bait, pelagic longline, and purse seining. They were largely driven by developments in the Japanese fishing and trade markets (Whynott 1995). These methods were much more capital and gear-intensive, but allowed fishers to take larger harvests and more fish per trip (Mather et al. 1995). By the late 1960s, bluefin tuna were declining in the western Atlantic waters (Mather et al. 1995). As a direct result of the increased attention to the declining stocks of bluefin tuna, ICCAT was formed in 1966 (ICCAT 2006). In doing so, ICCAT became one of the world’s first RFMOs, and the Convention Area was established as most of the Atlantic Ocean and Mediterranean Sea (ICCAT 2006, See Figure 7).

Figure 7. Map of RFMO jurisdictions; ICCAT jurisdiction is represented in orange.



FAO. 2012f. pg. 4.

D. Development of Ranching in the Mediterranean Sea

The development of the bluefin tuna ranching, or aquaculture industry in the Mediterranean Sea in the 1990s has important implications for how the eastern Atlantic/Mediterranean Sea fishery is managed. Ranching involves capturing wild tuna and placing them in offshore net pens to be fattened, while aquaculture involves growing bluefin tuna in captivity for their entire lives (Pew 2010). Juvenile bluefin tuna are captured for fattening in pens almost exclusively by purse seines, because they can capture entire schools of fish and transfer them to tow cages for transport to stationary net pens at tuna ranches (Ehrenberg 2008, Pew 2010, See Figure 8).

Figure 8. A tow-cage transferring bluefin tuna to a net pen for fattening.



Image from ICIJ 2010. pg. 16.

The fish are fattened to increase the quality of their meat to obtain higher prices in the market (FAO 2012d). The industry developed directly in response to seasonal shortages of fatty bluefin tuna that fetch high prices at Tokyo's Tsukiji Fish

Market (Issenberg 2007). Bluefin tuna are by far the most heavily farmed or ranched fish in the Mediterranean Sea (FAO 2012d). Importantly, this industry is non-existent in the western Atlantic Ocean because spawning aggregations that are required to supply fish to the ranches do not occur nearshore as they do in the Mediterranean Sea (Ehrenberg 2008). It is highly unlikely that this practice beginning in the western Atlantic Ocean. Croatia, Italy, Spain, Turkey, and Malta currently lead production of ranched bluefin tuna in the Mediterranean Sea (FAO 2012d).

3. Demand of the Sushi Market Drives Bluefin Prices

The market for bluefin tuna meat is driven by the rapid expansion of the world's sushi industry since the 1970s, which relies upon the invention of flash-freezing technology, high-speed trucking, and logistical breakthroughs in overnight flights to Tokyo (Bestor 2001, Issenberg 2007, NMFS 2010b). The most valuable portion of the tuna, the *honmaguro* or *kuromaguro*, is the deep red, fat-marbled flesh that is seen in sushi restaurants (Bestor 2001). Single bluefin tuna have sold for several hundred thousand U.S. dollars in recent years (Collette et al. 2011).

4. Relative Stock Statuses of Eastern/Western Bluefin Tuna Stocks

The prime conservation problem for tunas is the depletion of... bluefin (FAO 2012f pg. 4).

This section provides background information on the two stocks of Northern Atlantic bluefin tuna, (western Atlantic and eastern Atlantic/Mediterranean Sea) and the relative health of each stock. There is considerable debate surrounding the scientifically based stock status of ICCAT-managed bluefin tuna. On the one hand,

the International Union for the Conservation of Nature (IUCN), the National Geographic Society, popular media, and many other groups suggest that both stocks of bluefin tuna are “endangered” throughout the ICCAT Convention Area (IUCN “Redlist,” National Geographic Society 2012). On the other hand, there is a perception among industry groups that there is no such decline (ABTA 2010).

Currently, the eastern Atlantic/Mediterranean Sea stock is both still overfished and overfishing is still occurring (ICCAT 2010a, See Figure 9).

Figure 9. Estimates of eastern Atlantic/Mediterranean Sea bluefin stock biomass.

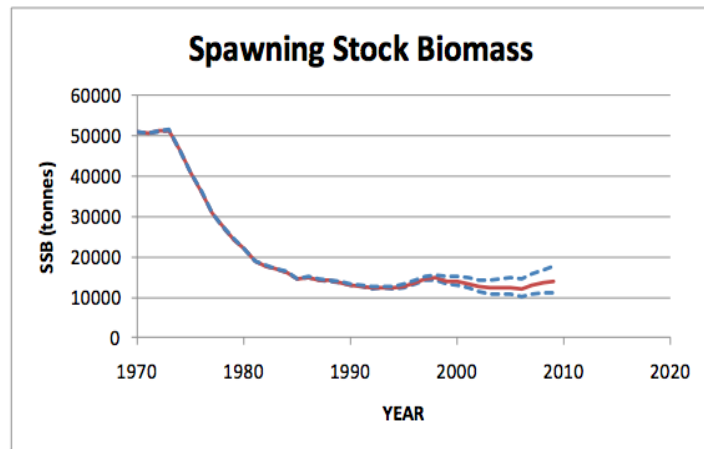


Image from ICCAT 2012c, pg. 98. Note: Dashes indicate 80% confidence intervals.

This means that both the level fishing mortality (overfished) and level of fishing effort (overfishing) remain too high to sustain Maximum Sustainable Yield (MSY) in the long-term, which is ICCAT’s stated management goal for the stock (ICCAT 2010a). Overfishing a stock means subjecting a stock to a fishing mortality rate (F) that exceeds the fishing mortality rate associated with MSY (F_{MSY}) (Hilborn 2005, Kell et al. 2012). The estimated mass of spawning-age adults is estimated to be 57% of the highest recorded levels in the past few decades for the Eastern

Atlantic/Mediterranean Sea stock (ICCAT 2010a). The stock biomass has not declined to the degree seen the western Atlantic, but ranching and aquaculture operations as well as significant latent fishing capacity in the form of many boats in port waiting to fish make bluefin's status in the Mediterranean Sea quite fragile (Porch 2005).

The western Atlantic stock is also overfished and overfishing is still occurring (ICCAT 2010a). The spawning stock biomass of the western Atlantic stock is currently estimated to be less than 30% of pre-1970 collapsed levels (ICCAT 2010a). This biomass is too low to sustain MSY, and has caused considerable concern among fisheries managers and conservation groups (ICCAT 2010a, See Figure 10, Table 5).

Figure 10. Estimates of western Atlantic bluefin tuna spawning stock biomass.

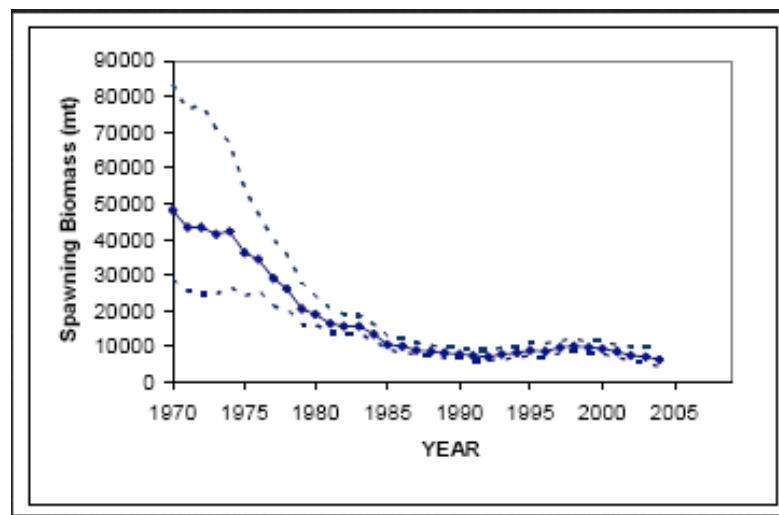


Image from ICCAT 2010c, pg. 76. Note: Dashes indicate 80% confidence intervals.

Table 6. Summary of ICCAT-managed species' stock status from stock assessments.

NON- TUNA SPECIES	Stocks, Year Assessed	MSY in metric tonnes	Stock Status
Atlantic Swordfish	Northern – 2010	13,000 – 14,000	Neither Stock Overfished, Overfishing Not Occurring
	Southern - 2010	15,000	
Mediterranean Swordfish	2009	14,600	Overfished, Overfishing is Occurring
Sailfish	Western – 2009	600 – 1,100	Western/Eastern Stocks Overfished, Overfishing is Occurring
	Eastern - 2009	1,250 – 1,950	
White Marlin	2006	600 – 1,300	Overfished, Overfishing is Occurring
Blue Marlin	2011	1,000 – 2,400	Overfished, Overfishing is Occurring

Tuna Species	Stocks, Year Assessed	MSY or Proxy in metric tonnes	Stock Status
Albacore <i>Thunnus alalunga</i>	Northern - 2009	29,000	Northern/Southern Stocks Overfished, Overfishing Occurring Mediterranean Stock Status Unknown
	Southern - 2011	23,000 – 98,000	
	Mediterranean – 2011	No MSY proxy	
Bigeye <i>Thunnus obesus</i>	2010	78,000 – 102,000	Not Overfished, Overfishing Not Occurring
Bluefin <i>Thunnus thynnus</i>	Western – 2010	2,500	Eastern/Western Stocks Overfished, Overfishing Occurring
	Eastern/ Mediterranean – 2010	13,500	
Skipjack <i>Katsuwonus pelamis</i>	Western – 2008	30,000 – 36,000	Neither Stock Overfished, Overfishing Not Occurring
	Eastern/ Mediterranean - 2008	143,000 – 170,000	
Yellowfin <i>Thunnus albacares</i>	2011	115,000 – 145,000	Overfished, Overfishing Not Occurring
Small Tunas Group	No assessment available	No MSY proxy	Stock Status Unknown

Data from ICCAT 2012a.

Importantly, bluefin tuna is the only ICCAT species for which all of its stocks are overfished and currently experiencing overfishing (ICCAT 2010a).

5. Common Explanations for Complex Management of Bluefin Tuna

The biological peculiarities of bluefin, their high market value, political pressures, history of management, and capital-intensive fisheries make them unique and particularly vulnerable to overexploitation because mature adults can be targeted in large schools during spawning migrations to known areas year after year (Porch 2005, Webster 2011). Several common theories in fisheries economics and management literature seek to explain the management framework in place for, and decline of, bluefin tuna; these common explanations are the foundation of this thesis. These theories are not necessarily mutually exclusive.

A common argument for why bluefin tuna stocks have generally declined and for their unique management is rooted in Garret Hardin's "Tragedy of the Commons" (Hardin 1968). This idea is pervasive in economics literature, the popular media, and even marine resource management literature (Nickler 1999, McWhinnie 2006, Revkin 2008 in *The New York Times*, *The Economist* 2008, Sumaila and Huang 2012). A simple Internet search for the terms "tragedy of the commons, bluefin tuna" returns nearly 8,000 results. Many of these are publications on conservation organizations' websites, teachers' lessons, marine conservation blogs, and respected international sources of information such as the UK's *Guardian* and *The New York Times*.

The widely accepted primary reason for the current state of this stock is its common property and shared stock status, which together can easily drive exploiters of a given natural resource into non-cooperative behaviour, known as the 'tragedy of the commons' (Sumaila and Huang 2012, pg. 502).

Applying the “Tragedy of the Commons” idea to explain decline in bluefin tuna fisheries is inappropriate, however (Buck-Cox 1985, Hanna 1990). ICCAT member countries are clear user groups that adopt management measures to govern the collective actions of the group of fishers. Bluefin tuna fishing has existed since the *tonnara* operated in Roman times, and governance structures have continuously shaped these practices (Maggio 2000, Longo and Clausen 2011). ICCAT has also rebuilt overfished swordfish stocks using similar management tools to those used in the bluefin fishery, which highlights that a “tragedy” or collapse of the resource is not imminent (ICCAT 2008).

Some academics contribute the decline of bluefin tuna instead to the species’ extremely high market value. They argue that cultural norms to “leave fish for the next year” that regulated how traditional *tonnara* and other fishing methods that have operated for millennia have been undermined by capitalistic forces (Maggio 2000, Longo and Clausen 2011). Further, they argue that changing fisheries for Atlantic bluefin tuna in the Mediterranean Sea reflect the “Tragedy of the Commodity”:

Modern ABFT production, born of capitalist private property and the unending quest to maximize surplus value, became the form-determinant of fishing methods, technology, and the labor process in the modern era, resulting in a host of social and ecological contradictions (Longo and Clausen 2011, pg. 324).

Under this explanation, the high market prices paid for bluefin tuna led directly to the development of capital- and technology-intensive modern fisheries for the species as well as government subsidies throughout the EU and Mediterranean countries (Foster et al. 2010). Too many boats are built to catch decreasing numbers of fish each year (Miyake and Kebe 1996, Clausen et al. 2011, FAO 2012a). Industry

groups pressure their respective governments for higher quotas to cover the high capital costs they sink into the fishery, and governments respond with subsidies and pressure on ICCAT Commissioners to push for TACs that are much higher than the scientifically-based TAC recommended by the ICCAT SCRS (ICIJ 2010, Longo and Clausen 2011). Against this backdrop, bluefin tuna TAC allocations and management became a much larger battle over continuation of cultural practices, food security, and employment (Longo and Clausen 2011). In addition, high market prices of bluefin from the expanding popularity of sushi led to infusion of international capital and intense marketing campaigns that allowed the bluefin tuna become a “boutique species” (Safina 2001) that has low use value but high market value (Issenberg 2007).

A third argument has been put forward that suggests that the best available science on which ICCAT purports to base its management decisions has been highly politicized. Some argue that the leading scientific advice over time has been undermined, ignored, or even shelved before becoming public or presented at ICCAT meetings in response to political pressure within member country delegations (Whynott 1995, Fromentin and Powers 2005, Porch 2005, MacKenzie et al. 2008). Further, the same authors argue that imperfect or incomplete science has been seized, co-opted, and exploited by various interest groups to argue for or against specific management changes (Whynott 1995, MacKenzie et al. 2008, Ruais 2011):

We hypothesize that authorities have been unwilling or unable to resist political pressure by the bluefin tuna fishing industry to implement recommended measures... (MacKenzie et al. 2008, pg. 30).

A fourth argument hinges upon the idea that “free-riders,” or parties that are not party to ICCAT and disregard management rules, undermine the effectiveness of

conserving the resource and drive depletion of bluefin tuna (McWhinnie 2006). There are several examples of “free riders” engaged in bluefin tuna fishing in the Eastern Atlantic and the Mediterranean Sea such as Bolivia and Georgia, so this theory has a factual basis (McWhinnie 2006, Pew 2010, Ruais 2011). Catches of bluefin tuna from free riders make up a small percentage of the estimated IUU fishing in a given year, whereas IUU fishing from CPCs can be very large (Pew 2010, ICIJ 2010).

The fact that bluefin tuna in the Atlantic Ocean and Mediterranean Sea constitute a resource that is shared among 48 CPCs and 5 Cooperating Non-Members makes their management particularly difficult to coordinate. In a 2010 book on international environmental governance, Conca and Dabelko summarize the challenge that all RFMOs like ICCAT face:

Just as state sovereignty imposes a pattern of political authority that does not correspond exactly to the underlying ecological reality, so transnational capitalism imposes patterns of economic activity that do not wholly correspond to the prevailing pattern of political authority. Both features of system structure give environmental problems an inherently transnational dimension, and both greatly complicate the prospects for global cooperation. (Conca and Dabelko 2010, pg. 59).

These four common explanations will be reviewed for their merit and appropriateness for helping to describe the current overfished status of both stocks of bluefin tuna and the reasons for adoption of specific management tools in the following chapters.

CHAPTER III. ICCAT MANAGEMENT OF BLUEFIN TUNA

1. History of ICCAT Management

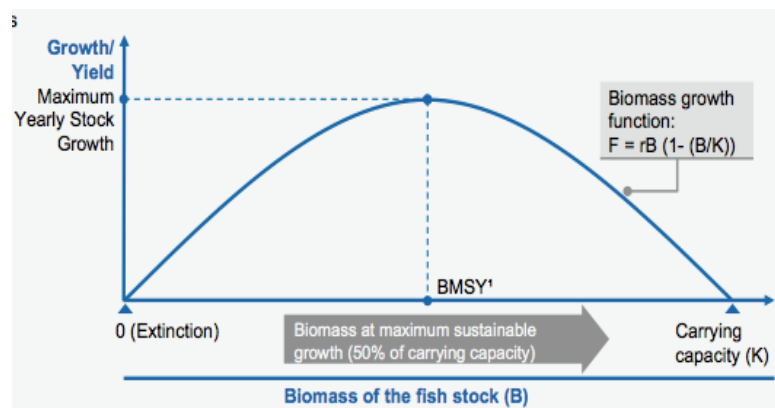
A. ICCAT History and Fisheries Management Framework

Understanding ICCAT itself is essential to grasping its methods of management. After urging from the FAO Fisheries Governing Body in 1966, the Convention for the Conservation of Atlantic Tunas was signed and entered into force in 1969 (ICCAT 2011a). The Preamble of the Convention states ICCAT's goal:

...to co-operate in maintaining the populations of [tuna] at levels which will permit the maximum sustainable catch for food and other purposes (ICCAT 2011a in Foreword).

The objective of sustaining maximum sustainable yield (MSY) is a common goal of many fisheries management regimes (FAO 2012d). The goal is to harvest a species at about half of the total biomass their environment can sustain for that species because stock growth rate is highest at that point (See Figure 10).

Figure 11. Diagram showing the theoretical point intersection of maximum growth in biomass (on the x-axis) and corresponding MSY (on the y-axis) of a fish stock.



From: ICCAT 2012i, Figure 9 pg. 64.

ICCAT is comprised of 48 Contracting Party Countries, including several parties that are not even adjacent to the Atlantic Ocean, making it the largest RFMO in the world (ICCAT 2011a, See Table 6).

Table 7. CPCs and cooperating fishing entities involved in ICCAT.

CPCs and Cooperators	Status
United States, Japan, South Africa, Ghana, Canada, France* (on behalf of St-Pierre et Miquelon), Brazil, Morocco, Republic of Korea, Cote D'Ivoire, Angola, Russia, Gabon, Cape Verde, Uruguay, Sao Tome e Principe, Venezuela, Equatorial Guinea, Republic of Guinea, United Kingdom* (on behalf of the Oceanic Territories), Libya, People's Republic of China, Croatia, European Union, Tunisia, Panama, Trinidad and Tobago, Namibia, Barbados, Honduras, Algeria, Mexico, Vanuatu, Iceland, Turkey, Philippines, Norway, Nicaragua, Guatemala, Senegal, Belize, Syria, St. Vincent and the Grenadines, Nigeria, Egypt, Albania, Sierra Leone, and Mauritania	48 Contracting Parties. Any United Nations country, specialized UN agency, or inter-governmental economic organization may join ICCAT
Chinese Taipei, Guyana, Curacao, Colombia, and Suriname	5 Cooperating Non-Contracting Parties, or Fishing Entities in ICCAT
Cuba, Benin, Spain**, Portugal**, Italy**, Cyprus**, and Malta** are no longer Contracting Parties due to accession of the European Community to ICCAT in 2004 (ICCAT 2012g).	7 CPCs are no longer active in ICCAT

Data from ICCAT 2012g. Note: France and the UK represent St. Pierre et Miquelon & Ascension Island, respectively, and are denoted with an asterisk (*). All other European Union (EU) Member Parties are superseded in this Convention as a result of agreements with the European Community and are denoted with a double asterisk (**)

B. ICCAT-Managed Species

ICCAT manages over thirty species of fish and sharks (ICCAT 2012f, See Table 7).

Table 8. Major ICCAT managed species.

ICCAT Managed Species' Common Name	Species' Scientific Name
Atlantic bluefin tuna	<i>Thunnus thynnus</i>
Skipjack tuna	<i>Katsuwonus pelamis</i>
Yellowfin tuna	<i>Thunnus albacares</i>
Albacore tuna	<i>Thunnus alalunga</i>
Bigeye tuna	<i>Thunnus obesus</i>
Black skipjack tuna	<i>Euthynnus alletteratus</i>
Frigate tuna	<i>Auxis thazard</i>
Atlantic bonito	<i>Sarda sarda</i>
Swordfish	<i>Xiphias gladius</i>
White marlin	<i>Tetrapturus albidus</i>
Blue marlin	<i>Makaira nigricans</i>
Sailfish	<i>Istiophorus albicans</i>
Spearfish	<i>Tetrapturus pfluegeri</i>
Spanish mackerel	<i>Scomberomorus maculatus</i>
King mackerel	<i>Scomberomorus cavalla</i>

Data from ICCAT 2012f in “Introduction.”

C. Structure and Specific Responsibilities of ICCAT

ICCAT is responsible for the conservation of tunas in the Atlantic Ocean and adjacent seas, which it achieves through collecting and disseminating fisheries statistics and data, coordinating research, and developing management plans. ICCAT’s area of jurisdiction, or Convention Area, encompasses all of the Atlantic Ocean and the Mediterranean Sea (ICCAT 2006). The ICCAT organization itself is made up of a Commission body, a secretariat headquartered in Madrid, permanent Working Groups, and four Panels (ICCAT 2012b). A Standing Committee on Research and Statistics (SCRS) provides the Commission with impartial, objective scientific information to frame discussions over recommendations and resolutions that the Commission may choose to enact (Porch 2005, ICCAT 2012b). The SCRS is comprised of CPC

scientists, and their peer-reviewed findings are presented to ICCAT to inform harvest decisions and TAC allocations (ICCAT 2012b). Formal Recommendations and Resolutions are also based upon these publications and findings (ICCAT 2012b).

ICCAT has four permanent committees: the Standing Committee on Research and Statistics (SCRS); Standing Committee on Finance and Administration; Conservation and Management Measures Compliance Committee; and Permanent Working Group for the Improvement of ICCAT Statistics and Conservation Measures (ICCAT 2012b). Four Panels discuss a species group or specific species (ICCAT 2012a). Panel 1 concerns tropical tunas such as skipjack, yellowfin, and bigeye; Panel 2 deals with northern temperate tunas including Northern albacore and Northern Atlantic bluefin tuna; Panel 3 works with southern temperate tunas such as Southern albacore and swordfish; and Panel 4 advises on all other species, such as bycatch species (ICCAT 2012g, NMFS 2012a).

2. ICCAT's Two-Stock Hypothesis

A. History of the 2-Stock Hypothesis

Though the Northern Atlantic bluefin tuna is one species that inhabits the entirety of the Atlantic Ocean and Mediterranean Sea, ICCAT has been managing the fishery as if it were composed of two separate stocks ever since the 1980s (Porch 2005). This peculiarity is due to the fact that ICCAT scientists assumed that migrating bluefin return annually to spawning grounds they have used before, which may not be accurate (ICCAT 1995). The majority of bluefin tuna catch was made close to either side of the Atlantic Ocean in those years, making this management arrangement

convenient (ICCAT 1995, Mather et al. 1995). As a result of this convenience, a management boundary line was drawn at the 45-degree meridian to separate the Eastern Atlantic /Mediterranean Sea stock from the Western Atlantic stock (Mather et al. 1995. Whynott 1995, ICCAT 1995, See Figure 11).

Figure 12. Illustration of ICCAT’s east-west management boundary line (in bold).

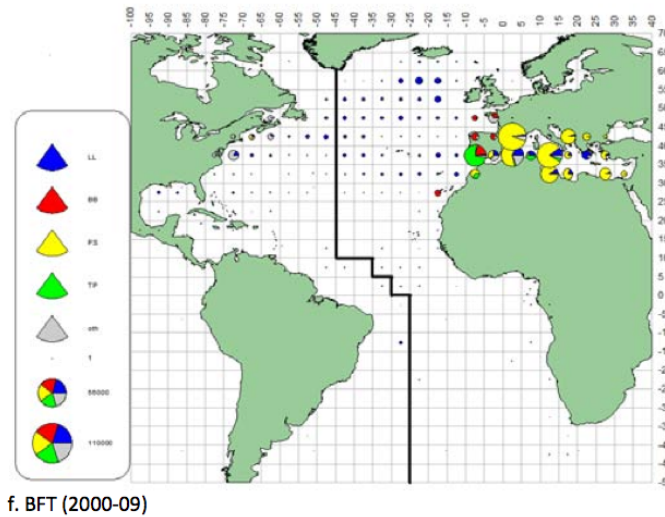


Image from ICCAT 2012f, pg. 90.

The line is somewhat arbitrary and not reflective of the actual biology of the species, which frequently swim beyond this political boundary (Whynott 1995, Porch 2005). According to an ICCAT report from a 2001 workshop on bluefin “mixing,” or swimming across the management boundary:

The dividing line was based on the distribution of catches and some notion of the midpoints between the continents (ICCAT 2010a, pg. 367).

B. Eastern or Western Stock? Why does it Matter?

The debate over the accuracy of the two-stock hypothesis is a critical one for bluefin tuna management because ICCAT CPCs share a portion of the total TAC, or

quota, of each stock. Imagine the two “stocks” (eastern Atlantic/Mediterranean Sea and western Atlantic) as two pies that when combined represent the total ICCAT bluefin TAC in a fishing season. The western Atlantic stock, or pie, is small and shared by three countries: the U.S., Canada, and Japan. The Eastern Atlantic/Mediterranean Sea pie is about five times the size, because bluefin are more abundant there, and is shared among dozens of countries. When a party catches a bluefin in a specific area of the Convention Area, it gets counted as a slice against that specific pie. If that individual fish was not actually born on the side of the management boundary where it was caught, then the counting is inaccurate, and the pies are no longer divided equitably as they were intended by ICCAT.

Due to the uncertain degree of mixing of bluefin tuna over the Convention Area, parties can become adversarial over perceived inequities in allocation of the valuable bluefin tuna resource (Porch 2005). If scientists attribute an incorrect proportion of fish caught to one stock or the other, then stock assessments for both sides become compromised because the total TAC shares are no longer divided up based on relative sizes of each stock. ICCAT’s SCRS acknowledges the problems that this mixing can introduce for managers:

...even small rates of mixing from East to West can have significant effects on the West due to the fact that Eastern plus Mediterranean resource is much larger than that of the West (ICCAT 2012a, pg. 85).

3. ICCAT Management Context

A. Managing a Migratory Species

Bluefin are a highly migratory species, or a “straddling stock” as they are known in international legal regimes, and they swim beyond national jurisdictions in

the form of Exclusive Economic Zones (EEZs) (UN LOS Convention III 1982, United Nations Conference Conf.A. 164/38, 1995). When fish swim beyond the boundaries of any one state in the open ocean, or into the “High Seas,” they are managed exclusively by ICCAT (ICCAT 2011a). While an estimated 90% of commercial and recreational fish are caught within EEZs of states, the bluefin tuna fishery doesn’t follow this pattern, making its management complex (Juda 2008). Specific fishery management tools are required to manage such transboundary stocks (Weber 2002).

B. Stock Management Measures

ICCAT has applied many fishery management tools to limit fishing effort and constrain total catch of both stocks in the bluefin tuna fishery (ICCAT 2012b, Table 5). Different tools employed for the eastern and western stocks (See Tables 8 and 9).

Table 9. Overview of western Atlantic management tools.

WESTERN ATLANTIC MEASURES

Recommendation Year - Number	Measure Type	Measure Goal
1974-01	Minimum Size	Reduce juvenile mortality
1982-01	Closed Season/Area	Protect spawning aggregations in Gulf of Mexico
1991-01	National Shares of TAC	Percentage sharing of TAC among CPCs and Cooperating Non-Members
1993-05	Certification Scheme	Reduce sale of IUU fish, reduce total catch in fishery
1996-04	Research Set- Aside	Portion of annual quota dedicated to scientific research program
1998-07	Rebuilding Plan	Rebuild Spawning Stock Biomass (SSB) to levels that support MSY by 2019

Data from ICCAT 2012b.

Table 10. Overview of eastern Atlantic management tools.

EASTERN ATLANTIC/MEDITERRANEAN SEA MEASURES

Measure Year, #	Measure Type	Measure Goal
1992-01	Catch Certification	Certify origin of landed fish to accurately allocate quota shares, reduce IUU fishing
1993-07	Closed Season/Area	Mediterranean Sea closed to longlining, reduces mortality in Tyrrhenian Sea
1994-11	Capacity Reduction	Reduce fishing effort to 1995 levels, reduce catch by 25% from those years
1995-04	Research Set-Aside	Allocate quota share for scientific tagging research program
1996-03	Minimum Size Limit	Reduce juvenile mortality
1998-05	National Shares of TAC	Percentage sharing of TAC among CPCs and Cooperating Non-Members
2006-05	Stock Rebuilding Plan	Rebuild Spawning Stock Biomass (SSB) to levels that support MSY by 2023
2006-07	Farming Capacity Reduction	Better monitoring of total catch, transfer of tuna to net-pens, reduce IUU fishing
2007-04	TAC Overages Payback Program	Allow over-quota catches in one year to be repaid with lower allocation in future
2007-10	Mandatory Trade Reporting Requirement	Mandatory declaration of farmed bluefin trade from CPCs, Cooperating Non-Members to reduce IUU fishing
2008-06	Multilateral Trade Sanctions	Reduce IUU fishing, activities that undermine ICCAT management
2009-06	Capacity Reduction	“Drastic reductions in fishing capacity for all Parties” (ICCAT 2010b pg.5).

Data from ICCAT 2012b.

Unique management tools are used in the Eastern Atlantic/Mediterranean Sea to constrain effort, reduce fishing and farming or ranching capacity, and to reign in total catch (Porch 2005). Due to these unique threats to the eastern stock stemming from ranching and high levels of IUU fishing, there is a corresponding increase in the number and type of management measures employed to govern that fishery (Pew

2010, ICIJ 2010). These tools help to address the transfer of illegally caught fish to pens and ranches in the Mediterranean Sea, which has been identified by ICCAT as critical to reducing IUU fishing and increasing the health of the eastern bluefin stock by ICCAT (ICCAT 2012a). This is partially due to the fact that at-sea transfers of bluefin do not count toward a country's share of the TAC, only landed fish do. Further, illegal catch of undersized and immature tuna to supply the ranching pens significantly undermines ICCAT's ability to forecast availability of mature, spawning fish necessary to support maximum sustainable yield of the fishery (ICCAT 2012a).

4. Politics Surrounding Bluefin Tuna

A. Political Pressure Affects Bluefin Tuna Management

Bluefin is an emblematic example of a shared stock and this creates a tricky political context...the main challenge for the conservation and management of this stock is nowadays more political than scientific... (Fromentin and Fonteneau 2002, pg. 74).

Each CPC has its own motivations for engaging in bluefin fisheries; this situation causes political tension between states that want to halt the decline of bluefin tuna worldwide and the states that catch, ranch, and sell tuna. For example, recent high unemployment in countries like Spain, Italy, and Greece, renders little political support for enforcing rules that would keep boats and fishermen in port in these countries (Sumaila and Huang 2012). These countries often pay large sums to developing states like Libya, Tunisia, and Egypt in order to catch portions of their allocated tuna quotas to keep their large fishing industries working during hard economic times (Sumaila and Huang 2012, European Commission on Fisheries 2012).

Small-scale tuna fishers and operators of fish traps claim they wish to continue traditional fishing practices as part of a cultural identity (Roesti 1966, Maggio 2000). The complex interplay of these factors create pressure that impacts bluefin tuna stocks perhaps more than any other stock under ICCAT's management. According to one ICCAT scientist, "There was just no political will to enforce the rules" of setting reduced TACs in the face of these economic and cultural considerations in the late 1990s to mid-2000s, which contributed to bluefin stock declines (ICIJ 2010, pg. 8).

B. Bluefin Tuna as a Special Status Species

The large size, wide migrations, over-exploited status, charisma, popularity, economic importance, recognition, and high demand in the sushi industry have helped bluefin tuna achieve an elevated status (Doyle et al. 1995, Leader-Williams and Dublin 2000, Entwistle and Dunstone 2000, Sergio et al. 2008, ICCAT 2008, Martin-Lopez et al. 2009, Collette 2011). Non-scientific information can play a crucial role in conservation initiatives and legal status of a species, as it has with bluefin tuna (Safina and Klinger 2001, Worm and Duffy 2003, Martin-Lopez et al. 2009). Conservation biology literature notes that listing a species as "threatened" or "endangered" of extinction in national or international arenas is linked with such "iconic" species that capture humans' attention and imagination (Ray 2005, Sergio et al. 2008, Martin-Lopez et al. 2009, Collette 2011). As a result of this elevated status, conservation groups now "pursue protective measures [for bluefin] with a zeal usually reserved for whales" (Porch 2005, pg. 364). This status, however, has important policy implications, both positive and negative (Weber 2002, Webster 2011).

Bluefin tuna have become a powerful policy symbol of overfishing and the need for conservation over the past few decades as a result of their “iconic,” “charismatic” attributes. Policy symbols can be used to unite and promote and effect change (Brunner 1987). They can help lead to issue expansion, whereby an issue takes on a more important, prominent role than it once had because different advocacy coalitions rally around it for a specific cause to try to garner support for their specific position (Brunner 1987, Yanow 1993, Harvey 1994). In addition, symbols can help an issue such as overfishing obtain meaning by communicating the complex science involved with a simple image (Yanow 1993). They can also help create consensus on issues, such as “overfished” status of species or the need for conservation, and lead to rapid opinion formation on an issue (Brunner 1987). Finally, policy symbols can also be used to exploit, coerce, subvert, or de-emphasize the empirical or scientific understanding of a subject and overemphasize the social understanding of an issue depending on the perceptions of those involved in creating the symbol (Appleyard 1979, Brunner 1987). This can be especially problematic for an international symbol such as the bluefin tuna, because different cultural meanings from across the Convention Area can become attached to it (Yanow 1993).

In the context of the bluefin tuna management policy problem, the symbolism associated with bluefin tuna has changed considerably over time. Ancient Phoenician and other Mediterranean cultures put bluefin tuna images on the opposite side of coins stamped with the epic hero Hercules to represent the power, bounty, and wonder of the sea (Maggio 2000). Recently, environmental and NGO groups can use the symbol of the beleaguered bluefin tuna to argue for broader changes within ICCAT and fisheries

management in general. Groups such as the World Wildlife Fund, Oceana, Greenpeace International, Pew Environment Group, and others now use the image of bluefin tuna as a symbol of overexploitation of fisheries and marine resources more generally. This strong symbolism has been used to evoke a sense of wonder and awe in people concerned about species conservation and effective fisheries management, which potentially attracts non-scientific explanations and information on the subject (Yanow 1993). It helped fuel the recognition of the troubled plight of bluefin tuna in popular media over time, as well as recent pushes to ban trade on the species in the United States and internationally. This will be discussed more in Chapter VI.

CHAPTER IV. THESIS METHODOLOGY

1. Literature Review Methodology to Test Six Hypotheses

A. ICCAT Management Regime Comparison

In this Chapter, I describe the literature review and key informant interview methods used to analyze documents and extract insights from key informant interview transcripts to test the following hypotheses about the factors that contribute to the management of bluefin tuna:

1. High market value of bluefin tuna meat does not fully account for the unique management of this species.
2. Individual market value, fleet size, and scale of the bluefin tuna fishing industry are not greater in proportion to the special management attention this species receives compared to other ICCAT-managed fisheries.
3. Bluefin tuna have achieved an “iconic” or “charismatic” status in popular media, peer-reviewed literature, and in non-governmental group publications that other ICCAT-managed stocks have not.
4. This “iconic” status contributes to the management approaches adopted by ICCAT to manage this species differently than others, and has important implications for both the resource and the fishing industry.
5. Non-scientific information and political pressure play a major role in influencing which management tools are adopted at ICCAT meetings, and a disproportionate amount of management attention and focus is afforded to bluefin tuna.
6. Media scrutiny and heightened status of the bluefin tuna affects ICCAT’s ability to effectively manage the species.

To explore these hypotheses, I first compiled and compared the management measures used to regulate the bluefin tuna fishery to those of used to manage the ICCAT-managed fisheries for bigeye tuna, swordfish, and yellowfin tuna. These fisheries were utilized as useful comparison subjects because they represent the

bluefin's closest peers in terms of value, size, and attributes of the fisheries. To do this, I reviewed ICCAT reports of management measures for each stock. This methodology is similar to Krippendorff's qualitative content analysis, which he summarizes as a collection of methods of examining communication that yield inferences from verbal, illustrative, and symbolic information (Krippendorff 2013). I used this methodology to draw insights and make explanatory comments about the discourse and messages communicated in literature to assess my six hypotheses. I focused on ICCAT published documents, NGO reports, and academic publications as the major sources for my literature review. I compared quantitative data where appropriate, such as comparing relative numbers of management actions used for a specific fishery, but focused mainly on qualitative presentation of information.

B. Comparing Relative Market Value of ICCAT-Managed Fisheries

To address my first two hypotheses, I needed to compile ICCAT data on the relative scale and fleet size in each fishery as well as market data. Since high prices are cited as a reason for different ICCAT management, I wanted to find out if bluefin tuna fishery was actually the most valuable one managed by ICCAT. There are no comparative analyses of the market value of all ICCAT fisheries that are publicly available, so I had to piece together one of my own that was consistent. To assess market value, I calculated and compared the estimated value of bluefin fisheries to those for bigeye and yellowfin tuna and swordfish, because those fisheries are most similar to the bluefin fishery in terms of size of fleets, methods, and areas where the fisheries are focused. To estimate the relative market value of these fisheries within

the ICCAT Convention Area, I first summarized which methods of capture accounted for the majority of catch in each one based on ICCAT's published summary reports. Then, I used ICCAT's official Record of Vessels to compare number of vessels actively engaged in the fishery for each species to get an idea of the Convention-wide scale of each fishery. This rough comparative tool is not meant to be precise, but is intended to illustrate relative economic importance of the fisheries for each species.

In order to complete a useful comparative analysis, I used the number of vessels involved in unique fisheries as a proxy for effort in the ICCAT Convention Area for the bigeye tuna, swordfish, and yellowfin tuna fisheries. I took into account the fact that ICCAT only requires accurate accounting of vessels in the Mediterranean Sea, not throughout the rest of the Convention Area. This skews the fishing effort data considerably for swordfish, bigeye tuna, and yellowfin tuna, whose fisheries are mostly prosecuted outside of the Mediterranean Sea and on the eastern side of the Atlantic Ocean. Despite these limitations, this approach provides a reasonable estimate of size and effort involved in the fisheries because no other relevant data sources are accurately compiled or publicly available (Miyake and Kebe 1996).

These data on the number of vessels and CPCs actively involved in each fishery were gathered to complement market data from Madrid's Fish Market, Mercamadrid, to estimate the total market value of each fishery to help address my research questions. Actual market prices for ICCAT-managed species were obtained from this fish market because it is the second largest in the world and it lies at the center of the Convention Area. Market data from Tokyo's Tsukiji Fish Market were not available for this assessment. I used market data for bluefin tuna, bigeye tuna,

swordfish, and yellowfin tuna to summarize the average price in U.S. dollars per kilogram of fish from the Convention Area, which I multiplied by the most current legal MSY or proxy (measured in metric tonnes) provided by ICCAT's website to obtain an estimate of the total relative market value of each fishery. In this estimate of relative value of ICCAT-managed fisheries, I assumed that all else but the market price and average size of these species is equal.

C. Assessing Effects of Bluefin Tuna's Special Status on its Management

To assess the special status that bluefin tuna have attained and its impacts in hypotheses 3 and 4, I reviewed conservation biology literature and environmental NGO and conservation group publications, and created a tool with which to gauge bluefin tuna's "iconic" and "charismatic" status. I summarized conservation biology literature on charismatic megafauna and its impacts on conservation to compile a list of attributes that all such species have in common. Next, I examined the records of five influential journals in the field of fisheries conservation to get a sense of the body of published research on bluefin tuna compared to other ICCAT-managed stocks. I examined the records of the journals *Science*, *Nature*, *Fisheries Research*, *Marine Policy*, *Ecology* and *Frontiers in Ecology and the Environment* from 1964, or as long as the journals have been published, to present. I chose five journals to act as a rough illustration of the publishing popularity of each species out of practical considerations. I could have examined the records of dozens of journals, but my intent here is merely illustrative. I assessed their relative importance in terms of the number of times these journals have been cited in the documents I used for my literature review.

Finally, I relied on a combination of literature review and interviews to assess hypotheses 5 and 6. I extracted information from each to create a chronological narrative of the special status bluefin tuna have attained since the 1970s through the influence of interest groups. I qualitatively assessed some of the relative pressure these groups have put on ICCAT to manage bluefin tuna through various domestic and international conservation vehicles such as the U.S. Endangered Species Act to gauge this assessment. I also examined how non-scientific information has played into these efforts and affects how ICCAT adopts various management measures.

2. Key Informant Semi-Structured Interview Methodology

A. Background

I used a semi-structured interview methodology to test my hypotheses about why bluefin tuna are managed differently than other ICCAT-managed stocks that reflect current popular beliefs. Semi-structured, purposive interviews are not useful for generalizing about populations on a large scale, but are effective at offering general impressions and insights into a particular issue by offering flexibility with how questions are asked (Tremblay 1957, Bernard 2006, Dalton 2006). This methodology suits my purposes in this study, because this research requires qualitative information and targeted sampling of specialized knowledge that relatively few individuals hold. This methodology afforded me the flexibility to progressively re-structure questions to probe various aspects of a respondent's specific topical knowledge (Bernard 2006).

I compared findings from the literature review to the themes that emerged in the interviews while keeping in mind that not all interviews would provide me with a

perfect sample of information. Some key informants have more firsthand expertise about some topics than others, and even people with the same level of experience on an issue may have different perceptions of the same idea or experience (Bernard 2006). To address this, I sought to interview key informants from a pool of thirty people that are intimately familiar with Northern Atlantic bluefin tuna management and the ICCAT management process from a United States perspective. I contacted fifteen experts (50% of the total pool) with a generic email explaining my intent to conduct semi-structured, confidential key informant interviews to assist me in my research as well as a formal, voluntary Consent to Participate Form explaining the research project in detail (See Appendices I and II). The respondents represent every interest group with representation on the U.S. ICCAT delegation. I interviewed the twelve potential informants that responded, making my response rate 80% and securing a representative sample of 80% of the total pool.

B. Choosing Key Informants

I chose to interview U.S.-based bluefin tuna experts that have attended at least one ICCAT General Meeting or Special Meeting in the last decade. I reached out to interview only U.S. bluefin tuna management experts out of expediency. Since ICCAT is the largest RFMO, there are hundreds of individuals representing over fifty countries with a working knowledge of their management, but language barriers and practical considerations prevented me from contacting them for this research. The next logical step in making this study more representative of perspectives of other ICCAT members would have been to interview experts from Japan and the EU, the other two

most influential bluefin tuna fishing nations. However, language barriers and practical concerns made taking this next step difficult and unviable for this thesis research.

The respondents I interviewed serve as a useful representation of the many different groups and interests involved in ICCAT meetings from a U.S. perspective, but perhaps not ICCAT as a whole. I chose these participants from lists of U.S. ICCAT delegations to the ICCAT Annual Meetings from the U.S. National Marine Fisheries Service (NMFS 2012). In this regard, my interview methods are representative in that I interviewed a representative of every major interest group listed that takes part in ICCAT meetings as part of the official U.S. delegation (Bernard 2006). The U.S. delegation is one of the most influential at ICCAT meetings, and their scientists and NGO representatives help provide the science that drives management decisions on bluefin tuna (Weber 2002, Ruais 2012). Therefore, it is valuable to sample U.S.-based experts as I have here.

C. Conducting Key Informant Interviews, Compiling Results

After initial emails were sent to potential key informants, I began interviewing twelve respondents that had read, signed, and returned the Consent to Participate Form that took place between November and December 2012. During phone interviews that each lasted between forty-five minutes and an hour and fifteen minutes, I asked respondents a prepared list of seven questions and additional questions about their years of experience in bluefin tuna management issues and any specialized fisheries expertise they may have (See Appendix III).

I transcribed the interview responses by hand, and typed them immediately after each interview had been completed. I created a spreadsheet to compile and organize interview responses. Rather than use direct quotations from key informants that might betray their identities in this confidential study, I grouped similar responses together based on keywords and overarching themes. I split up responses to each question by respondent, and looked for common themes or general trends. I organized transcripts from each interview and developed a structured coding scheme to identify themes of contributing factors of bluefin management (Bernard 2006). The coding scheme was grounded in either ICCAT management tools or emerging themes from the literature review using grounded theory interpretation techniques (Bernard 2006, Matchar et al. 2006).

For questions referring to specific management tools or approaches, I grouped responses according to tools identified in ICCAT documents. For questions referring to perceptions or impacts of these tools, I used my own value judgments based on my literature review to group them into impact themes. I used keywords to group these responses, which is admittedly an imperfect and non-subjective component of my coding methods. However, a reasonable person that had conducted a literature review would be led to similar coding choices, making my methods and results realistically repeatable. Then, I aggregated general impressions from the notes and compared them to the responses of the group as a whole in a qualitative manner. Since the sample size was relatively small for this study ($n = 12$), I avoided percentage breakdowns of frequency of responses. I summarized how many participants responded a certain way to each question, and present these results in Chapter V.

D. Comparing Respondents' Input with Literature Review

I compared the literature review findings with respondents' insights to determine if my hypotheses were supported or rejected. The usefulness of these exercises lies in the insight they provide into the complexities and difficulties of managing Northern Atlantic bluefin tuna within the ICCAT-management framework while dispelling common misperceptions about bluefin tuna management. This is particularly valuable for those generally interested in fisheries management.

CHAPTER V. RESULTS

1. Hypothesis Testing

A. Hypotheses 1, 2: Market Value, Fleet Size, and Scale of Bluefin Fishery

In this chapter, I provide an overview of the results of content analysis and interview responses in the same order as my hypotheses are listed. Hypothesis 1 questions whether the high market value of bluefin tuna meat fully accounts for the unique management of bluefin tuna. Similarly, Hypothesis 2 posits that both the individual market value of individual fish, fleet size, and scale of the fishery for bluefin across the ICCAT Convention Area are not greater in proportion to the special management attention this species receives.

To assess the relative market value and create a proxy for the relative scale of the bluefin tuna fishery, I summarized the number of vessels officially registered with ICCAT to pursue bigeye tuna, bluefin tuna, swordfish, and yellowfin tuna in the Convention Area (ICCAT 2011b, See Table 10).

Table 11. Summary of registered numbers of vessels in four ICCAT fisheries.

ICCAT-Managed Species	Registered Number of Vessels in Fishery
Bigeye and Yellowfin Tuna	1,277**
Bluefin Tuna	1,012*
Swordfish	12,600**

ICCAT 2011d. Note: These numbers represent catching-vessels only. * Denotes a fishery where the reported vessels account for a majority of catch of that species. ** Denotes a fishery where the reported vessels do not account for a majority of catch of that species; the fishery is mostly prosecuted elsewhere in the Convention Area.

For this comparison, I ignored the numbers of processing and transport ships involved in these fisheries for this comparison, because these vessels are often

engaged in multiple fisheries (ICCAT 2011d). Also, the majority of the fishery for bigeye tuna, swordfish, and yellowfin tunas is prosecuted outside the Mediterranean Sea, which contrasts with the fishery for bluefin tuna (ICCAT 2011d). I provide evidence here that market value, fleet size, and scale of the bluefin tuna fishery is not greater than those of fisheries for other ICCAT-managed species, and is not currently in proportion to the magnitude of management attention it receives.

Estimating total value of these fisheries is complicated by considerable multiplier effects of economic factors such as labor, travel, lodging, bait, ice, gear, and other costs that are highly variable, diverse, and largely unreported among the various fleets for these four species (ICIJ 2010). I avoid complex economic analysis of these forces and instead compiled June 2012 average price data (in U.S. Dollars per kilogram) of various ICCAT species below to illustrate market value of these fisheries (FIS 2012, VASEP 2012). I chose to use June data because this was the most recent data available at the time, and I wanted to reflect the relatively high seasonal prices of bluefin tuna that are paid in the summer months (Issenberg 2007, See Table 11).

Table 12. Average actual market prices of ICCAT-managed species, in \$US/kg, from Mercamadrid, Spain, in June 2012.

ICCAT Species, Market Product	Average Price (\$US/kg)
Bullet/Frigate Tuna, Whole	\$2.10 – 2.75
Swordfish, Gutted Whole	\$14.42 - 18.92
Yellowfin Tuna, Whole	\$4.81 - 6.32
Albacore Tuna, Whole	\$6.61 – 8.68
Bigeye Tuna, Whole*	\$8.46 – 9.36
Bluefin, Gutted, Head Off*	\$11.82 – 16.58

Data from FIS 2012. *Bigeye and bluefin tuna price data were originally recorded in Japanese Yen in reports on their market value and then converted using June 2012 exchange rates of for the Japanese Yen to the U.S. Dollar.

From this compiled data, gutted and beheaded bluefin tuna were more valuable than any other tuna species, but were about 20% less valuable than whole gutted swordfish in the summer of 2012 (FIS 2012). This simple market analysis represents only a snapshot in time of the very complex tuna trading industry, but nonetheless **supports Hypothesis 1** and provides further evidence to **support Hypothesis 2**. The available average market prices paid for each ICCAT species is compiled along with each species' ICCAT-mandated MSY or proxy in metric tonnes (See Table 12).

Table 13. ICCAT MSY for stocks of bigeye tuna, bluefin tuna, swordfish, and yellowfin tuna and actual June 2012 average price in US Dollars per kilogram.

Species	MSY or Proxy of Stock in metric tonnes	Reported Market Value in US Dollars per kilogram
Bigeye Tuna	78,000 – 102,000	\$8.46 – 9.36
Bluefin Tuna	Western – 2,500	\$11.82 – 16.58
	Eastern/Mediterranean – 13,500	
	Northern - 13,000 – 14,000	\$14.42 - 18.92
Swordfish	Southern – 15,000	
	Mediterranean – 14,600	
Yellowfin Tuna	115,000 – 145,000	\$4.81 - 6.32

Data from ICCAT 2012a, FIS 2012.

I then multiplied the total ICCAT-set MSY of each fishery by its respective market price to compare the relative market value of each fishery. To ensure consistency in this analysis, I applied the highest reported market price to the highest MSY value or proxy for each stock. My calculations of the rough market value for the fisheries for these four species follow in alphabetical order:

1. Bigeye Tuna: 102,000 total mt x 1000kg = 102,000,000kg
\$9.36/kg: 102,000,000 x \$9.36 = **\$954,000,000**

2. Bluefin Tuna: 16,000 total mt x 1000kg = 16,000,000kg
\$16.58/kg: 16,000,000 x \$16.58 = **\$265,280,000**

3. Swordfish: 43,600 total mt x 1000kg = 43,600,000kg
\$18.92/kg: 43,600,000 x \$18.92 = **\$824,912,000**

4. Yellowfin Tuna: 145,000 total mt x 1000kg = 145,000,000kg
\$6.32/kg: 145,000,000 x \$6.32 = **\$916,400,000**

In summary, the value of the bluefin tuna fishery seems to be lowest of the four fisheries compared across the Convention Area (See Table 13).

Table 14. Ranked summary of estimates of total market value of four ICCAT-managed fisheries.

ICCAT-Managed Fishery	Estimated Total Market Value of Fishery Ranking
Bigeye Tuna	1. \$954,000,000
Yellowfin Tuna	2. \$916,400,000
Swordfish	3. \$824,912,000
Bluefin Tuna	4. \$265,280,000

These data contrast sharply with the common misperception that bluefin tuna represent the most valuable fishery in the Atlantic Ocean and Mediterranean Sea. This MSY-based comparison is imperfect due to inflated catches of species that exceed MSY, and has the potential to underestimate the total value of the fisheries by not including multiplier effects and seasonality differences in prices paid for each fish. However, this analysis is meant to be illustrative, and I have estimated the value of the bluefin tuna fishery is many times lower than the others. My analysis is further supported by an independent consulting firm's estimate of the approximately US\$300 million dollar value of the bluefin tuna fishery, which is reasonably close to my

estimate (Bonini et al. 2011, pg. 16.). In addition, bluefin tuna catch constitutes less than 5% of total tuna catch in the Convention Area. In light of its small contribution to total tuna catch, it seems that bluefin tuna attract disproportionate magnitude of ICCAT management and media attention. **This analysis supports Hypothesis 2.**

B. Hypotheses 3, 4: “Iconic” Status of Bluefin Tuna

I assert that bluefin tuna have been made popular in part through media attention in the forms of television specials, movies, newspaper articles, and social media campaigns. Popular television shows and documentaries such as “Fighting Tuna,” “Wicked Tuna,” and “Tuna Wranglers” focus on catching and ranching bluefin tuna. The British Broadcasting Corporation and National Geographic Society each produced educational specials about bluefin, including “Blue Planet-Open Ocean” and “Superfish: Bluefin Tuna” (National Geographic Society 2012). These media productions focus on the over exploitation of many of the world’s fisheries, and highlight the perceived “endangered” status of bluefin tuna, as in Charles Clover’s *The End of the Line* (Clover 2008).

This “iconic” status makes bluefin tuna a powerful policy symbol that has the effect helping to draw attention to an issue by groups of actors and advocacy coalitions such as environmental and conservation NGOs (Harvey 1994). This symbolism is powerful, as noted in the policy literature, because it helps to bring issues such as the overfished state of both stocks of bluefin tuna, that are distant or poorly-understood, into people’s homes (Appleyard 1979). When the plight of bluefin tuna is brought into people’s homes through ads and conservation campaign media,

social meanings about overfishing problems and the need to conserve ecosystems tend to take the place of a focus on scientific information and meanings based on research (Appleyard 1979, Harvey 1994). However, at the same time bluefin’s symbolic power in the policy realm is on the rise, they have also captured the attention of researchers more than other ICCAT species (See Tables 14 and 15).

Table 15. Results of peer-reviewed, published literature search queries for “Northern Bluefin Tuna”.

Peer-Reviewed Journal Records Reviewed	Years Covered	Number of Articles with “Northern Bluefin Tuna” in Title, Abstract
<i>Nature</i>	1973 - Present	10
<i>Science</i>	1974 - Present	60
<i>Fisheries Research</i>	1986 - Present	180
<i>Marine Policy</i>	1986 - Present	50
<i>Ecology and Frontiers in Ecology and the Environment</i>	1998 - Present	30
TOTAL		330

Table 16. Combined results of peer-reviewed, published literature database search queries for “Bigeye Tuna” and “Yellowfin Tuna”.

Peer-Reviewed Journal Records Reviewed	Years Covered	Number of Articles with “Yellowfin Tuna” or “Bigeye Tuna” in Title, Abstract
<i>Nature</i>	1964 - Present	3 + 3
<i>Science</i>	1968 - Present	2 + 1
<i>Fisheries Research</i>	1976 - Present	90 + 25
<i>Marine Policy</i>	1986 - Present	18 + 16
<i>Ecology and Frontiers in Ecology and the Environment</i>	1997 - Present	12 + 4
TOTAL		165

Articles about bluefin tuna are published 30% more frequently than works about other ICCAT species. This provides **support for Hypotheses 3 and 4.**

Research popularity and powerful symbolism have helped bluefin tuna attain and perpetuate an “iconic” and “charismatic” status (Doyle et al. 1995, Sissenwine et al. 1998, Safina 1998, Worm and Duffy 2003, Mace 2004, Sergio et al. 2008, Martin-Lopez 2009, Collette 2011, Wolinsky 2012, See Table 16). ICCAT referenced this special status of the species in their independent performance review, which was driven by cries in the international community for a “hard look” at their effectiveness:

Civil society has taken stronger interest in management, especially for iconic [bluefin] tuna species (ICCAT 2008 pg. 4).

Table 17. Characteristics of “charismatic,” “iconic” species and bluefin tuna compiled from conservation biology and fisheries management literature (Doyle et al. 1995, Sissenwine et al. 1998, Safina 1998, Worm and Duffy 2003, Mace 2004, Sergio et al. 2008, Martin-Lopez 2009, Collette 2011, Wolinsky 2012).

Attributes of “Charismatic” or “Iconic” Species	Corresponding Attributes of Northern Atlantic Bluefin Tuna
Large Size	Largest bony fishes in the ocean.
Rare	More rare than any other tuna species, and perhaps more than any other commercially harvested species
Popular	Found in every ocean in the world and migrate great distances; interact with humans commonly. Fisheries for bluefin are the oldest recorded in the world. Demand for their flesh largely drives expansion of the world’s sushi industries. There are numerous documentaries and popular television shows about bluefin tuna.
Ability to Capture Public Imagination	Bluefin tuna are highly regarded as game, sport, and table-fish around the world, and are one of the fastest fishes in the sea. They are utilized by environmental NGOs as “flagship” species to attract public attention to conservation campaigns.
High Economic Importance	No fish sells for a higher price at market than bluefin tuna.
“Threatened” or “Endangered” Status	The International Union for the Conservation of Nature (IUCN) has listed all three bluefin tuna species around the world as “Endangered” on their “Redlist”. Several attempts to list bluefin under CITES have also been made. Both stocks of bluefin tuna in the Convention Area are currently overfished.

Based on these attributes, bluefin tuna meet and surpass the requirements of an “iconic” species. They display all of the characteristics necessary to have attained this status, and have the added benefit of a long, storied history of use as a powerful symbol since at least 4,000 B.C., as evidenced by cave paintings with their image from Sicily (Maggio 2000). This summary of literature **supports Hypothesis 3.**

C. Hypothesis 4: “Iconic” Status Contributes to ICCAT Management

A literature review provided little support for this hypothesis. The only published evidence that supports this idea comes from the American Bluefin Tuna Association and is anecdotal (Ruais 2011). I revisit this hypothesis in Chapter VI.

D. Hypothesis 5: Political Pressure Affects ICCAT Management

According to Hypothesis 5, non-scientific information and political pressure from interest groups play a major role in influencing adoption of management tools at ICCAT meetings, and a disproportionate amount of management attention and focus is afforded to bluefin tuna. Non-Governmental Organizations (NGOs) do put pressure on ICCAT to manage bluefin tuna, as evidenced by various attempts to forbid trade of the species internationally by many countries (ICCAT 2008, See Table 17). No such attempts at legal protection have been made for other ICCAT species.

Table 18. Summary table of attempts to secure legal protection for bluefin tuna.

Year	Type of Legal Protection Sought	Major Responsible Party
1974	“Endangered” status under Sec. 4 of the U.S. Endangered Species Act (ESA)	Sport Fishing Institute (SFI)
1992	Appendix 1 CITES listing	National Audubon Society; Government of Sweden
1994	Appendix 1 CITES listing	Greenpeace International; Government of Kenya
2010	Appendix CITES listing	Prince of Monaco
2010	“Threatened” or “Endangered” status under Sec. 4 of the U.S. ESA	Center for Biological Diversity
2011	“Endangered” status under Canada’s legal structure	Committee on the Status of Endangered Wildlife in Canada (COSEWIC)

E. Hypothesis 6: Status Affects ICCAT’s Management of Bluefin Tuna

According to Hypothesis 6, media scrutiny and heightened status of the bluefin tuna affects the ability of ICCAT to effectively manage the species at MSY levels. The efforts of conservation groups and environmental NGOs, coupled with intense media attention on ICCAT in the mid-2000s, drove ICCAT to order an independent review of the effectiveness of its organization (ICCAT 2008). The independent review concluded that ICCAT’s handling of bluefin tuna management, on which the public judges the effectiveness of the whole organization, amounted to an “international disgrace” because they consistently set higher TACs than were recommended by their own SCRS experts (ICCAT 2008, pg. 19). This disgrace impacted how ICCAT made quota allocation decisions and set TAC levels, and provides some evidence to support the idea that the strong policy symbol that the bluefin tuna has become impacts its own management in complex ways.

Specifically, there appears to be a link between attempts to list the bluefin tuna under CITES and the U.S. Endangered Species Act and the setting of TACs in line with scientific recommendations for the first time in decades. Some respondents and the ICCAT Independent Performance Review in 2008 suggest that these two specific efforts to secure legal protection for the fish were taken extremely seriously by ICCAT for fear that they would lose their management mandate over the species forever (ICCAT 2008). This symbolic power of the bluefin tuna helped create one of the small successes in its management. As a result of the strong amount of scientific and non-scientific information fueled by environmental NGOs and other advocacy coalitions pushing of the symbol of the overfished bluefin tuna, ICCAT began to lower TACs substantially starting in the 2011-fishing year (ICCAT 2012c). This started a decreasing trend in SCRS recommendations for TACs and the actual quotas set in a given year (See Table 18). TACs and recovery plans based on them were identified in Chapter I as the two bright spots in bluefin tuna management, and there is evidence from the public policy literature that the use of the symbol of bluefin tuna and its “iconic,” elevated status helped to create the momentum for this change. Importantly, there is a lag time of a few years to ratchet TACs down in to scientifically based levels, but this is due to the fact that TACs are set every other year for two years, so are not adjusted at every annual meeting (ICCAT 2012a).

Table 19. ICCAT SCRS TAC recommendation and TAC set for eastern Atlantic/Mediterranean Sea bluefin tuna by year.

Year	SCRS TAC Recommendation (mt)	Quota Set by ICCAT (mt)
2003	15,000	32,000
2004	15,000	32,000
2005	15,000	32,000
2006	15,000	32,000
2007	15,000	29,500
2008	15,000	28,500
2009	8,500 - 15,000	22,000
2010	8,000	19,950
2011	8,000	13,500
2012	8,000 - 15,000	12,900
2013	8,000 - 15,000	13,500

Modified and updated from Sumaila and Huang 2012. Table 5, pg. 507.

The second failed CITES listing attempt in 2010 led directly to Recommendation 11-17 which emphasized ICCAT’s commitment to seeking out the best available science on which to make its decisions, Recommendation 11-18 which improves the use of trade sanctions and their effectiveness for flag states of vessels involved in IUU fishing, and Recommendation 11-20 which strengthened the existing bluefin catch documentation scheme to close catch reporting loopholes (ICCAT 2011c). Pressure from environmental groups also drove development of the eBCD scheme (ICCAT 2011c). There is evidence that these measures were partially driven by the special status of the species and public and NGO attention on bluefin tuna management from the interviews, which will be discussed further in Chapter VI.

The special status of bluefin tuna influenced proposals to list Northern the species under Section 4(a) 1 of the U.S. Endangered Species Act of 1973 and Appendix 1 of CITES (Ruais 2011). These attempts failed to secure legal protection

of bluefin tuna from directed fishing effort and international trade, but did succeed in heightening public interest in the species. Interest group campaigns over the last four decades have played a role in the politicization of the science presented at ICCAT meetings that inform management decisions (Whynott 1995, Porch 2005, Ruais 2011). For example, scientific advice was largely ignored in setting TACs in the Eastern Atlantic/Mediterranean Sea until several proposals for an Appendix 1 CITES listing were made, partially due to the intense public attention on the subject (ICCAT 2008).

Finally, the poor state of the fisheries for bluefin tuna in the Western and Eastern Atlantic/Mediterranean Sea had a lasting effect on the focus on management of bluefin tuna that has not been consistent with the amount of attention paid to other ICCAT-managed stocks (ICCAT 2008, Webster 2011). For decades, the main focus of ICCAT has been on the bluefin tuna at the expense of yellowfin and bigeye management, further research, and increasing compliance with mandatory ICCAT Recommendations. Though bigeye tuna, yellowfin tuna, and swordfish stocks are much larger and more valuable than bluefin tuna stocks in the Convention Area, proactive management of these species has taken a backseat to bluefin tuna priorities (Webster 2011). These data provide evidence that **supports Hypotheses 5 and 6.**

2. Respondent Interview Results

A. The Respondents

Of the twelve interview respondents, five were female and seven were male. The respondents had a minimum of two years and a maximum of twenty-two years of experience in bluefin tuna management issues. The mean of the years of experience

data per respondent was 14.25, and the mode of the data was fifteen years. Only three of the twelve respondents had less than ten years of experience working on bluefin tuna management issues, suggesting that the respondents had a sufficient amount of expertise on the topic. One of the twelve key respondents had not personally taken part in an ICCAT meeting, but had an in-depth knowledge of the tuna ranching industry and management tools that made that respondent's unique insight particularly valuable. The respondents represent nine different interest groups from academia, government agencies, fishing industry experts and bluefin tuna fishers and embody a representative knowledge of bluefin tuna management from a U.S. perspective.

B. Fishery Management Tools Employed in Bluefin Tuna Fishery

First, respondents were asked to identify the current tools used by ICCAT to manage the both stocks of bluefin tuna. Eleven respondents mentioned thirty-seven tools, which were grouped into nine categories based on ICCAT lists (See Table 19).

Table 20. Summary of the management tool categories used by ICCAT to manage stocks of bluefin tuna as identified by respondents in order of response frequency.

- TACs (7)
- Time/area closures (5)
- East/west management boundary (5)
- Minimum size limits (5)
- Gear restrictions (4)
- Catch documentation programs (4)
- Limited effort programs (3)
- Recovery plans (3)
- MSY reference points (1)

Note: The number in parentheses in this chapter represents the number of respondents who gave that specific response. Each participant provided more than one response.

C. Factors Leading to Adoption of These Tools

Respondents were then asked to identify factors that led to adoption of the specific tools. Forty-six factors were identified by eleven respondents, which were grouped into sixteen categories. The mode of the data was four (See Table 20).

Table 21. Factors identified by respondents as important to ICCAT adoption of management tools for the bluefin tuna fishery in order of response frequency.

- East/west management boundary (6)
- Complexity of fishery (5)
- History of fishery (4)
- Political pressure put on ICCAT (4)
- Unique biology of the species (4)
- CITES listing proposal threat (3)
- Different management capacities of CPCs (3)
- Insufficient catch reporting (3)
- Bluefin tuna ranching and aquaculture (3)
- Market value of species (2)
- ICCAT independent performance review (2)
- Organization of ICCAT (2)
- Scientific uncertainty (2)
- Threat of fishery closure (1)
- TAC allocation change (1)
- Broad media attention (1)

D. Management Tools Not Effectively Used in Bluefin Fishery

Third, respondents were asked what management tools have not yet been effectively employed by ICCAT in the bluefin tuna fishery to identify possible alternative management tools. Ten respondents identified twenty-two new potential management tools. These tools were grouped into ten categories. The mode of the number of tools noted by respondents was two (See Table 21).

Table 22. Management tools not effectively used to manage bluefin tuna according to respondents in order of response frequency.

- Time/area closures (4)
- Protecting spawning aggregation hotspots (3)
- Complete fishery closure (3)
- Target and limit reference points for fishing mortality (2)
- Dismiss CPCs from ICCAT for noncompliance (2)
- Rescind bluefin quota from CPCs (2)
- Fishery-wide limited access scenarios (2)
- Improve catch reporting requirements (2)
- Gear changes (1)
- Increased peer review of scientific information (1)

E. Iconic Status of Bluefin and Implications for Management

Fourth, respondents were asked if bluefin tuna were an “iconic” or “charismatic” species. One respondent thought that bluefin tuna should not be labeled as an “iconic” species, but as “charismatic” instead. Respondents were also asked to identify the impacts of this “iconic” or “charismatic” status on the management of bluefin tuna. Twelve respondents identified forty-eight different impacts, which were grouped into nine categories. The mode of the data was eight (See Table 22).

Table 23. Impacts and attributes of “iconic” or “charismatic” status of bluefin tuna on their management as noted by respondents in order of response frequency.

- Shaped public perception of bluefin tuna (9)
- Increased media attention (8)
- Became an important factor for bluefin tuna management (8)
- Led to more effective management of bluefin tuna (6)
- Increased focus on scientific information (5)
- Complicates bluefin tuna management (4)
- Helped grow conservation group membership (4)
- Not as important as market value of scale of fishery (3)
- Only important factor in developed countries (1)

F. Impacts of Iconic Status of Bluefin on Resource, Industry

Respondents were asked about the impacts of the “iconic” or “charismatic” status on both the bluefin resource and the fishing industry. Eleven respondents suggested forty-six impacts that were grouped into ten impact themes. The mode of the number of impacts mentioned was three (See Table 23).

Table 24. Impact themes of “iconic” or “charismatic” status of bluefin tuna on the resource and fishing industry in order of response frequency.

- ICCAT focuses on bluefin tuna at expense of other stocks (7)
- Positive impact for the stock status of the species (7)
- Created pressure for CITES listing proposal (7)
- Affected prices/markets for bluefin tuna meat (6)
- Created pressure to heed scientific advice of SCRS (5)
- Introduced inter-country TAC allocation issues (3)
- Led to catch documentation tool scheme changes (3)
- Negatively impacted bluefin tuna fishing industry (3)
- Introduced intra-country TAC allocation issues (2)

G. Future Priorities for ICCAT

Finally, experts were asked what ICCAT should prioritize in order to sustain healthy populations of bluefin tuna in the short-term (less than five years). Eleven respondents noted twenty-six priorities for ICCAT, which were grouped into seven subject themes based on similarities. The mode of the number of priority themes noted was three. Ten out of eleven respondents suggested that ICCAT prioritize funding for scientific research programs such as tagging fish, researching bluefin tuna life history such as mixing levels and data gathering projects (See Figure 12). The results of all interviews are summarized in tabular form (See Table 24).

Figure 12. Respondents' opinions on what ICCAT should prioritize to maintain healthy stocks of bluefin tuna over the next five years.

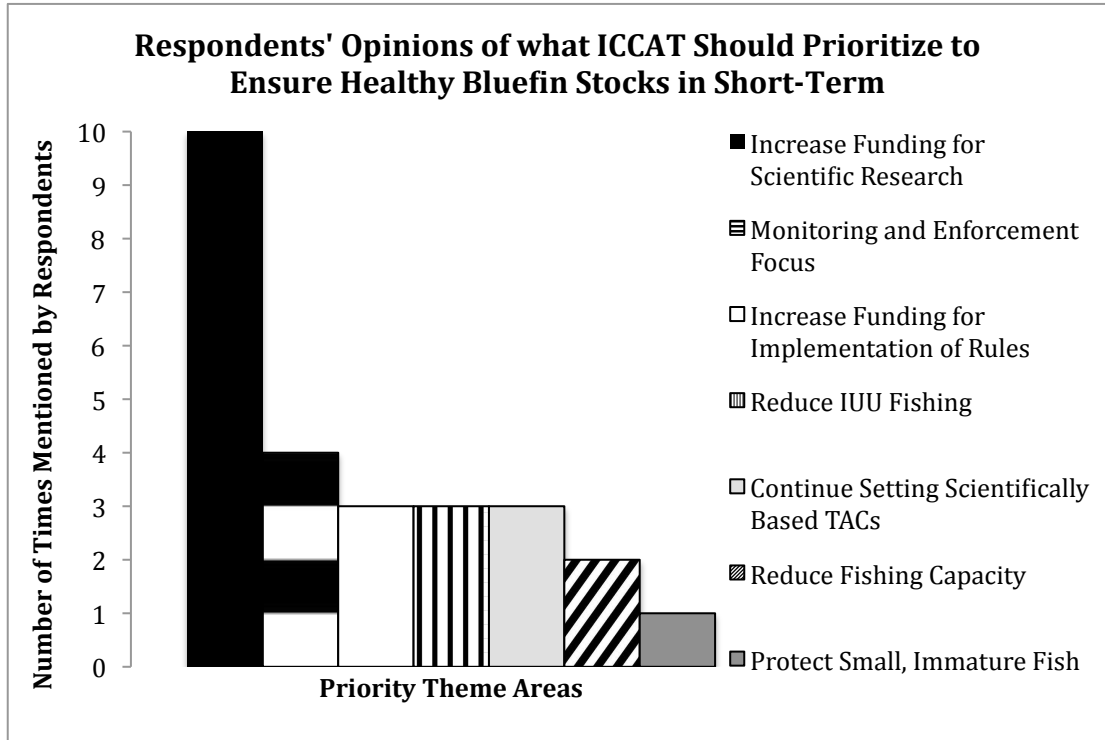


Table 25. Quantitative summary table of respondents' responses showing highest levels of agreement on specific concepts.

Number of Respondents Mentioning Concept / Total Respondents	Concepts
4 / 11	Time/Area closures have not yet been effectively utilized
6 / 12	High market value of species is an important factor leading to the different management of bluefin tuna
7 / 11	“Iconic” status focused public attention for Appendix 1 CITES listings, had overall positive impact on the species but at the expense of management of other ICCAT-species
7 / 11	National shares of TACs are an important bluefin tuna management tool
9 / 12	“Iconic” status shaped public perception of the species
10 / 11	Scientific research should be an ICCAT priority to ensure stocks of bluefin tuna remain healthy in the short-term
11 / 12	Bluefin tuna are an “iconic” species

CHAPTER VI. DISCUSSION AND CONCLUSION

This discussion aims to dispel misconceptions about the nature of bluefin tuna management in the ICCAT Convention Area by shedding light on common themes from my literature review and key informant interview responses. I first examine the contributing factors that led to the adoption of specific management tools in the bluefin tuna fishery. Then, I summarize various levels of agreement of experts from different interest groups to point to specific factors that drive bluefin's unique management, such as importance of the history of the fishery and the two-stock hypothesis. Based on these findings, I provide management recommendations for ICCAT to encourage effective management of bluefin tuna in the next five years.

1. Discussion of Literature Review Results

A. Bluefin Tuna Fishery is Not Most Valuable under ICCAT

I estimated that the bluefin tuna fishery was actually the lowest-value fishery compared to the fisheries for bigeye tuna, swordfish, and yellowfin tuna. When media outlets cite very high prices paid for a single bluefin tuna, they often erroneously or carelessly assume that this is the market price for all bluefin tuna (Whynott 1995, Mather et al. 1995, Ruais 2012). While the market value comparison presented in this research does not attempt to provide an exact estimation of fishery value, it provides a useful comparative tool that is reasonably close to a published economics firm estimate (Bonini et al. 2011). Market factors such as seasonality of prices, changes in prices of substitute and complimentary goods, and myriad multiplier effects such as costs of highly-industrial longline and purse seine fleets could be taken into account in

a more rigorous and complex market value analysis, but they are beyond the scope of this project. Also, my analysis does not take IUU fishing into account, which would likely skew the catch of all species far above MSY for each stock (ICCAT 2012c).

However, the illustrative nature of my analysis is enough to provide evidence that bluefin's market value does not vastly overshadow those of other fishes as is commonly noted. My comparison is somewhat corroborated by the respondents. Several respondents noted that the ICCAT-managed yellowfin tuna fishery is the most valuable in the Atlantic Ocean; this assertion is plausible in light of my comparison.

B. Bluefin Tuna are a Popular, Special Status Species

As noted in Chapter V, a search engine query of "bluefin tuna" in five influential, peer reviewed scientific journals in the fisheries management field reveal that bluefin tuna are the most popular species for publication of all ICCAT-managed stocks in terms of the frequency with which they are the topic of the research publication in five influential journals. Whether or not this translates into the idea that bluefin are the source of more research than both bigeye and yellowfin tuna combined is a different issue. The point here is that for some reason, research with bluefin tuna as its subject is undertaken and gets published more frequently than research with other ICCAT-managed stocks (bigeye and yellowfin tuna) as its subject. Eleven of twelve respondents agreed with the literature that state that bluefin tuna are in fact a "charismatic," "iconic" species that embody cultural or societal values, has physical attributes such as large size, great speed, perceived intelligence, or exceeding rarity that help humans identify with them.

C. Special Status of Bluefin Tuna Affects its Management

Many NGO conservation groups with offices in the United States such as Greenpeace International, Oceana, Pew Environment Group, World Wildlife Fund, International Union for the Conservation of Nature, the Center for Biological Diversity, and the National Geographic Society all have specific bluefin tuna conservation campaigns that solicit donations from members and non-members to bolster Atlantic bluefin tuna populations through advocacy campaigns to reduce the TACs for them (Oceana 2005, World Wildlife Fund 2012, Pew Environment Group 2009, National Geographic Society 2012, International Union for the Conservation of Nature 2012). These groups were involved in both failed CITES listing proposals, as well as numerous attempts to get Atlantic bluefin tuna protected domestically via the Endangered Species Act (Whynott 1995, MacKenzie et al. 2008, Ruais 2011). These campaigns have had an effect on bluefin tuna management over time (ICCAT 2008, Ruais 2011). This added pressure from environmental groups put the management focus of ICCAT squarely on bluefin tuna while increasing media attention and public scrutiny (Weber 2002). It also fundamentally changed the public's perception of a fish that was once hardly considered cat food to the "iconic" and "charismatic" one it is today. The ABTA sums up the effects of these conservation campaigns:

As a result of these relentless campaigns, the "magnificent" bluefin tuna has evolved into the "charismatic" giant bluefin and now into the 'iconic' giant bluefin (Ruais 2011. pg. 2).

While there have been six attempts by many different countries worldwide since 1975 to legally protect ICCAT-managed bluefin tuna with "threatened" or "endangered" listings, there have been zero attempts made to legally protect other

ICCAT-managed commercial species during the same amount of time. The architects of these proposals were mostly coalitions of environmental non-profit groups and some recreational fishing interests, which banded together to put political pressure on ICCAT Commissioners and decision makers through media, advocacy campaigns, fundraising, and direct lobbying (Whynott 1995, Porch 2005, Ruais 2011). The “iconic” status of bluefin tuna helps drive its unique management by shaping public perception, providing ammunition for interest groups to pressure ICCAT Commissioners, and by affecting adoption of management recommendations.

D. Summary

All but Hypothesis 4 listed in Chapter I are supported to varying degrees by literature review of peer-reviewed scientific literature, ICCAT official reports, publications from environmental NGOs and conservation groups, real market prices, industry group insights, and other documents. Actual market data, ICCAT official reports, records of vessels, and literature from the Food and Agriculture Organization of the United Nations (FAO) partially support Hypotheses 1 and 2 that the high market value of bluefin tuna does not fully-account for the special attention and unique management of the species. In addition, the relative value of the bluefin fishery itself is not the greatest among ICCAT-managed stocks, nor is the value of the fishery proportional to the special management attention it receives from ICCAT. Analyses of these sources provide evidence to support Hypothesis 3 and partially support Hypothesis 4. Bluefin have attained an “iconic” and “charismatic” status and that this status contributes to ICCAT managing bluefin tuna differently than other species.

Further, these sources suggest that non-scientific information and political pressure play an important role in bluefin tuna management, and that this role is perhaps larger for this species than for any other. In addition, ICCAT reports provide affirmative support for Hypotheses 5 and 6, that suggest that non-scientific information and the heightened status of the species affect ICCAT's management of bluefin tuna.

2. Discussion of Key Informant Interview Results

A. Concordance of Literature Review and Respondent Insights

The point that bluefin tuna are the only “iconic” status species managed by ICCAT is central to the argument made in this thesis: this special status directly and indirectly influences the management of the species. All but one respondent noted that the elevated status of the species is deserved, but that it pressures ICCAT to not afford proportional management attention to other stocks based on scientific or empirical information, such as relative market value, fleet size, or scale of fisheries. If other species were to have an elevated status, perhaps they would be managed differently or more intensely and with more creative management measures than other more valuable or larger-scale ICCAT fisheries.

The weight of this “iconic” status seems to be quite large and has important implications for bluefin tuna management. One respondent noted in their interview that the iconic status of the species only matters to people in developed countries, and that the status would probably matter less to people in developing countries. However, in the case of bluefin tuna management, the most powerful and influential ICCAT delegations that provide the science that supports management decisions and

funding for research are all from developed countries, where this status has high importance. ICCAT meetings, management focus, and research are all focused squarely on bluefin tuna, at the expense of other species some respondents noted.

Three respondents mentioned an interesting anecdote on this topic. ICCAT does not proportionally manage all stocks under its management. Silky sharks (*Carcharhinus falciformis*) and porbeagle sharks (*Lamna nasus*), which each have very poor stock statuses, do not have an “iconic” or “charismatic” status, and are much worse off from a survival standpoint than bluefin tuna (Oceana 2012, ICCAT 2012c). Yet these shark species are not a focus of ICCAT at management meetings because they are caught as bycatch in non-targeted fisheries. Despite repeated attempts by environmental NGOs and conservation groups, they have not been afforded the same protections that bluefin tuna have (Oceana 2012). Respondents went further to note that perhaps an “iconic” or “charismatic” status could help to contribute to better management of these species by ICCAT, which raises important prioritization issues.

Interestingly, several respondents suggested that perhaps ICCAT’s management focus should be on other non-bluefin tuna species, namely the Atlantic swordfish or yellowfin tuna. While the “iconic” label of bluefin tuna seems to affect its management, it remains a very complex and difficult question to gauge how not having this label could impact other fisheries. For example, one informant noted that ICCAT has shown an ability to effectively rebuild an overfished, valuable fishery that they could use as a model for rebuilding bluefin tuna stocks. The swordfish fishery was overfished with overfishing occurring for all three management stocks back in the 1990s (ICCAT 1994). Despite lack of an “iconic” or “charismatic” label or pressure

for legal protection for swordfish, ICCAT imposed strict catch limits, adopted measures to reduce capacity in the fleet, and established an aggressive rebuilding goal for these stocks. All three swordfish stocks were successfully rebuilt by the mid 2000's ahead of the rebuilding timeline (ICCAT 2008). This success story raises the question of what impact an "iconic" status would have had on swordfish.

A few respondents expressed concern and confusion that yellowfin tuna, with a significantly higher biomass and a much lower susceptibility to overfishing than bluefin tuna in the Convention Area, are not prioritized by ICCAT for rigorous scientifically based management. These stocks should not be ignored, however, in light of the large scale, fleet, and high value of the fisheries for them. Several respondents also noted that the so-called "tropical tunas" are not prioritized for research by the United States, or any other CPC for that matter. "Grande" and other scientific research programs are largely driven by contributions from developed, wealthy CPCs that put value on the iconic status of the bluefin tuna. This species is the focus of scientific research while other stocks still may not even have MSY estimates or proxies, which are basic parameters necessary to effectively manage their stocks based on ICCAT's stated management goals.

It is necessary to continue to study levels of mixing in bluefin tuna stocks, and the Grande program should be continued. However, it seems as though the "iconic" status of bluefin tuna may actually have an overall negative impact on management of ICCAT's stocks on the whole, because the bluefin tuna takes up most of the limited management capacity, attention, and research and enforcement funding even though other stocks have equally poor stock status. While eleven respondents called for more

funding to research bluefin tuna to help sustain healthy stocks in the near future, perhaps more research on non-bluefin species would spur more equitable allocation of management resources and lead to more effective management of ICCAT stocks.

B. Outlook for ICCAT-Managed Bluefin Tuna

ICCAT continued the recent trend of adopting TACs that are within the scientific recommendations of the SCRS to help rebuild the western Atlantic and the eastern Atlantic/Mediterranean Sea stocks at the November 2012 ICCAT General Meeting in Agadir, Morocco:

The International Commission for the Conservation of Atlantic Tunas (ICCAT) [has] adopted positive measures that will help conserve the iconic Atlantic bluefin tuna, and advance shark protection in the future (World Fishing and Aquaculture 2012, pg. 1).

Based on the 2012 updated stock assessments for bluefin tuna, both the western Atlantic and eastern Atlantic/Mediterranean Sea stocks are showing signs of increasing abundance and recovery, which is good news for the species and managers alike. As six respondents noted, this trend can be extended to the benefit of the species and the fishery with a dedicated effort by ICCAT and its CPCs to implement and enforce scientifically based TACs. However, the pressures that contributed to the decline of bluefin tuna stocks, namely overfishing, IUU fishing, under-reporting of catch, high market value of individual bluefin tuna, and others, remain. ICCAT still has the difficult, but not impossible, task of transparently managing its bluefin fishery.

3. Recommendations and Future Research

A. Specific Recommendations for ICCAT Management of Bluefin Tuna

Despite recent signs of increasing abundance of bluefin tuna stocks, recovery of the species remains uncertain. Recovery would be very important to the field of fisheries management since ICCAT is perhaps the most closely monitored fishery management organization in the world, and successful bluefin tuna management could restore some faith in international fisheries management. Toward these ends, I provide practical recommendations for ICCAT based on this thesis. ICCAT must:

1. Retain much of their present management scheme for bluefin tuna for the foreseeable future.
2. Continue funding the Atlantic-wide bluefin “Grande” research program to obtain important life history information to better-manage stocks.
3. Work with, and not against, environmental NGOs and conservation groups to draw attention to other managed stocks in need of conservation, such as silky sharks and porbeagle sharks, and focus management attention more equitably across all stocks.
4. Work with, and not against, environmental NGOs and conservation groups to shift media spotlight away from bluefin tuna and toward other stocks, so that they may be managed based on scientific evidence for the benefit of the fishing industry and CPCs.

ICCAT manages bluefin tuna differently than other stocks for a variety of reasons including the peculiar biology, life history, and characteristics of the fishery. It should continue to utilize regulations that govern ranching and farming operations, reduce and eliminate IUU fishing, and divide up national shares of the TAC based on the best available science. The current provisions for multilateral trade sanctions against non-compliant fishing entities, mandatory observer coverage, IUU vessel blacklist, record of ranching operations, documentation schemes, and research quota set-asides currently in place should be retained to allow for effective management of the fishery. It is critical that ICCAT continue to set scientifically based TACs and

prove to the world that they can rebuild bluefin tuna stocks to restore confidence in RFMO management of shared resources. However, efforts to reduce IUU fishing and to increase understanding of the science undermining the current two-stock management framework should be undertaken with more vigor.

In this light, it is imperative that ICCAT CPCs continue to fund the “Grande” bluefin research program around the Convention Area in order to decipher complex life history attributes of bluefin tuna. The appropriateness of both the two-stock management framework currently employed by ICCAT to manage bluefin tuna and the low- and high-recruitment stock status scenarios presented by the SCRS remain hotly debated topics in scientific and ICCAT literature, and must continue to be fueled by the best scientific advice possible. Increased bluefin tuna life history information should inform new management frameworks to replace ICCAT’s current 2-stock management based on landings data and further information on rates of mixing. Scientific evidence seems to suggest that managing bluefin tuna as a single stock is more appropriate from a biological perspective, and could allow for easier implementation of uniform Recommendations and Resolutions throughout the Convention Area. Alternatives to the two-stock management should be explored.

Next, while bluefin tuna get most of the media and management attention over other ICCAT stocks, they are not most susceptible to becoming collapsed. Instead, stocks of sharks, billfishes, and other species caught as bycatch in other non-target fisheries are much worse off than bluefin, especially silky and porbeagle sharks. These are the species that should have the attention of conservation and environmental NGOs, both because of their poor stock status and because they are not harvested

commercially. ICCAT can work together with environmental NGOs and conservation organizations to draw attention to these species through education campaigns.

I do not recommend that ICCAT, scientists, the media, or conservation groups ignore bluefin tuna just because their stocks seem to be rebounding according to aerial and tagging surveys, but rather that these groups should strive to work together to prioritize management focus on other stocks in a triage-like fashion in the next five years. ICCAT could cooperate with NGOs, academics, and others to learn from the rise of bluefin to an “iconic” species, and utilize these lessons learned, momentum and techniques to build up public interest and standing of other species with poor stock statuses. This could also help build political will and momentum to more effectively manage such stocks. Then, ICCAT should strive to provide proportional management focus and effort to other managed stocks based on three utilitarian criteria: CPC involvement, rough employment, fleet size, and scale of the fishery. Perhaps this approach can allow for more balance of management effort. Nor do I recommend striving to elevate all species’ statuses to the “iconic” level that bluefin tuna have attained. In fact, a species cannot be considered “iconic” or “charismatic” unless they share some specific attributes such as large size, rarity in nature, ability to capture public imagination, or other characteristics. Instead, I suggest that ICCAT and NGOs be mindful of the rise of the status of bluefin tuna, and be cognizant of the fact that this elevated status does not necessarily help in allowing the species to be managed based on the best scientific advice of the SCRS. This research suggests that there is potential of a species’ elevated status to positively affect its management, but at a potential cost. Therefore, ICCAT and other partners should strive to call attention to

species in need of conservation but keep their mandate of managing based on the best available science in mind as well.

Finally, the added media scrutiny, non-scientific information, and political jockeying that accompany bluefin tuna discussions at ICCAT meetings do not seem to help Commissioners set scientifically-based Recommendations to manage stocks. These efforts instead seem to hurt specific sectors of the fishing industry for bluefin tuna that are well managed, such as the highly selective artisanal hook-and-line, harpoon, or trap fishers. The groups responsible for these sources of information should instead focus on truly detrimental fishing practices, such as IUU fishing, that have undermined ICCAT's management for decades (Pew 2010, ICCAT 2012c).

B. Future Research

With additional time and funding for travel, I would present a synopsis of my research to a major peer-reviewed scientific journal for publication and to the ICCAT SCRS for consideration and review at one of their semi-annual meetings. In addition, I would conduct research on the specific impacts that the “iconic” status of bluefin has on its management compared to other ICCAT stocks that do not share that status, such as silky sharks. A comparison of ICCAT's management of Northern bluefin tuna to the management of the Pacific bluefin and the Southern bluefin tuna by other RFMOs around the world would hold valuable lessons for fisheries management as well. Specifically, I propose a study to explore whether or not all three bluefin species share an “iconic” status and the implications of this status on their management.

4. Conclusion

Bluefin tuna are different than other ICCAT managed stocks in many ways as a result of a complex interaction of biological, social, political, and economic factors that continue to evolve over time. These factors include, but are not limited to, development of increasingly capital and technology-intensive fisheries for bluefin tuna, commercialization and industrialization of the fishery, the unique life history of the species, and the increasing value of meat for the sushi market. Not all factors have equal bearing or weight on management outcomes, and no one factor fully accounts for the management framework in place to manage bluefin tuna fisheries. This thesis research dispels common misconceptions that bluefin stocks are overfished and overfishing is occurring for them solely due to Hardin's "Tragedy of the Commons," or because of the high prices paid for bluefin meat alone. It is important that the common perceptions in the fisheries management, political science, and legal literature are accurate and based on factual information. The literature should be more clearly informed on the role of these relevant factors that contribute to management in order to inform more logical thinking, decision-making and management of fisheries.

The fact that bluefin tuna are the only "iconic" status species managed by ICCAT is central to the argument made in this thesis. This status influences the management of the species in tangible ways, namely through its role in creation of an important policy symbol that can be seen in greater numbers of Recommendations and Resolutions, management and media attention, and greater non-scientific inputs to the decision-making process of bluefin tuna management. This research suggests that the special status has been beneficial to the stock status of the bluefin tuna in the

Convention Area, but not necessarily for other ICCAT stocks or ICCAT management on the whole. ICCAT tends to focus management attention, intensity, and limited resources on bluefin tuna while not prioritizing management of other stocks. This understanding is critical in finding solutions to perhaps the most complex fisheries management saga of our time: rebuilding stocks of this important and unique species, and restoring the management effectiveness of ICCAT as a whole (Magnuson 2001). Through broader understanding of the context of the Northern Atlantic bluefin tuna fishery of the Atlantic Ocean and Mediterranean Sea, opportunities exist for more effective management of this and other ICCAT-managed fisheries in the future.

APPENDICES

Appendix I. Copy of Email to Potential Key Informants for Interview Request

Mr./Mrs. _____,

I am currently a Master's student at the University of Rhode Island working on a thesis on the management of Northern Atlantic bluefin tuna.

Would you be willing to share some of your insights with me in a short, confidential interview to support my thesis research? I am especially interested in hearing some of the politics involved in the unique management of bluefin tuna.

Thank you very much in advance. I look forward to speaking with you soon.

Sincerely,

Patrick Samuel

Appendix II. Copy of Consent to Participate Form

“The Management Regime of the International Commission for the Conservation of Atlantic Tunas (ICCAT): What Makes Bluefin Tuna (*Thunnus thynnus*) Different?”

CONSENT FORM FOR RESEARCH

You have been invited to take part in a research project described below. The researcher will explain the project to you in detail. Feel free to ask questions. If you have more questions later, I, Patrick Samuel, may be reached at (916) 502-6874 or my advisor, Professor Seth Macinko, may be reached at (401) 874-2471 to discuss them with you.

Description of the project:

This research will use data from interviews to allow the researcher to gain a better understanding of factors that contribute to ICCAT’s unique management of bluefin tuna among other managed species in the Atlantic Ocean and Mediterranean Sea.

What will be done:

If you decide to take part in this study, you will be interviewed regarding your thoughts as they pertain to ICCAT’s management approaches used for bluefin tuna. The interview will last roughly an hour and I will take notes with your permission. The only additional involvement that may be asked of you would be a brief follow-up at some point after the initial interview for clarification of any information originally shared.

Risks or discomfort:

There is minimal risk in participating in this interview.

Benefits of this study:

This study can benefit the management of bluefin tuna in the Atlantic Ocean in enhancing understanding of the factors that contribute to unique management for one species (bluefin tuna) among others. This study may benefit you as a stakeholder in bluefin tuna management by allowing you to talk through some of these factors and potential implications of these for the resource and the fishing industry.

Confidentiality:

Your participation and information shared in this study is confidential. None of the information will identify you by name. No one else will know if you participated in this study and no one else can find out what your answers were. All written records will be stored in a locked file cabinet in Patrick Samuel’s office at the Coastal Institute Kingston at the University of Rhode Island. Transcripts from interviews will be encrypted and stored on the student investigator’s password protected computer. Scientific reports and academic presentations of this study will be based on group data and will not identify you or any individual as taking part in this project. Data will be destroyed three years after the completion of the study.

In case there is any injury to the subject:

This study is not expected to cause any injury. If this study causes you any injury, you should write or call the office of the Vice President for Research, 70 Lower College Road, University of Rhode Island, Kingston, Rhode Island, telephone: (401) 874-4328.

Decision to quit at any time:

The decision to take part in this study is voluntary. If you decide to take part in the study, you may decline to answer any question. You may also quit at any time. If you wish to quit during the interview, please inform the interviewer immediately. If you wish to quit at a later time, please inform Professor Seth Macinko at (401) 874-2471 or Patrick Samuel at (916) 502-6874 of your decision.

Rights and Complaints:

If you are not satisfied with the way this study is performed, you may discuss your complaints with Seth Macinko, Associate Professor of Marine Affairs, at (401) 874-2471 or macinko@uri.edu, or Patrick Samuel, Master of Marine Affairs student, at (916) 502-6874 or pjsamuel@my.uri.edu, anonymously, if you choose. In addition, if you have questions about your rights as a research participant, you may contact the office of the Vice President for Research, 70 Lower College Road, Suite 2, University of Rhode Island, Kingston, Rhode Island, or by telephoning (401) 874-4328.

Important:

Although this research is studying the factors that contribute to the unique management of Atlantic bluefin tuna, this research is neither for nor against any management regime. My research is about the factors that contribute to this unique management and the implications it has for the resource and the fishing industry. Answer questions based simply on what you know; do not worry about not knowing some answers.

You have read the Consent Form. Your questions have been answered. Your signature on this form means that you are at least 18 years old, you understand the information, and you agree to participate in this study.

Thank you for your voluntary participation.

Signature of Participant

Signature of Researcher

Typed/printed Name

Typed/printed name

Date

Date

Appendix III. List of Questions Posed to Interview Respondents

1. How long have you been involved in bluefin tuna research or management issues?
2. What approaches does ICCAT currently use to manage bluefin tuna?
3. What factors contributed to adoption of these specific management tools?
4. What management tools has ICCAT not tried to use to manage bluefin tuna?
5. What are the impacts, if any, of broad media attention and the “iconic” or “charismatic” status that bluefin tuna have attained on their management?
6. What are the consequences, if any, of this status on the bluefin tuna resource and the fishing industry?
7. What should ICCAT prioritize in the short-term to ensure stocks of bluefin tuna remain healthy?

BIBLIOGRAPHY

American Bluefin Tuna Association. 2012. "Artisanal Harpoon Category: Commercial." Web: < <http://www.theabta.com/harpoon.html>>. Accessed 16 October 2012.

Applebaum B. and Donohue A. (1999). "The Role of Regional Fisheries Management Organizations," in *Developments in International Fisheries Law*. Hey, E., ed., Kluwer Law International, Netherlands.

Appleyard, D. (1979). "The Environment as a Social Symbol." *American Planning Association Journal* 45: 143-153.

Aranda, M. de Bruyn, P. and H. Murua. 2010. "A Report Review of the Tuna RFMOs: CCSBT, IATTC, IOTC, ICCAT, and WCPFC." EU FP7 Project #212188 TXOTX Deliverable.

Aristotle. *The History of Animals*. Book VIII. Translated by Thompson Wentworth D'Arcy. 2012. Web: <<http://www.mlahanas.de/Greeks/Aristotle/HistoryOfAnimals/HistoryOfAnimals8.html>>. Accessed 12 October 2012.

Bernard, H. 2006. *Research Methods in Anthropology – Qualitative and Quantitative Approaches*. "Nonprobability Sampling and Choosing Informants." Third Edition. Sage Publications, Thousand Oaks, CA. pp. 188-193.

Berelson, B. 1952. *Content Analysis in Communication Research*. Free Press, New York, NY. 200pp.

Bestor, T. 2001. "Supply-Side Sushi: Commodity, Market, and the Global City." *American Anthropologist*. 103(1): 76-95.

Blake, R. 2004. "Review Paper: Fish Functional Design and Swimming Performance." *Journal of Fish Biology* 65: 1193-1222.

Block B. et al. 2001. "Migratory Movements, Depth Preferences, and Thermal Biology of Atlantic Bluefin Tuna." *Science*. 293: 5533. 1310-1314.

- Bonini, S. et al. 2011. "Design for Sustainable Fisheries: Modeling Fishery Economics." McKinsey & Company, Melbourne, Australia. 56pp.
- Boustany, A. 2011. *Bluefin Tuna: The State of the Science*. Ocean Science Division, Pew Environment Group, Washington DC, USA.
- Brunner, R. 1987. "Key Political Symbols: The Dissociation Process." *Policy Sciences* 20: 53-76.
- Buck-Cox, S. 1985. "No Tragedy on the Commons." *Environmental Ethics* 7: 49-61.
- Care 2. "Getting Serious About Illegal Tuna Fishing in the Mediterranean." Web: <<http://www.care2.com/causes/getting-serious-about-illegal-tuna-fishing-in-the-mediterranean.html>>. Accessed 8 September 2012.
- Carr, C. and H. Scheiber. 2002. "Dealing with a Resource Crisis: Regulatory Regimes for Managing the World's Marine Fisheries." *Stanford Environmental Law Journal* 21: 45-77.
- Chubby Fish Company. "How We Grade Tuna: A Chubby Fish Grading System Primer." Rhode Island, USA. Web: <http://www.chubbyfish.com/tuna_grading.html>. Accessed 18 October 2012.
- Clover, C. 2008. *The End of the Line: How Overfishing is Changing the World and What We Eat*. New Press Publishing, New York, NY. 238pp.
- Collette, B. et al. 2011. "High Value and Long Life – Double Jeopardy for Tunas and Billfishes." *Science* 333: 291-292.
- Conathan, M. 2012. "Fish on Fridays: Sustaining the 'Wicked Tuna.'" Center for American Progress. Issues – Energy and Environment. Web: <<http://www.americanprogress.org/issues/green/news/2012/03/30/11359/fish-on-fridays-sustaining-the-wicked-tuna/>>. Accessed 16 September 2012.
- Conca, K. and Dabelko, G. 2010. *Green Planet Blues: Four Decades of Global Environmental Politics*. Fourth Edition. Westview Press, Boulder, CO USA.

Convention on International Trade in Endangered Species of Fauna and Flora (CITES). 2012. "The CITES Appendices." Web: <<http://www.cites.org/eng/app/index.php>>. Accessed 1 December 2012.

Cort, J. 2005. "Bluefin Tuna (*Thunnus thynnus*) Fishing in the Mediterranean Sea." *Memoirs of the Faculty of Agriculture of Kinki University* 38:54-67.

Cullis-Suzuki, S. and D. Pauly. 2010. "Failing the High Seas: A Global Evaluation of Regional Fisheries Management Organizations." *Marine Policy* 34: 1036-1042.

Dalton, T. 2006. "Exploring Participants' Views of Participatory Coastal and Marine Resource Management Processes." *Coastal Management* 34: 351-367.

De Stefano, V. and P. Van der Heijden. 2007. "Bluefin Tuna Fishing and Ranching: A Difficult Management Problem." *New Mediterranean*. 2:59-64.

Doyle, P., Bolze, D., and Koontz, F. 1995. "COWRI: Critical Ocean Wildlife Recovery Initiative." *International Zoo Yearbook* 34(1): 25-30.

Ehrenberg, R. 2008. "Bluefins Mingle across the Ocean: Findings Could Complicate Fish Management Plans." *Science News*, 174: 9. 15.

Ellis, R. 2008. *Tuna: Love, Death, and Mercury*. Vintage Books, New York, NY. 346pp.

Entwistle, A. and N. Dunstone, eds. 2000. *Priorities for the Conservation of Mammalian Diversity: Has the Panda Had Its Day?* University of Cambridge Press, UK. 179pp.

European Commission, Maritime Affairs and Fisheries Directorate General (DG). Fisheries and Aquaculture in Europe in the News. 2012. "Bluefin Tuna: Cooperating with Scientists." 56. pg. 4. Web: <http://ec.europa.eu/fisheries/documentation/magazine/index_en/htm>. Accessed 2 November 2012.

European Commission on Fisheries. 2012. "Morocco Fisheries Partnership Agreement." Web: <http://ec.europa.eu/fisheries/cfp/international/agreements/morocco/index_en.htm>. Last Updated September 6 2012. Accessed 12 October 2012.

Fackler, M. 2013. "New High for Tuna at Tokyo Fish Sale." *New York Times*, 5 January 2013. Web: <http://www.nytimes.com/2013/01/06/world/asia/new-high-for-tuna-at-tokyo-fish-sale.html?ref=world&_r=0>. Accessed 6 January 2013.

Food and Agriculture Organization of the United Nations (FAO). 2011. "Fishery and Aquaculture Statistics: Capture Production." Chapter B-36 Tunas, Bonitos, Billfishes. Web: <ftp://ftp.fao.org/FI/CDrom/CD_yearbook_2009/navigation/index_content_capture_e.htm>. Accessed 16 October 2012.

FAO. 2012a. "Development of the Atlantic Tuna Fisheries." Rome, Italy. Section 2.4 "Atlantic Bluefin Tuna". Web: <<http://www.fao.org/docrep/007/y5428e/y5428e04.htm>>. Accessed 18 October 2012.

FAO. 2012b. "Biological Characteristics of Tuna." Edited by Michel Goujon and Jacek Majkowski. Web: <<http://www.fao.org/fishery/topic/16082/en>>. Accessed 22 November 2012.

FAO. 2012c. "Global Tuna Catches By Stock: Collection Overview." Web: <<http://www.fao.org/fishery/statistics/tuna-catches/en>>. Accessed 16 October 2012.

FAO. 2012d. "Global Tuna Fisheries 2009." Web: <<http://firms.fao.org/firms/fishery/459/en>>. Accessed 12 October 2012.

FAO. 2012e. "History of Tuna Fisheries." Web: <<http://www.fao.org/fishery/topic/16917/en>>. Accessed 19 October 2012.

FAO. 2012f. "Tuna Fisheries and Utilization." Web: <<http://www.fao.org/fishery/topic/16917/en>>. Accessed 14 October 2012.

Food and Wine Magazine. September 2005. "Innovators - Anatomy of a Bluefin Tuna." Illustration by Wayne Samieri, Honolulu Fish Company on pg. 132.
Web:<<https://www.google.com/search?q=honolulu+fish+company+anatomy+of+a+bluefin&ie=utf-8&oe=utf-8&aq=t&rls=org.mozilla:en-US:official&client=firefox-a>>.
Accessed 10 October 2012.

Fonteneau, A. and J. Fromentin. 2002. "The Atlantic Bluefin Tuna: A Global Perspective." International Symposium on Domestication of the Bluefin Tuna (*Thunnus thynnus*). Cartagena, Spain, 3-8 February 2002. CIHEAM-IAMZ, Zaragoza, Spain.

Foster, J. et al. 2010. *The Ecological Rift: Capitalism's War on the Earth*. New York, NY: Monthly Review Press.

Fromentin, J. and A. Fonteneau. 2001 "Fishing Effects and Life History Traits: A Case-Study Comparing Tropical Versus Temperate Tunas." *Fisheries Research* 53:133-150.

Fromentin, J. and J. Powers. 2005. "Atlantic Bluefin Tuna: Population Dynamics, Ecology, Fisheries and Management." *Fish and Fisheries* 6(4): 281-306.

Fromentin, J. and C. Ravier. 2005. "The East Atlantic and Mediterranean Bluefin Tuna Stock: Looking for Sustainability in a Context of Large Uncertainties and Strong Political Pressures." *Bulletin of Marine Science* 76(2): 353-361.

Galuardi, B. et al. 2010. "Complex Migration Routes of Atlantic Bluefin Tuna (*Thunnus thynnus*) Question Current Population Structure Paradigm." *Canadian Journal of Fisheries and Aquatic Sciences* 67(6): 966-976.

Goni et al. 2010. "On-Going Bluefin Tuna Research in the Bay of Biscay (Northeast Atlantic): The 'HEGALABUR 2009' Project". Collection of Voluntary Scientific Papers, ICCAT. 65(3): 755-769. SCRS/2009/128.

Greenberg, P. 2010. "Tuna's End." In *New York Times Magazine*. June 27(37): 44-48.

Greenberg, P. 2011. *Four Fish: The Future of the Last Wild Food*. Penguin Publishing, New York, NY. 304pp.

Gremillet, D. and A. Lescroel. 2011. "Libyan Uprising May Boost Bluefin Tuna." *Nature*. 472: 169-170.

Hanna, S. 1990. "The 18th Century English Commons: A Model for Ocean Management." *Ocean and Shoreline Management* 14: 155-172.

Hardin, G. 1968. "The Tragedy of the Commons." *Science*, 162, 1243-1248.

Harvey, M. 1994. *A Symbol of Wilderness: Echo Park and the American Conservation Movement*. University of Washington Press, Seattle, WA. 147pp.

Heinisch et al. 2008. "Spatial-Temporal Pattern of Bluefin Tuna (*Thunnus thynnus*) Gonad Maturation Across the Mediterranean Sea." *Marine Biology* 154: 623-630.

Hilborn, R. et al. 2005. "Institutions, Incentives and the Future of Fisheries." *Philosophical Transactions: Biological Sciences*. "Fisheries: A Future?" 360:1453, 47-57.

Holland, D. 2007. "Managing Environmental Impacts of Fishing: Input Controls Versus Output-Oriented Approaches." *International Journal of Global Environmental Issues*. 7(2/3): 255-272.

Hutton J. and Leader-Williams N. 2003. "Sustainable Use and Incentive-Driven Conservation: Realigning Human and Conservation Interests." *Oryx* 37: 215-226.

International Commission for the Conservation of Atlantic Tunas (ICCAT). 1995. "Report for the Biennial Period 1994-1995." ICCAT Secretariat: Madrid, Spain. 110pp. Web:< http://www.iccat.int/en/pubs_biennial.htm>. Accessed 2 October 2012.

ICCAT. 2006. "Convention Area." Web: <<http://www.iccat.es/en/convarea.htm>>. Accessed 1 December 2012. Updated 17 October 2006.

ICCAT. 2008. "Report of the Independent Review." Prepared for ICCAT by Hurry, G., Hayashi, M., and Maguire, J. 105pp. Web: <www.iccat.int/Documents/Meetings/Docs/Comm/PLE-106-ENG.pdf>. Accessed 19 September 2012.

ICCAT. 2010a. "Recommendation 10-03: Supplemental Recommendation by ICCAT Concerning the Western Atlantic Bluefin Tuna Rebuilding Program." Web: <iccat.int/Documents/Recs/compendiopdf-e/2010-03-e.pdf>. Accessed 15 October 2012.

ICCAT. 2010b. "Expert Panel on CITES Listing Proposals: Conference of Parties 15, Document 68." Prepared for the Secretary General of the Convention on International Trade in Endangered Species of Flora and Fauna (CITES). Madrid, Spain.

ICCAT. 2011a. "Basic Texts." Website: <http://www.iccat.es/en/t1.asp>. Last updated 4 November 2011.

ICCAT. 2011b. "Record of Bluefin Tuna Farming Facilities." Web: <<http://www.iccat.es/en/ffb.asp>>. Updated 30 March 2011. Accessed 4 October 2012.

ICCAT. 2011c. "Recommendations and Resolutions Adopted at the 2011 Commission Meeting." ICCAT Circular #5058/2011. Madrid, Spain. Web: <www.iccat.int/Documents/Recs/RECS_ADOPTED_2011_ENG.pdf>. Accessed 18 October 2012.

ICCAT. 2011d. "Record of Vessels." Web: <<http://www.iccat.es/en/vesselsrecord.asp>>. Updated 23 November 2011. Accessed 2 October 2012.

ICCAT. 2012a. "Stock Assessments." Summary Prepared by the ICCAT Secretariat. Madrid, Spain. Web: <<http://www.iccat.es/en/assess.htm>>. Accessed 16 October 2012.

ICCAT. 2012b. "Resolutions, Recommendations, and other Decisions." Web: <<http://www.iccat.int/en/RecsRegsresults.asp?cajaYear=checkbox&cajaKey=checkbox&cajaType=checkbox&selectGroup=BFT&cajaAct=checkbox&selectidioma=en&txtidioma=&Submit=Search>>. Accessed 19 October 2012.

ICCAT. 2012c. "Executive Summary: Updated Atlantic Bluefin Tuna Stock Assessment." Prepared for ICCAT by the SCRS. Web: <www.iccat.int/Documents/SCRS/ExecSum/BFT_EN.pdf>. Accessed 11 December 2012.

ICCAT. 2012d. "Collective Volume of Scientific Papers." Web: <http://www.iccat.int/en/pubs_CVSP.htm>. Updated 14 August 2012. Accessed 12 September 2012.

ICCAT. 2012e. "ICCAT Record of Bluefin Tuna Farming Facilities." Web: <<http://www.iccat.int/en/ffb.asp>>. Accessed 21 September 2012.

ICCAT. 2012f. "Introduction." Web: <<http://www.iccat.int/en/introduction.htm>>. Accessed 18 September 2012.

ICCAT. 2012g. "Organization." Web: <<http://www.iccat.int/en/organization.htm>>. Accessed 19 September 2012.

ICCAT. 2012h. "Record of Traps." Web: <<http://www.iccat.int/en/Traps.asp>>. Accessed 12 September 2012.

ICCAT. 2012i. "Statistical Bulletin: 1970-2010." Prepared by ICCAT Secretariat. Madrid, Spain. Volume 40. July 2012. 184pp. Web: <http://www.iccat.int/en/pubs_sbull.htm>. Accessed 4 December 2012.

International Consortium of Investigative Journalists (ICIJ). 2010. "Looting the Seas." Web: <<http://www.publicintegrity.org/treesaver/tuna/01-the-black-market-in-bluefin.html>>. Accessed 19 March 2012.

Issenberg, S. 2007. *The Sushi Economy: Globalization and the Making of a Modern Delicacy*. New York, NY: Gotham Books.

Jadran-Tuna Company. 2012. "Tuna Farming." Biograd na Moru, Croatia. Web: <<http://www.jadran-tuna.hr/uzgoj-en.html>>. Accessed 18 October 2012.

Juda, L. 2011. "World Marine Fisheries: A Threatened Resource," *World Politics Review*, 8-13. Web: <www.uri.edu/cels/maf/577/juda_marine_fisheries_2011.pdf>. Accessed 8 September 2012.

Kell et al. 2012. "A Kobe Strategy Matrix Based Upon Probabilistic Reference Points: An Example Using A Biomass Dynamic Assessment Model." *ICCAT Collection of Volumes and Scientific Papers*. 68(3): 1030-1043. pg. 1038.

Krippendorff, K. 2013. *Content Analysis: An Introduction to Its Methodology*. Third Edition. Sage Publications. Thousand Oaks, CA. 439pp.

Leader-Williams, N. and H. Dublin. 2000. "Chapter 4: Charismatic Megafauna as 'Flagship Species.'" In *Priorities for the Conservation of Mammalian Diversity: Has the Panda Had Its Day?* Entwistle A. and N. Dunstone, eds. Cambridge University Press. 457pp.

Logan et al. 2010. "Diet of Young Atlantic Bluefin Tuna (*Thunnus thynnus*) in eastern and western Atlantic Foraging Grounds." *Marine Biology* 158: 73-85.

Mace, G. 2004. "The Role of Taxonomy in Species Conservation." *Philosophical Transactions of the Royal Society of London* 359: 711-719.

MacKenzie, B., Mosegaard, H., and Rosenberg, A. 2008. "Impending Collapse of Bluefin Tuna in the Northeast Atlantic and Mediterranean." *Conservation Letters* 2: 25-34.

Maggio, T. 2000. *Mattanza: Love and Death in the Sea of Sicily*. Perseus Publishing, Cambridge, MA USA.

Magnuson, J., Safina, C., and Sissenwine, M. 2001. "Whose Fish are they Anyway?" *Science* 293: 1267-1268.

Martin-Lopez, B. et al. 2009. "What Drives Policy Decision-Making Related to Species Conservation?" *Biological Conservation* 142: 1370-1380.

Matchar D. et al. 2006. "Developing a Methodology for Establishing a Statement of Work for a Policy-Relevant Technical Analysis." *Technical Reviews* 11(4). 45pp. Agency for Healthcare Research and Quality, Rockville, MD. Web: <<http://www.ncbi.nlm.nih.gov/books/NBK44041/>>. Accessed 18 December 2012.

Mather et al. 1995. "Historical Document: Life History and Fisheries of Atlantic Bluefin Tuna." NOAA Technical Memorandum NMFS-SEFSC-370. National Oceanic and Atmospheric Administration. Available from National Marine Fisheries Service, Southeast Fisheries Science Center, 75 Virginia Beach Drive, Miami, FL 33149.

McWhinnie, S. 2006. "The Tragedy of the Commons in International Fisheries: An Empirical Examination." Research Paper 2007-05. University of Adelaide Press, Adelaide, Australia.

Miyake, P. and P. Kebe. 1996. *Multi-Species and Multi-Gear Tuna Fisheries in the Atlantic and Possible Interactions between Gears and Species*. Eds. R. S. Shomura, J. Majkowski, and R. F. Harman. Tokyo, Japan.

National Geographic Society. 2012. "Atlantic Bluefin Tuna *Thunnus thynnus*." Web: <<http://animals.nationalgeographic.com/animals/fish/bluefin-tuna/>>. Accessed 23 October 2012.

Nickler, P. 1999. "A Tragedy of the Commons in Coastal Fisheries: Contending Prescriptions for Conservation, and the Case for Atlantic Bluefin Tuna." *Boston College Environmental Affairs Law Review*. 26(3): 549-576.

NOAA National Marine Fisheries Service (NMFS). 2010a. "A Guide to the Tunas of the Western Atlantic Ocean." Guide Prepared by the Office of Highly Migratory Species (HMS). 10pp. Web: <www.hmspermits.gov>. Accessed 16 October 2012.

NMFS. 2010b. "United States Annual Bluefin Tuna International Trade Report From January 1 2009 to December 31 2009." Report Prepared for ICCAT. 11pp.

NMFS. 2011. "Status Review Report of the Atlantic Bluefin Tuna (*Thunnus thynnus*)." Prepared for NMFS Northeast Regional Office by the Atlantic Bluefin Tuna Status Review Team. March 2011. 104pp.

NMFS. 2012. "ICCAT 2011 Regular Meeting, Istanbul, Turkey." Web: <http://www.nmfs.noaa.gov/sfa/hms/Advisory%20Panels/AP2012/Spring/iccat_2011.pdf>. Accessed 10 September 2012.

NMFS Office of International Affairs. 2012. "International Agreements Concerning Living Marine Resources of Interest to NOAA Fisheries." Silver Spring, MD. 242pp.

NMFS. 2012a. "Annual Report of the United States to ICCAT." Silver Spring, MD. 34pp.

NMFS. 2012b. "NMFS Announces Final 2012 Atlantic Bluefin Tuna Quotas." 26 July 2012. Press Release Prepared by NOAA National Marine Fisheries Service.

Oceana. 2005. "Saving the Most Expensive Fish on Earth." 8 June 2005. Press Release: Washington, DC. Web: <http://oceana.org/.../oceana/...fishing/Bluefin_Tuna_Petition_Press_Release>. Accessed 23 October 2012.

Oceana. 2012. "Oceana Applauds ICCAT Decision to Protect Vulnerable Silky Sharks." Web: <<http://oceana.org/en/news-media/press-center/press-releases/oceana-applauds-iccat-decision-to-protect-vulnerable-silky-sharks>>. Accessed 2 December 2012.

Pew Environment Group. 2010. "Mind the Gap: Analysis of the Gap Between Mediterranean Bluefin Tuna Quotas and International Trade Figures." Web: <<http://pewenvironment.org/news-room/other-resources/mind-the-gap-an-analysis-of-the-gap-between-mediterranean-bluefin-tuna-quotas-and-international-trade-figures-85899364820>>. Accessed 4 November 2011.

Pew Environment Group. 2012. "Atlantic Bluefin Tuna Fact Sheet – ICCAT." Web: <http://www.pewtrusts.org/news_room_detail.aspx?id=55939>. Accessed 23 October 2012.

Pope, J. 2012. "Input and Output Controls: The Practice of Fishing Effort and Catch Management in Responsible Fisheries." In *A Fishery Manager's Guidebook Management Measures and their Applications*. FAO. Rome. Web: <<http://www.fao.org/docrep/005/y3427e/y3427e06.htm>>. Accessed 19 November 2012.

Porch, C. 2005. "The Sustainability of Western Atlantic Bluefin Tuna: A Warm-Blooded Fish in a Hot-Blooded Fishery." *Bulletin of Marine Science* 76(2): 363-384.

Powers, J. and C. Porch. 2004. "Approaches to Developing Management Procedures which Incorporate Mixing." *Collected Volumes of Scientific Papers of ICCAT* (56) 3: 1144-1152.

Relini, G. 2003. "Fishery and Aquaculture Relationship in the Mediterranean: Present and Future." *Mediterranean Marine Science* 4:125-154.

Revkin, A. 2008. "The (Tuna) Tragedy of the Commons." *New York Times Opinion Pages*, 26 November 2008.

Roesti, R. M. 1966. "The Declining Economic Role of the Mediterranean Tuna Fishery." *The American Journal of Economics and Sociology* 25(1): 77-90.

Ruais, R. 2011. "Requiem for 'Iconic' Bluefin Extinction Myth." *Commercial Fisheries News* 39(2): 1-22

Safina, C. and Klinger, D. 2008. "Collapse of Bluefin Tuna in the Western Atlantic." *Conservation Biology*. 22(2): 243-246.

Schick R. and M. Lutcavage. 2009. "Inclusion of Prey Data Improves Prediction of Bluefin Tuna (*Thunnus thynnus*) Distribution." *Fisheries Oceanography* 18(1): 77-81.

Secor, D., Gahagan, B. and J. Rooker. 2011. "Atlantic Bluefin Tuna Population Assignment Based on Otolith Stable Isotopes: The 2003 Year Class Within the U.S. North Carolina Recreational Fishery." *Collected Volumes of Scientific Papers of ICCAT* 68(1): 212-222.

Sergio, F. et al. 2008. "Top Predators as Conservation Tools: Ecological Rationale, Assumptions, and Efficacy." *Annual Review of Ecology, Evolution, and Systematics* 39: 1-19.

Shackleton, M. 1986. *The Politics of Fishing in Britain and France*. Gower Publishing: Aldershot, England. 407pp.

Sissenwine, M. et al. 1998. "A Commentary on Western Atlantic Bluefin Tuna Assessments." *Transactions of the American Fisheries Society* 127(5): 838-855.

Sumaila, R. and L. Huang. 2012. "Managing Bluefin Tuna in the Mediterranean Sea." *Marine Policy*. 36: 502-511.

Sutinen, G. 1999. "What Works Well and Why: Evidence from Fishery-Management Experiences in OECD Countries." *ICES Journal of Marine Science* 56:1051–1058.

Tamura, Y. and T. Tagaki. 2009. "Morphological Features and Functions of Bluefin Tuna Change with Growth." *Fisheries Science*. 75: 567-575.

Teo, S. et al. 2006. "Annual Migrations, Diving Behavior, and Thermal Biology of Atlantic Bluefin Tuna, *Thunnus thynnus*, on their Gulf of Mexico Breeding Grounds." *Marine Biology* 151: 1-18.

The Economist. 2008. "Managed to Death." 30 October 2008. Web: <<http://www.economist.com/node/12502783>>. Accessed 21 October 2012.

Tremblay, M. 1957. "The Key Informant Technique: A Nonethnographic Application." *American Anthropologist* 59(4): 688-701.

Tudela, S. 2004. "Ecosystem Effects of Fishing in the Mediterranean: An Analysis of the Major Threats of Fishing Gear and Practices to Biodiversity and Marine Habitats." In *Studies and Reviews: General Fisheries Commission for the Mediterranean*. 74. FAO, Rome, Italy. 44pp.

United Nations General Assembly (UN). 1982. "United Nations Conference on the Law of the Sea," Third Conference, 1982. Web: <http://www.un.org/depts/los/convention_agreements/convention_overview_convention.htm>.

UN. 1995. "United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks." Sixth Session, New York, USA 24 July – 4 August. Web: <http://www.un.org/depts/los/convention_agreements/texts/fish_stocks_agreement/C_ONF164_37.htm>.

Weber, M. 2002. *From Abundance to Scarcity: A History of U.S. Marine Fisheries Policy*. Island Press, Washington, D.C. USA. 245pp.

Webster, D. 2011. "The Irony and the Exclusivity of Atlantic Bluefin Tuna Management." *Marine Policy* 35: 249-251.

Wolinsky, H. 2012. "Genomics has Become A Powerful Tool to Inform Conservation Measures." *European Molecular Biology Organization Reports* 13(4): 308-312.

World Fishing and Aquaculture. 2012. "Mixed Feelings over New ICCAT Measures." 19 November 2012. Web: <<http://www.worldfishing.net/news101/mixed-feelings-over-new-iccat-measures>>. Accessed 21 November 2012.

World Wildlife Fund. 2012. "Atlantic Bluefin Tuna."

Web:<<http://worldwildlife.org/species/bluefin-tuna>>. Accessed 23 October 2012.

Worm, B. and J. Duffy. 2003. "Biodiversity, Productivity and Stability in Real Food Webs." *Trends in Ecology & Evolution* 18(12): 628-632.

Whynott, D. 1995. *Giant Bluefin*. Farrar, Straus, and Giroux Publishing. New York, NY. 242pp.

Yanow, D. 1993. "The Communication of Policy Meanings: Implementation as Interpretation and Text." *Policy Sciences* 26:41-61.