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# **Tonnare in Italy: Science, History, and Culture of Sardinian Tuna Fishing<sup>1</sup>**

**Katherine Emery**

The Mediterranean Sea and, in particular, the *crystallina* waters of Sardinia are confronting a paradox of marine preservation. On the one hand, Italian coastal resources are prized nationally and internationally for their natural beauty as well as economic and recreational uses. On the other hand, deep-seated Italian cultural values and traditions, such as the desire for high-quality fresh fish in local cuisines and the continuity of ancient fishing communities, as well as the demands of tourist and real-estate industries, are contributing to the destruction of marine ecosystems. The synthesis presented here offers a unique perspective combining historical, scientific, and cultural factors important to one Sardinian *tonnara* in the context of the larger global debate about Atlantic bluefin tuna conservation.

This article is divided into four main sections, commencing with contextual background about the Mediterranean Sea and the culture, history, and economics of fish and fishing. Second, it explores as a case study Sardinian fishing culture and its *tonnare*, including their history, organization, customs, regulations, and traditional fishing method. Third, relevant science pertaining to these fisheries' issues is reviewed. Lastly, the article considers the future of Italian *tonnare* and marine conservation options.

## *Fish and fishing in the Mediterranean and Italy*

The word 'Mediterranean' stems from the Latin words *medius* [middle] and *terra* [land, earth]: middle of the earth.<sup>2</sup> Ancient Romans referred to it as "*Mare nostrum*" or "our sea": "the territory of or under the control of the European Mediterranean countries, especially Italy."<sup>3</sup> Today, the Mediterranean Sea is still an important mutually used resource integral to littoral and inland states' cultures and trade.

The Mediterranean region has a rich fish and fishing culture, complicated by the fact that the sea's resources are shared by many users often at odds with one another. Despite the expansion of the Mediterranean fishing fleet in the 1970s and 1980s, which is believed to have contributed to ecological destruction and financial difficulties for

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<sup>1</sup> I am indebted to the Fulbright Program, the Fisheries and Aquaculture Department of the Food and Agricultural Organization of the United Nations (UN FAO), and the University of Cagliari for the opportunity and support to conduct this research. I am especially grateful for the assistance and graciousness of Dr. Piero Addis and Dr. Angelo Cau of the University of Cagliari, and the owners and fishermen of the Carloforte *tonnara*, who helped to make possible the research for this essay. I wish to also thank Dr. Jon Snyder and several anonymous reviewers for helpful insights that greatly improved this paper.

<sup>2</sup> *Webster's New Twentieth Century Dictionary*, 2<sup>nd</sup> ed., s.v. "Medius" and "Terra."

<sup>3</sup> *Webster's New Twentieth Century Dictionary*, 2<sup>nd</sup> ed., s.v. "Mare" and "Nostrum.";

*Oxford English Dictionary Online*, June 2008, s.v. "Mare Nostrum," <http://dictionary.oed.com/> (accessed 25 February 2009).

numerous fishermen, fleets continue to grow in many areas, as do local populations.<sup>4</sup> Fisheries and fish products are essential in the Mediterranean region because of their roles in providing “food security” and employment.<sup>5</sup> In Italy, which ranks among the world’s leading developed economies, in particular, food quality and safety are of great importance to consumers; genetically modified crop production is banned, and many Italians are resistant to genetically modified aquaculture.<sup>6</sup> Nevertheless, there is no consensus concerning the ways in which Mediterranean seafood may be best managed for its long-term sustainability. For example, in the case of Atlantic bluefin tuna, which migrate through the Mediterranean on the way to their breeding grounds, there is disagreement among scientists, policy makers, and conservationists about how the local tuna fisheries may best be regulated.

A paradox: many contemporary Italians want their millennial culture of fish and fishing to continue to exist, while at the same time prioritizing immediate access to abundant, fresh and high-quality seafood. Over the last three decades, reduced fish stocks and increased fishing restrictions have lowered the Italian fishing industry’s profile in the national and international economy.<sup>7</sup> Nevertheless, despite often low incomes that fishermen earn, Italian fisheries continue to be economically significant because they provide local jobs and seafood production.<sup>8</sup> An array of institutions and cooperatives are responsible for the Italian fishing industry and marine resource management.<sup>9</sup> These agencies and organizations help to determine how to meet the constantly growing demand for seafood both inside and outside of Italy.<sup>10</sup> They are not, however, the only

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<sup>4</sup> John Caddy and Pere Oliver, “Some future perspectives for assessment and management of Mediterranean fisheries for demersal and shellfish resources and small pelagic fish,” in *Resource and environmental issues relevant to Mediterranean fisheries management*, *GFCM Studies and Reviews*, no. 66, ed. JF Caddy (Rome: FAO, 1996) 19-38.

<sup>5</sup> *Ibid.*

<sup>6</sup> Robin Pomeroy, “Italian Campaign Plans Mass ‘Vote’ against GM Food,” *Reuters*, October 3, 2007, <http://www.reuters.com/article/environmentNews/idUSL0311973520071003>.

<sup>7</sup> Camillo Catarci, *The Seafood Market in Italy. GLOBEFISH Research Programme vol. 92* (Rome: FAO/Globefish, 2008), 12.

<sup>8</sup> Italy’s fishing fleet consists of ~14,000 vessels of which 9,000 are less than 12 meters long. The fleet is diverse, including bottom trawlers, purse seiners, midwater pair trawlers, dredges, vessels using passive gears and longlines: 32% of total landings come from bottom trawlers. Main targeted species include shrimp, hake, mullet, nephrops, and cuttlefish. The Italian small-scale fishery accounts for 65% of all vessels and over 25% of national landings. See General Fisheries Commission for the Mediterranean (GFCM), *Report of the 10<sup>th</sup> session of the Scientific Advisory Committee*, Nicosia, Cyprus, 22-26 October 2007, FAO Fisheries Report, no. 856 (Rome: FAO, 2008), 109.

<sup>9</sup> Regarding rules and regulations, the Italian fish industry falls mostly under the *Direzione Generale della Pesca e dell’Aquacoltura*, part of the Ministry of Agriculture. Other ministries also play a role monitoring fisheries: the Ministry of Defense, Italian Navy, Carabinieri, Ministry of the Interior, Ministry of Economy and Finance, and Ministry of Health. Coastal administrative duties are carried out at regional and local levels. Italian fishery legislation includes the Decree of the President of the Italian Republic 1639/1968 regarding the “regulation for the execution of the law of 14 July 1965, no. 963, concerning the discipline of marine fishing.” Law 41/1982 manages fisheries by “promoting the rational utilization and enhancement of marine biological resources through an equitable development of sea fishing.” Additional laws exist for aquaculture and food quality. See FAO Fisheries and Aquaculture Department, *National Fishery Sector Overview: Italy Fishery and Aquaculture Country Profile*, (Rome: FAO, 2005), [http://www.fao.org/fishery/countrysector/FI-CP\\_IT/en](http://www.fao.org/fishery/countrysector/FI-CP_IT/en)

<sup>10</sup> Regarding market demand, seafood consumption is high in many parts of the world. Top seafood importers are the European Union, Japan and the United States. In 2006, 5.71, 3.02 and 2.45 million metric

factor involved in the evolution of the culture of fish and fishing around the country. Consumer demand for seafood in Italy is higher than ever, and evolving gender and work roles are now modifying traditional customs in relation to how fish is purchased, prepared and consumed.<sup>11</sup> In step with changes in the marketplace, Italians' cultural values and seafood views have evolved over time.

### *Economics, culture and conservation clash*

A number of recent studies analyze Mediterranean fishing communities and their attempts to balance economic, cultural, and environmental interests. On the one hand, in many countries, national governments endorse economic growth via development and tourism at the expense of traditional fishing communities. For example, increased globalization and funds are creating new transportation hubs along the coast of northern Morocco, Algeria, Egypt, Malta, and Tunisia. Morocco's new seaport, near Tangier, is predicted to be one of the largest container ports in the Mediterranean, after Rotterdam.<sup>12</sup> On the other hand, marine conservation and restoration are also being advocated around the Mediterranean, sometimes by nongovernmental groups and individuals. For example, one wealthy Italian pursues protecting the Sardinian coast from resort tourism by acting as the "Ambassador for the Coasts" in the United Nation's Environment Programme.<sup>13</sup> The UN's Environment Programme promotes bilateral agreements to strengthen marine conservation collaboration between countries within the Mediterranean basin; for example, in 2007 and 2008 there were discussions about expanding marine protected areas and scientific collaboration offshore of Sardinia.<sup>14</sup> These actions demonstrate that there are Italians (and others) today who are actively working to protect the marine environment. At this point, it is unclear whether or not these UN programs will succeed. While many of the proposed projects may promote coastal health, others may provide economic progress at the potential expense of the Mediterranean's unique ecology and traditional fishing cultures.

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tons of seafood were imported respectively. In Italy, while other meats are also frequently eaten, seafood consumption is continually increasing (2% per year from 1961 to 2003). Demand for seafood in Italy is greater than production, even including production from aquaculture. Therefore, seafood imports continue to rise, approximately three times from 1976 to 2006 (from 353,300 metric tons in 1976 to 970,100 metric tons in 2006). Seafood exports from Italy, especially fresh anchovies and canned tuna, also continue growing.

See Camillo Catarci, *The Seafood Market in Italy*. *GLOBEFISH Research Programme vol. 92*. (Rome: FAO/Globefish, 2008), 1, 10, 26-27.

<sup>11</sup> In general, Italian food buyers prefer fresh over frozen products. Due to changes in work schedules and gender roles, seafood shopping, food preparation, and consumption trends are evolving. For instance, as women and men work longer hours, many often choose to buy ready to cook seafood from large supermarkets instead of fresh fish at local wholesale markets. See Catarci, *The Seafood Market in Italy*, 11, 12.

<sup>12</sup> "Med's Moment Comes," *The Economist*, July 10, 2008.

<sup>13</sup> Peter Popham, "The Savior of Sardinia," *The Independent*, July 7, 2007, News World Europe section.

<sup>14</sup> United Nations Environment Programme Mediterranean Action Plan for the Barcelona Convention, "Italy and UNEP/MAP agree on initiatives to protect the Mediterranean," 2007. <http://www.unepmap.org/index.php?module=news&action=detail&id=17>

And Augusto Navone, Director of Tavolara Marine Protected Area, interview by author, Olbia, Sardinia, May 20, 2008.

One specific issue exemplifying the conflict between science, policy, and conservation is whether or not to fish Atlantic bluefin tuna during their annual migration through the Mediterranean. Each year, Atlantic bluefin tuna show strong natal homing (returning to their spawning grounds) in the Gulf of Mexico and the eastern and western Mediterranean Sea.<sup>15</sup> Atlantic bluefin tuna enter the Mediterranean Sea through the Strait of Gibraltar, migrating annually to spawn in the places where they were born, mainly in the Ionian, Tyrrhenian, and Balearic seas.<sup>16</sup> For hundreds of years, the tuna have been caught during their Mediterranean Sea travels, and thus, aspects of Mediterranean marine culture and economics are vitally connected to their annual migration. Described in greater detail later in this article, critical studies investigate the migrating behavior of the Atlantic bluefin tuna to better understand how the population is subdivided and the related consequences for fishery management and conservation.<sup>17</sup> Environmentalists across the globe advocate for Atlantic bluefin tuna conservation through a number of methods, including dramatically decreasing its fishing in the Atlantic Ocean and Mediterranean Sea, boycotting its sale to retailers, restaurants, and consumers, or establishing property rights for fishermen.<sup>18</sup> The World Wildlife Fund Mediterranean (WWF) published a report in spring 2008 describing the escalating race to harvest bluefin tuna, despite dwindling stocks and fleet overcapacity.<sup>19</sup> Purse seiners, longlines, and fixed nets (such as those used in the *tonnare* in Sardinia) are used to catch bluefin tuna. An estimated 617 purse seiners, equipped with the most efficient gear, fish the Mediterranean for bluefin tuna. These boats have a yearly catch potential of 54,783 metric tons, almost double the 2008 legal total allowable catch of 28,500 metric tons, which has been set by the International Commission for the Conservation of Atlantic Tunas (ICCAT).<sup>20</sup> After Turkey, Italy has the second highest purse seine fleet overcapacity for bluefin tuna in the Mediterranean Sea.<sup>21</sup>

The plight of Atlantic bluefin tuna and its Mediterranean fishery reach beyond conservation groups to industry and global policy forums. International seafood industry, trade, and sustainable development groups report regular news updates on tuna fishing rules; one report, Trade and Biological Resources News Digest (Bridges Trade BioRes),

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<sup>15</sup> Anthony M. Boustany et al., "Mitochondrial DNA and electronic tracking reveal population structure of Atlantic bluefin tuna (*Thunnus thynnus*)," *Marine Biology* 156:1 (2008): 13, 21; Jay A. Rooker et al., "Natal Homing and Connectivity in Atlantic Bluefin Tuna Populations," *Science* 322 (2008): 742.

<sup>16</sup> Boustany, "Mitochondrial DNA," 14.

<sup>17</sup> Barbara A. Block et al., "Migratory Movements, Depth Preferences, and Thermal Biology of Atlantic Bluefin Tuna," *Science* 293:5533 (2001): 1310-14; J. Carlsson, et al., "Microsatellite and Mitochondrial DNA Analyses of Atlantic Bluefin Tuna (*Thunnus thynnus thynnus*) Population Structure in the Mediterranean Sea," *Molecular Ecology* 13 (2004): 3345-56; Barbara A. Block et al., "Electronic tagging and population structure of Atlantic bluefin tuna," *Nature* 434 (2005): 1121-27; Erika Viltz, "WWF Bluefin Tuna with Tags to Shed Light on Population Decline," World Wildlife Fund, August 14, 2008, Press release; Boustany, "Mitochondrial DNA," 13-24; Rooker, "Natal Homing," 742-44.

<sup>18</sup> Michael McCarthy, "Last Chance to Save the Tuna?" *The Independent*, June 24, 2008, Environment Nature section.

<sup>19</sup> World Wildlife Fund Mediterranean, *Race for the Last Bluefin: Capacity of the Purse Seine Fleet Targeting Bluefin Tuna in the Mediterranean Sea and Estimated Capacity Reduction Needs* (Rome: WWF Mediterranean, March, 2008).

<sup>20</sup> *Ibid*, ii.

<sup>21</sup> *Ibid*; World Wildlife Fund Mediterranean, *Bluefin tuna in the Mediterranean: Frequently Asked Questions* (Rome: WWF Mediterranean, 2008), 2.

produced by the International Centre for Trade and Sustainable Development in collaboration with International Union for Conservation of Nature (IUCN), the world's oldest and largest global environmental network with over one thousand government and NGO members, addresses the important intersection of trade and biological resources.<sup>22</sup> In some cases, industry groups openly recognize the need to conserve tuna resources. For example, James Wright, assistant editor of SeafoodSource.com, states that “a balance must be struck between protecting natural resources and preserving the industries that depend on them. But the alarm bells about bluefin tuna have been sounding for years, and ICCAT chooses to hit the snooze button every time. Without sustainable tuna stocks, there soon won't be much of an industry to preserve.”<sup>23</sup> Concern is high for Atlantic bluefin tuna in the Mediterranean because after these great predators migrate through the Strait of Gibraltar, on their way to spawning grounds around the Balearic Islands, Tyrrhenian Sea, and central and eastern Mediterranean, they are fished at what numerous scientists believe to be unsustainable levels by the fleets of many countries, including Italy. Despite a push for conservation by many international scientists and environmental activists before a catastrophic collapse of the bluefin tuna stocks occurs, growing global demand for tuna has encouraged increased rather than reduced fishing efforts.

### **Sardinia: A case study** *Fishery management*

Territorial issues, such as jurisdiction, are integral to Sardinia's marine resource management. One of five autonomous regions (including Sicily, Venezia Giulia, Alto Adige, and Val D'Aosta), the Autonomous Region of Sardinia was created following the election of the First Regional Council on May 8, 1949.<sup>24</sup> As an officially sanctioned Autonomous Region, Sardinia has special status due to its “history, traditions, language (recognized by law from the Italian State), and condition of insularity”; the Italian Constitution provides Sardinia special conditions of autonomy regarding its local government, including laws about fishing, tourism, and finances.<sup>25</sup>

The Sardinian fishing sector has to deal with four principal regulatory organizations: international, state (Italian), regional (Sardinian), and local. In addition to laws specific to regional seas, in 1975 there was an Action Plan for the entire Mediterranean in response to environmental problems related to fisheries and pollution. In Sardinia, fish and fisheries were recognized as important economic resources and as the basis of many

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<sup>22</sup> “Oceana: Bluefin Tuna Fishing Continues in Mediterranean,” *SeafoodSource.com*, June 24, 2008, SeaFood Business section; James Wright, “ICCAT Cuts Bluefin Quota; U.S. Says It's Not Enough,” *SeafoodSource.com*, November 25, 2008, SeaFood Business section; “ICCAT Tuna Quota Reductions not Enough: Environmentalists,” *Bridges Trade BioRes* 8:21 (2008).

<sup>23</sup> James Wright, “Tough Break for Tuna,” *SeafoodSource.com*, December 1, 2008, SeaFood Business section.

<sup>24</sup> <http://www.statoids.com/uit.html> and <http://www.ciaosardinia.com/eng/sardinia/politics> (accessed July 12, 2008)

<sup>25</sup> [http://www.aziendesarde.net/eng/sardegna\\_export.php](http://www.aziendesarde.net/eng/sardegna_export.php) (accessed November 30, 2008)

traditional activities. The European Union has subsequently intervened with the Region of Sardinia fishery sector about its technology, politics, laws, and total allowable catch.<sup>26</sup>

### *Sardinian maritime history and culture*

Anthropological studies provide valuable insight into enduring Italian fishery traditions, which may affect such aspects of commercial fishing as the industry's size, gender roles, and the importance of local markets. Perhaps even more than elsewhere in Italy, Sardinian maritime culture depends on a robust interplay of ecology, history, economics, and social customs.<sup>27</sup> Sardinian culture is sometimes considered "closed" and distinct from that of the rest of Italy because of its island status and distance from the mainland. Separated from mainland Italian coast by more than a hundred miles of open water, and originally almost entirely dependent on its terrestrial and marine natural resources and marine transportation of goods, Sardinia's culture is rooted in its island isolation (the word 'isolation' derives from '*isola*' or island) and particular set of resources. Nevertheless, industrial fisheries saw late and minimal development in Sardinia compared to other Italian regions.<sup>28</sup> Why? In Sardinia, fishing was and is risky for both ecological and economic reasons. Unpredictable weather and sea conditions, as well as variable fish stock distribution, make fishing in these waters challenging even for the most skilled.<sup>29</sup> Sustaining a livelihood as a fisherman on the island is economically difficult, moreover, because of poor market organization and shifting consumer demand. In the past, fishing just for Fridays and other religious holidays did not provide enough money to fishermen or encourage the establishment of regular local markets.<sup>30</sup> Additionally, market dynamics for products such as fresh fish are invariably volatile, and an unforeseen abundance of fish can lead to price decreases; only coral collectors can wait to sell their product when the market is favorable, because coral can be preserved indefinitely.<sup>31</sup>

Furthermore, for many centuries the waters around Sardinia were not always favorably looked upon as fishing grounds because of pirates and malaria along the

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<sup>26</sup> Loredana Mura, "La pesca nel diritto internazionale e comunitario," in *Pesca e pescatori in Sardegna. Mestieri del mare e delle acque interne*, ed. Gabriella Mondardini Morelli and Giovanni Lilliu (Milan: Silvana, 1997), 220-21.

<sup>27</sup> Gabriella Mondardini Morelli, *Gente di mare in Sardegna. Antropologia dei saperi, dei luoghi e dei corpi* (Nuoro: Istituto Superiore Regionale Etnografico, 1997).

<sup>28</sup> Margherita Zaccagnini, "Le migrazioni dei pescatori in Sardegna," in *Pesca e pescatori in Sardegna. Mestieri del mare e delle acque interne*, ed. Gabriella Mondardini Morelli and Giovanni Lilliu (Milan: Silvana, 1997), 127-132.

<sup>29</sup> In Sardinia, artisanal fisheries use traditional knowledge to find fish in specific habitats, at shallow depths and the sea bottom. Technological advances enable fishermen to follow exact routes, know bottom topography, and using acoustics, and determine the presence of fish. Furthermore, fishermen follow how catch changes over time, observe trends between weather temperatures and fish catch and modify their fishing activities, accordingly. During bad weather, in January and February, fishermen repair cages and boats. In good weather, they fish and in August, time is generally dedicated towards taking a break from work. See Morelli, *Gente di mare in Sardegna*, 182-83.

<sup>30</sup> Gabriella Mondardini Morelli, "La piccolo pesca," in *Pesca e pescatori in Sardegna. Mestieri del mare e delle acque interne*, ed. Gabriella Mondardini Morelli and Giovanni Lilliu (Milan: Silvana, 1997), 103-126.

<sup>31</sup> Mondardini Morelli, *Gente di mare in Sardegna*, 17.

coast.<sup>32</sup> Additionally, external events such as WWII and the subsequent industrialization of the mainland affected Sardinian fishing, because young fishermen left and in many fishing communities only the elderly, women, and children remained.<sup>33</sup> Despite these factors contributing to the decline of local fisheries, fishing for lobster, coral, and tuna has been a constant part of Sardinian culture and economics through time.<sup>34</sup>

### *Superstition and gender roles*

Although the Sardinian fishing industry is relatively small, fish and fisheries have long played an integral role in Sardinian culture because of their connection to religious rituals and gender relations. Myths, superstitions, and taboos, some of very ancient origin, are critical to the working of Sardinian fisheries. For example, historically speaking, no fishing occurred on November 1<sup>st</sup> and 2<sup>nd</sup> or on Christmas night in Sardinia; anyone who fished those days might find human bones and skulls, a sure sign of impending doom and damnation.<sup>35</sup> Important sacred events on the island linked to fish and fishing include *La festa della Madonna Stella Maris* at Bosa, *La festa di San Pietro* at Porto Torres, the celebration of the *Beata Vergine della difesa* at Stintino, and *Il battesimo della barca* at Stintino and Castelsardo.<sup>36</sup> Women are especially important in rituals and festivals having to do with the sea, such as *La festa del patrone*, which includes a procession to the sea with boats full of women and children. Women also play a mystical role in a boat's naming and baptism, as fishing boats usually are named after a woman. In general, however, there are distinct gender roles that affect the division of labor for men and women in Sardinian fisheries. For example, there are underlying assumptions that women should stick to finances on land while men go to sea, but anthropological studies reveal that women also weave nets, tend to cages, and help men at disembarkment.<sup>37</sup> In short, both genders participate in the intricate symbolic and productive web surrounding the activity of fishing in Sardinia.

### *Markets and society*

A critical slice of the importance of the sea and fishing to Sardinian culture can be seen through an anthropological study of the local fish markets. For example, the Wholesale Fish Market in Cagliari – the single most important market on the island – has a flexible atmosphere with much joking and bantering between buyers and sellers which provide social cohesion and “break up moments of social crisis.”<sup>38</sup> In addition to humor, according to one study, artful selling to consumers has been critical for the survival and success of Sardinian fishermen and dealers. For example, one informant describes how his father swapped a package of dead eels for the live creatures that a customer thought

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<sup>32</sup> Mondardini Morelli, “La piccolo pesca,” 103-26.

<sup>33</sup> Michele Gutierrez, “Pescatori e parchi marini,” in *Pesca e pescatori in Sardegna. Mestieri del mare e delle acque interne*, ed. Gabriella Mondardini Morelli and Giovanni Lilliu (Milan: Silvana, 1997), 227-51.

<sup>34</sup> Mondardini Morelli, “La piccolo pesca,” 103-26.

<sup>35</sup> Mondardini Morelli, *Gente di mare in Sardegna*, 184.

<sup>36</sup> Mondardini Morelli, *Gente di mare in Sardegna*, 184.

<sup>37</sup> Mondardini Morelli, “La piccolo pesca,” 103-26.

<sup>38</sup> Leide Porcu, “The Way We Deal with Harsh Reality: The Rhetorics of Stealing, Selling, Hoarding and Humor in the Fish Market of Cagliari” (Ph.D. diss., Columbia University, 2002), 12.

she was buying. In another case, mostly a custom of the past, vendors performed the so-called “eye operation” to freshen the appearance of fish and thus increase sales.<sup>39</sup> Teasing, trickery, and hard work combine in making the fish market a positive, dynamic, and fundamental piece of Cagliari’s culture.<sup>40</sup> Over the past fifty years, however, regional and global fish and market issues have become increasingly intertwined, “providing economic conditions of dependence and crisis that effect market goers.”<sup>41</sup> While local catch still dominates Sardinian markets, foreign fish products are increasingly invading Sardinia and weakening the ancient bond of traditional relations between local fishermen, dealers and consumers.

### *Tonnara: Historical fishing practice in Sardinia*

Throughout history, tuna in particular have played a critical role in defining Sardinia’s culture and economy of fish and fishing.<sup>42</sup> Italian-style *tonnare* (traditional tuna traps) boast a rich cultural history on the island. A Sicilian neolithic cave painting displays an image of tuna catching, and it is hypothesized that tuna fishing has occurred in Sardinia since *nuraghe* times, that is to say, circa 3500 years ago.<sup>43</sup> The *tonnare* were in existence at the time of the Phoenician, Carthaginian, and Roman invasions, respectively. Early modern Sardinian *tonnare* were formally established in 1587 by King Philip II to catch Atlantic bluefin tuna, *Thunnus thynnus*.<sup>44</sup> The *tonnara*, as an integral part of local culture, history, and economics, was long called “La manna del Mediterraneo.”<sup>45</sup> Throughout the late 1500’s, *tonnare* were owned by kings and shared locations with defense towers. In 1654, King Philip IV sold a *tonnara* for the first time to a Genoese man.<sup>46</sup> Towards the end of the 17<sup>th</sup> Century, there were eighteen active *tonnare* in Sardinia.<sup>47</sup> Throughout the 1700s, *tonnare* were a key part of the Sardinian economy and received increasing attention from the state; in 1777, a professor at Sassari wrote about the *rais* (*tonnara* commander).<sup>48</sup> In 1812, it was noted that tuna were abundant, regular, and of high quality. In 1868, tuna conservation in oil and tin casks began. Eleven years later, there was the first sign of crisis: processors decided to can tuna with oil in Spain and then sell the product in Italy at a reduced price. Italian fishermen were upset about losing jobs; there were over one thousand tuna workers in Sardinia at the time.<sup>49</sup> Nevertheless, the *tonnara* industry remained relatively large and by the end of the nineteenth century there were twenty-three active *tonnare* on the island.<sup>50</sup> During WWI, tuna fishers faced another

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<sup>39</sup> Ibid, 37, 38.

<sup>40</sup> Ibid, 4, 10.

<sup>41</sup> Ibid, 38.

<sup>42</sup> Ibid, 332-336.

<sup>43</sup> Salvatore Rubino, “La Pesca del Tonno,” in *Pesca e pescatori in Sardegna. Mestieri del mare e delle acque interne*, ed. Gabriella Mondardini Morelli and Giovanni Lilliu (Milan: Silvana, 1997), 60-88.

<sup>44</sup> Ibid.

<sup>45</sup> John Warre Tyndale, *The Island of Sardinia. Vol. 1.* (London: S&J Bentley, Wilson and Flex, 1857), 179.

<sup>46</sup> Rubino, “La Pesca del Tonno,” 60-88.

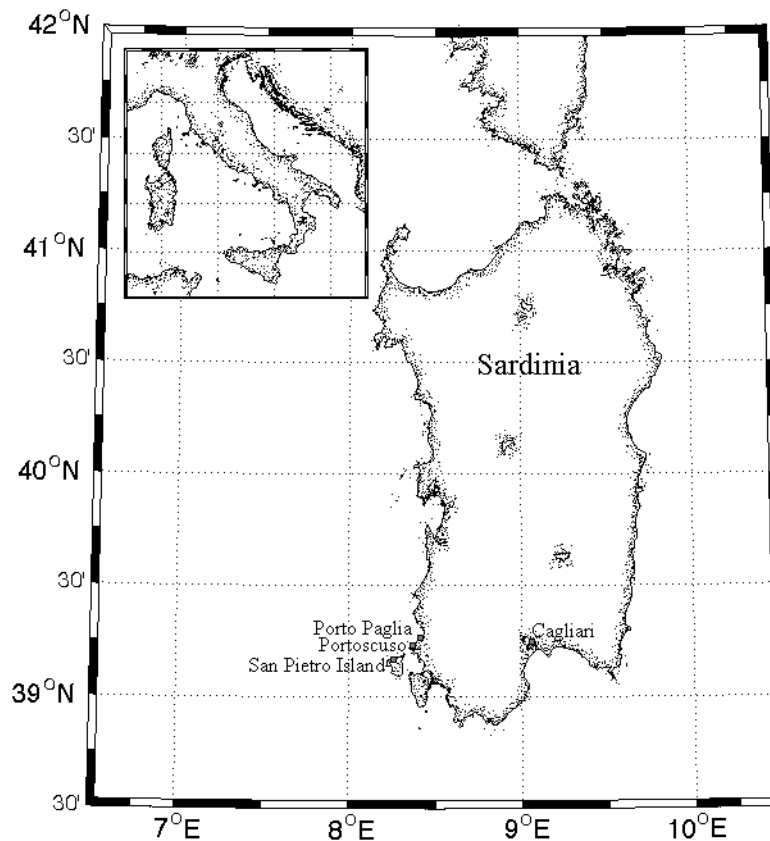
<sup>47</sup> Tyndale, *The Island of Sardinia*, 179.

<sup>48</sup> Rubino, “La Pesca del Tonno,” 60-88.

<sup>49</sup> Ibid, 60-88.

<sup>50</sup> F. Angotzi, *L’industria delle tonnare in Sardegna*, (Pongetti Editore, 1901), in Piero Addis et al., “Effects of Local Scale Perturbations in the Atlantic Bluefin Tuna (*Thunnus thynnus* L.) Trap Fishery of Sardinia (W. Mediterranean),” *Fisheries Research* 92 (2008): 243.

problem: they were threatened by nearby sardine fishing. At the end of the 1960s, the ancient *tonnara* system was overturned. Some crews were unionized and tuna workers held a strike in southwest Sardinia.<sup>51</sup> Now, after years of declining catches, there are just three main productive *tonnare* left in Sardinia: at Carloforte on the island of San Pietro, Portoscuso, and Porto Paglia (Figure 1).<sup>52</sup> Interest by Italian academics and the international scientific community is constantly growing in regard to the *tonnare* and fishing culture, which are invaluable indicators of the tuna's migration, physiology, and change in numbers over time.



**Figure 1 Map of Sardinia with locations of three *tonnare* (Carloforte of San Pietro Island, Portoscuso, and Porto Paglia) and Cagliari. Map courtesy of Brian Emery.**

#### *Tonnara organization*

Traditionally, tuna fishermen in Sardinia often came from Liguria, especially the Genoa area, specifically in order to work at the *tonnara* (Figure 2). In fact, since the 18<sup>th</sup>

<sup>51</sup> Rubino, "La Pesca del Tonno," 82.

<sup>52</sup> Piero Addis, personal communication with author, December 23, 2008.

Century, most fishermen in Sardinia were Genoese and Neapolitans.<sup>53</sup> For the *tonnara*, they arrived one to two months early to repair and set up the nets; fishermen returned to their hometowns after the season.<sup>54</sup> All workers had specific roles in the operation. Traditionally, younger fishermen were first assigned to moving stored gear, tuna innards, and other less glamorous work. With experience, they gained more responsibility.<sup>55</sup> The fate of the tuna harvest, then as now, depends on the intelligence and experience of the *rais*, who coordinates all fishermen and oversees repairs, preparation, and the placement of traps. He is respected by all participants and is given unlimited authority to decide when to start the *mattanza*.<sup>56</sup> Women traditionally are perceived to have a marginal role in the catching of the tuna because they do not go to sea; their responsibilities used to be primarily conserving tuna, but now they also do accounting and oversee processing of the catch.<sup>57</sup>



**Figure 2 Carloforte *tonnara*.**\*

### *Tonnara customs and regulations*

There are multiple *mattanze* during the season, which lasts from approximately April/May to June/July. One set of traps at the *tonnara* is set up each season, and nets are

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<sup>53</sup> Mondardini Morelli, “La piccolo pesca,” 103-26.

<sup>54</sup> Tyndale, *The Island of Sardinia*, 158.

<sup>55</sup> Theresa Maggio, *Mattanza: Love and Death in the Sea of Sicily* (Cambridge MA: Perseus Publishing, 2000), 126, 149, 159; and Rubino, 60-88.

<sup>56</sup> Tyndale, *The Island of Sardinia*, 161.

<sup>57</sup> Rubino, “La Pesca del Tonno,” 60-88.

\* All images, unless otherwise credited are the work of the author.

repaired between each *mattanza*. According to the current Carloforte *rais* Luigi, it is bad luck to kill fish on Tuesdays and it is critical to perform the *mattanza* under optimal wind and sea conditions, which can be highly variable. Around thirty to forty fishermen are involved in the functioning of the Carloforte *tonnara*.

In response to changes in technology and stock numbers, tuna fishing methods in Italy have evolved over time. For example, *tonnare* used to be predominantly employed in tuna fishing until *reti volanti* (flying nets), also known as purse seines, belonging principally to Japanese fleets, took over.<sup>58</sup> Longlines are also currently used offshore. The quota (total allowable catch) for tuna caught by Italy includes fish caught by traps, purse seines, and longlines. Therefore, if the purse seiners and vessels using longlines reach the quota, the *tonnara* also has to stop fishing. The decrease in bluefin's catch may be due to a number of reasons, including imprudent management, limited catch enforcement, lack of consumer awareness about which fish they choose to purchase, and rising consumer demand in Japan, America, and Europe for the tuna's rich meat served as sushi, sashimi, and steaks.<sup>59</sup> In addition, overexploitation (from increased gear efficiency of purse seines and longlines), nearby mining sediment pollution, and change in climate may contribute to decreased catch.<sup>60</sup> From 1992 to 2006, smaller and smaller tuna were caught at Carloforte.<sup>61</sup> This could be a potential sign of tuna overexploitation.<sup>62</sup> In addition to decreasing spawning stock, tuna fishing has the problem of dolphin and swordfish bycatch, thus endangering other threatened Mediterranean species.<sup>63</sup>

### *Location*

Atlantic bluefin tuna enter the Mediterranean from the north Atlantic and reproduce in the Balearic Islands and south Tyrrhenian Sea from mid-May to June.<sup>64</sup> Because of calmer oceanographic conditions, *tonnare* were traditionally placed in the Gulf of Asinara in the northwest and along Sardinia's west coast to the south gulf of Cagliari, following the migration route of the tuna. The east coast was too windy for fishing. Many of the most productive *tonnare* were off the southwest coast of Sardinia (Figure 1). One busy *tonnara* was at Porto Paglia. It was fished consistently in the early 1880s, but problems started when the nearby mining industry at Buggeru boomed. In 1964, a cooperative (Co.To.Ri.Ca.) was started, but the number of fishermen kept decreasing until it closed in 1977.<sup>65</sup> The busiest *tonnara* could be found a little further south at Portoscuso.<sup>66</sup> One of the oldest *tonnare*, which will be discussed in greater depth shortly, was at Isola Piana. In 1841, 2500 fish were captured at Porto Paglia; at Portoscuso, 3700;

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<sup>58</sup> Ibid.

<sup>59</sup> Fen Montaigne, "Still Waters, The Global Fish Crisis," *National Geographic* (April 2007) Feature Article. <http://ngm.nationalgeographic.com/2007/04/global-fisheries-crisis/montaigne-text>

<sup>60</sup> Piero Addis, interview by author, Carloforte, Sardinia, June 6, 2008.

<sup>61</sup> Ibid.

<sup>62</sup> Daniel Pauly et al., "Fishing Down Marine Food Webs," *Science* 279:5352 (1998): 860.

<sup>63</sup> Rubino, "La Pesca del Tonno," 60-88.

<sup>64</sup> Christelle Ravier and Jean-Marc Fromentin, "Long-term Fluctuations in the Eastern Atlantic and Mediterranean Bluefin Tuna Population," *ICES Journal of Marine Science* 58:6 (2001): 1299-1317.

<sup>65</sup> Rubino, "La Pesca del Tonno," 60-88; Piero Addis, personal communication with author, December 23, 2008, notes that Porto Paglia is an active *tonnara* as of 2008.

<sup>66</sup> Rubino, "La Pesca del Tonno," 60-88.

and at Isola Piana, 2965.<sup>67</sup> Including the 3200 fish caught at Flumentorgiu, a total of 12,365 fish were caught at these four *tonnare*, weighing about 1065 metric tons.<sup>68</sup> Over two-thirds were preserved with salt or oil; the rest were dried or eaten immediately.<sup>69</sup>

### *Isola Piana Tonnara*

On Isola Piana, an island off Sardinia's southwestern tip, was one of the oldest *tonnare*, known as the "most valuable, profitable, and best conducted of the tunny fisheries."<sup>70</sup> In operation since the 1500s, the property switched owners a few times and was often (and is currently) run by the Genoese. In 1698, it was owned by a local Sardinian from Cagliari, Giuseppe Cavassa. In 1711, it became government property. In 1853, it was the property of the Marquis di Villamarina, but subsequently became Genoese property until 1898. In 1980, fishing activities stopped for a period, perhaps due to changes in catch related to increased noise or chemical pollution in the ocean.<sup>71</sup>

Since the 1840's, the *tonnara* has functioned at Carloforte on San Pietro Island off southwest Sardinia instead of the nearby Isola Piana. Currently under Genoese ownership, the Carloforte *tonnara* is known as the only "real" functioning *tonnara* left in Sardinia. During one *mattanza* in June 2008, 111 legal-sized tuna were caught, weighing on average between 100 and 150 kg and selling for approximately 16-24 Euro/kg, depending on the quality of the catch and market demand. Additionally, four large swordfish were caught, weighing on average 260 kg per fish and selling for approximately 20-22 Euro/kg, or roughly 4000 Euro per fish (Figure 3).<sup>72</sup>

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<sup>67</sup> Tyndale, *The Island of Sardinia*, 178.

<sup>68</sup> Ibid; In 1841, 1048 tons of tuna had an approximate market value of 40,000 British pounds sterling, the equivalent as of February 27, 2009, of 2,900,000 Pounds Sterling (approximately 3,300,000 Euro) after adjusting for inflation. See [http://www.moneysorter.co.uk/calculator\\_inflation.html](http://www.moneysorter.co.uk/calculator_inflation.html) and <http://finance.yahoo.com/currency-converter#from=USD;to=EUR;amt=1>

<sup>69</sup> Tyndale, *The Island of Sardinia*, 178.

<sup>70</sup> Ibid.

<sup>71</sup> Rubino, "La Pesca del Tonno," 60-88.

<sup>72</sup> As a guest scientist of Dr. Piero Addis, University of Cagliari, Sardinia, I visited the Carloforte *tonnara* in spring 2008. See footnote 76.



**Figure 3 Tuna and swordfish.**

A Japanese buyer, who stays at the Carloforte *tonnara* during the season, checks the quality of each fish and purchases accordingly. Most tuna (60%) are exported to Japan, 30% are distributed to Italian 5-star hotels, and 10% are sold at local markets.<sup>73</sup> Compared to the past, relatively few fish are caught at the *tonnara* today, but they are of high quality and bring in a large sum of money to the fishermen. The fishermen practice their art with tremendous professionalism. For the time being, keeping the Carloforte *tonnara* open provides jobs, increases education and outreach about traditional Sardinian customs, and presents scientists with a unique opportunity to study the globally important fish that naturally migrate through the area each year.

#### *Tonnara fishing methods*

The word ‘*mattanza*’ comes from the Spanish verb ‘*matar*,’ meaning “to slay.” In Italian or Sardinian, derivatives of this same verb may mean “to conquer” or “to check-mate.”<sup>74</sup> Fishing at the *tonnara* is different from many other types of fishing – and thus deserves its own specialized vocabulary – because it requires complete collaboration among many fishermen. It depends on collective work and requires a strong bond among crew members. For centuries, tuna fishing techniques were passed from father to son. Even though pay was not always high because salary was tied to variable catch, it was considered a privilege to work at the *tonnara*.<sup>75</sup> Rituals, traditions, weather, biology, and years of experience unite to help the *tonnara* function each and every year. Superstition, laughter, “wild westness,” and seriousness provide the social and professional cohesion needed for the event to run seamlessly. Accordingly, the *tonnara* fishing method has not changed much over hundreds of years.

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<sup>73</sup> Piero Addis, interview by author, Cagliari, Sardinia, June 4, 2008.

<sup>74</sup> Tyndale, *The Island of Sardinia*, 154.

<sup>75</sup> Rubino, “La Pesca del Tonno,” 82.

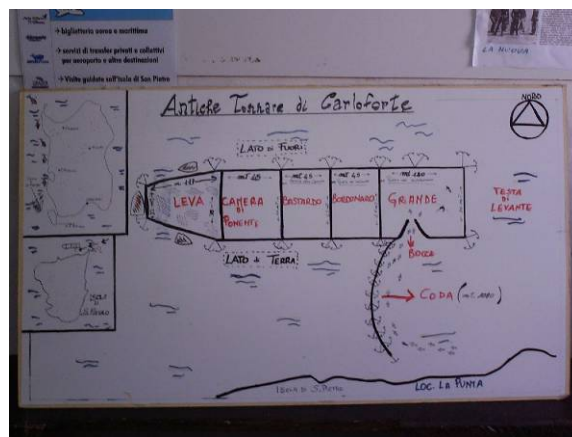
There are two major places where production takes place: *terra* [land] and *mare* [sea]. On land, there is extensive preparation to get the traps ready. In the spring, fishermen begin preparing the nets (Figure 4). Holes and entanglements in the delicate nets are repaired and anchors are assessed for damage (Figure 5). Next, the trap is set; on the sea, coordination is of utmost importance. Directed by the *rais*, fishermen and boats follow a series of coordinated movements to carefully put the heavy anchors in the right places. The nets are laid with equal precision, gestures, and ritual words. At Carloforte, the trap is a rigid yet flexible structure that can handle the “*maestrone*” (fierce winds from the north). Fish migrating from the north run into the *coda* [tail] and are then directed into the trap through the *bocca* [mouth]. The tuna are then trapped and directed through a series of five distinct netted “chambers”: the *castello/grande*, the *bordonaro*, the *bastardo*, the *camera di ponente*, and lastly, the *leva/camera della morte* [death chamber] (Figure 6). The *camera della morte* is the only chamber with a “floor,” namely a very strong net at the bottom of the chamber. During the actual *mattanza*, the “floor” is carefully raised, forcing the fish to move upwards towards the sea surface and the waiting fishermen.



**Figure 4** Repairing nets at the Carloforte *tonnara*.



**Figure 5 Anchors.**



**Figure 6 Tuna trap diagram from Carloforte Tonnare Dive Center.**

The *rais* determines the day the *mattanza* will occur. He posts a white flag outside the *tonnara* so that everyone knows it is the chosen day. After three failed attempts to witness the *mattanza*, due to unfavorable wind and water conditions, I was lucky enough to behold the tuna ritual.<sup>76</sup>

On the boat, there is order amongst chaos (or so it appears from the point of view of a bystander). During the *mattanza*, the *rais* directs all movements using a series of hand gestures and chants to coordinate perfect simultaneous lifting of the floor net by all surrounding boats. He moves among the fishermen and spends time in a small boat in the

<sup>76</sup> As part of a 2008 Fulbright award and under the generous invitation of Dr. Angelo Cau and coordination of Dr. Piero Addis, Department of Animal Biology and Ecology, University of Cagliari, Italy, I visited the Carloforte *tonnara* on San Pietro Island in spring 2008. During the internship led by Dr. Addis, I learned firsthand about the *tonnara*'s history and structure, witnessed the "*mattanza*," saw the fish processing and scientific data collection, and spoke with the *tonnara* owners and *rais*. Additionally, I joined an international group of scientists assessing marine biodiversity around San Pietro Island.

center of the *camera della morte* using a special viewing mask to see and follow the fish behavior under water (Figure 7). Two men in wetsuits stay in the water to watch the tuna behavior and help determine the timing of the net pulling. Upon the *rais*' lead, the men start singing together and pulling the nets (Figure 8). Five boats and thirty to forty fishermen work together to lift the bottom net of the *camera della morte*. The area in which the fish are swimming grows progressively smaller. As the tuna squeeze together, they panic and thrash about at the ocean surface (Figure 9).



**Figure 7** *Rais* in small central boat directing the pulling up of nets.



**Figure 8 Pulling the net up.**



**Figure 9 Enclosed area becomes smaller.**

Anticipation builds. The *rais* decides when the net is shallow enough and gives the signal for the slaying or *mattanza* to begin. A few men jump into the sea of storming fish (Figure 10). As seen in figure 11, they wrestle each giant tuna and sling a hook through its mouth. The hooked fish is then maneuvered to the side of the net, where the main fishing boat awaits it. Fishermen on board hoist the fish onto the boat's surface (Figure 12). There, the fish is stabbed under the pectoral fin to bleed and die quickly (Figure 13A). The fishermen use old burlap bags to cover the tuna's eyes, helping to calm it (Figure 13B). As the fish dies, blood splatters everywhere, turning the deck a vivid red. The boat surface where we stood was slippery with salt water and blood. Tuna are swung on large gaffs and rapidly piled up in the boat, then covered with ice and water to keep them fresh. Fish smaller than the minimum size limit of 30 kg, approximately four to five years old, are returned to the sea (Figure 14).



**Figure 10 Men jump into netted area.**



**Figure 11 A tuna is hooked.**



**Figure 12 A tuna is hoisted to the main boat.**



**Figure 13 (a) A tuna is stabbed under the pectoral fin to bleed and die quickly (b) fishermen use old burlap bags to cover the tuna's eyes, helping to calm it.**



**Figure 14 A tuna less than the minimum size limit (30 kg) is released back to the sea.**

After the fish are gaffed, bled, and iced on the big boat, they are brought to shore for processing. On land, the third major phase of the work occurs. The largest fish are weighed right off the boat down by the water (Figure 15). Fishermen and tourists stand by and ogle at these giants of the sea (Figure 16). A Japanese tuna specialist checks each tuna's quality by notching a small 'v' near the tail (Figure 17). At one *mattanza* in June 2008, out of 111 legal-sized fish, only two passed quality inspection and were shipped to Japan.



**Figure 15 Large tuna are weighed right off the boat.**



**Figure 16 Offloaded fish are appraised.**



**Figure 17 A Japanese buyer gives each tuna a ‘v’ notch near the tail to check its quality.**

Inside the onshore structure, the floor is slippery from water, innards, and blood, and large ceiling hooks fly by transporting the heavy fish (Figure 18). Each fish is tagged with a number, weighed, gutted, decapitated, and de-tailed (Figure 19). The Japanese buyers want the head and tail removed (Figure 20). Italians instead keep almost the entire fish, including head oil, *bottarga* (eggs), and jaw bones. After cleaning, the fish are put in ice water to prepare them for transport to the nearest local markets in Cagliari and, in some cases, a freezer with nitrous oxide for preservation to prepare them for shipping overseas (Figure 21). At the Carloforte *tonnara*, there is also an ancient tradition of making the Sardinian delicacy *bottarga*. Following the same recipe that has been used for hundreds of years, the eggs are dried with copious amounts of Mediterranean salt. They are pressed between wooden boards and large rocks, brushed off by a local plant called *Torba*, and stored hanging (Figure 22). *Bottarga* sells for about 180 Euro/kg and is prized throughout Italy.



**Figure 18** In the processing room, fish are weighed, tagged and flown across the ceiling on large hooks.



**Figure 19 Fish are tagged and gutted.**



**Figure 20 Fish are decapitated and eggs are removed.**



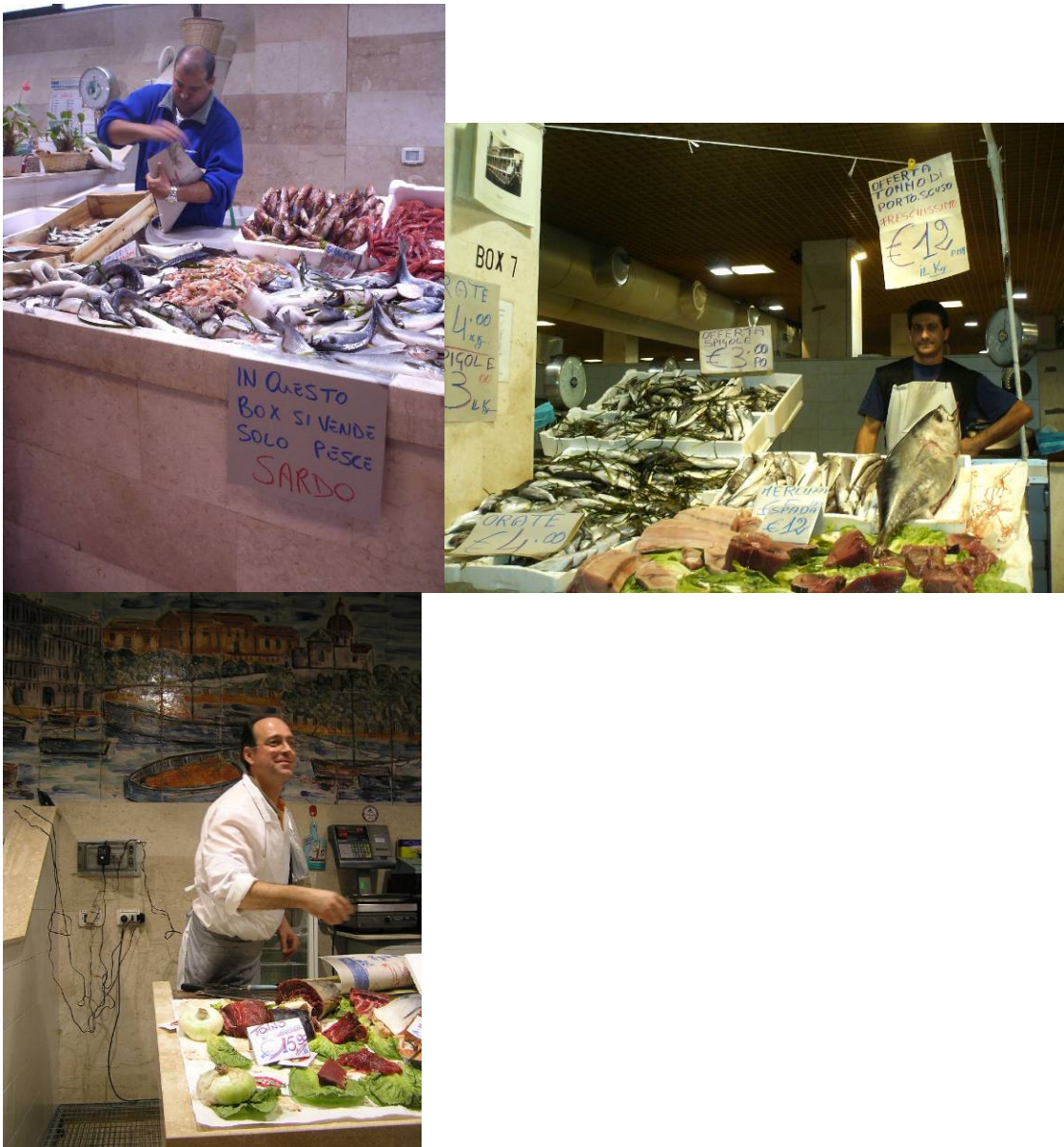
**Figure 21 Tagged tuna are stored in ice water and freezers.**



**Figure 22 (a) Room where *bottarga* is dried with salt, (b) pressed between wooden boards weighed down by large rocks, (c) cleaned with *Torba*, a native plant, and (d) hung for storage and additional drying.**

Tuna plays an important dietary and social role in local Carloforte and Sardinian kitchens, restaurants, and markets. The Atlantic bluefin tuna is served as steaks, with pasta, in pesto, and canned for salads. *Bottarga* is sliced thinly and eaten as an antipasto or grated to flavor pasta. The heart and other delicacies can be found smoked. Tourists come to Carloforte restaurants from all over Italy and the world to taste the tuna specialties. In addition to enriching tables throughout Sardinia and across Italy, tuna colors market life. For example, the importance of the sea, fish, and fishing to Italian

culture is evident at the bottom floor of the San Benedetto market in Cagliari (Figure 23). Fresh tuna are shown off with prominent cardboard signs stating where they were caught; the provenance of the fish signals its value and quality to the consumer. Tuna not only play an important role for local chefs, fishermen, vendors, and consumers, the fish are also critical to Sardinia's insertion in the global economy, because of the number of tourists they attract and, perhaps most importantly, the ever-increasing Japanese, American, and European market demand.<sup>77</sup>



**Figure 23 San Benedetto market, Cagliari, where Sardinian fish and local tuna are sold. Note: Bottom photo courtesy of Sally Dolembo.**

<sup>77</sup> Porcu, "The Way We Deal with Harsh Reality," 39; Fen Montaigne, "Still Waters, The Global Fish Crisis", Feature Article; Jean-Marc Fromentin and Joseph E. Powers, "Atlantic Bluefin Tuna: Population Dynamics, Ecology, Fisheries and Management," *Fish and Fisheries* 6 (2005): 282, 293, 297.

According to the Sardinian anthropologist Porcu, “Tuna, unlike any other Sardinian fish, is exported and can travel as far as the Japanese market”; therefore, studying this market helps us to understand Sardinia’s “material relation to the global economy.”<sup>78</sup> Yet this uniquely Mediterranean fishery may be moving ever closer towards extinction even as its products gain renown around the world.

### **Science of tuna in the Mediterranean**

Around the world, scientists are paying increasing attention to Atlantic bluefin tuna in the Mediterranean as fishing efforts and market demand rise to unsustainable levels. In some cases, the sustainability of the fishery has only recently been questioned and brought to public awareness.<sup>79</sup> In other circles however, such as at the Monterey Bay Aquarium, it has been consistently and clearly stated that already the “Atlantic bluefin tuna are severely overfished in all oceans.”<sup>80</sup> In response to this crisis and uncertainty, tuna fishery managers and scientists must consider not only biology, but also economics, environmental policy, culture, and oceanography that together affect tuna breeding stock sizes. There is a current debate among academics, managers, and industry players about the Atlantic bluefin tuna’s population, and therefore more interdisciplinary research is needed. For example, some scientists study tuna population structure, genetics, and physiology to better understand its stock size and behavior. Tagging studies in the western Atlantic reveal that North Atlantic bluefin tuna migrate across the Atlantic and consist of two stocks spawning in distinct areas (the Gulf of Mexico and Mediterranean) that return and overlap on North Atlantic foraging grounds.<sup>81</sup> Records of fish electronically tagged in the western Atlantic that swim across the Atlantic uncover movement and site fidelity patterns of the fast-moving predators; results from fish tagged over time (3.3-4.6 years) show that the tuna return to specific areas in the Mediterranean Sea to spawn.<sup>82</sup> One study investigates chemical composition in the fish’s otoliths (earbones) to identify individuals from western and eastern Atlantic nurseries and determine the amount of trans-Atlantic exchange between the fish; results reveal that movement and mixing of populations is high.<sup>83</sup> Genetic studies provide both evidence for a genetically distinct stock in the eastern Mediterranean Sea and lack of evidence that

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<sup>78</sup> Ibid.

<sup>79</sup> A recent Japanese market editorial noted that at the first auction of the year at Tsukiji fish market, a 128-kg Atlantic bluefin tuna sold for approximately 9.3 Japanese Yen (approximately 75,000 Euro): a record price since 2001. Growing demand and decreased catch increase the price of these prized fish and put pressure on other tunas, such as bigeye and yellowfish. The author comments that advances in fish finding and catching technology contribute to tuna overexploitation and that “agreement on restrictions and enforcement is now urgent.”

See “Final Curtain for Tuna?” *The Japan Times Online*, Opinion-Editorial section. January 12, 2009; Conversion of Japanese Yen for January 2, 2009 See <http://finance.yahoo.com/currency-converter>

<sup>80</sup> Monterey Bay Aquarium, “Bluefin Tuna in Trouble,” Seafood Watch Section, [http://www.montereybayaquarium.org/cr/cr\\_seafoodwatch/sfw\\_sushi\\_tuna.aspx](http://www.montereybayaquarium.org/cr/cr_seafoodwatch/sfw_sushi_tuna.aspx)

<sup>81</sup> Barbara A. Block et al., “Migratory Movements,” 1310; Barbara A. Block et al., “Electronic Tagging and Population Structure,” 1121.

<sup>82</sup> Block, “Electronic Tagging and Population Structure,” 1121, 1124; Boustany, “Mitochondrial DNA,” 13, 17.

<sup>83</sup> Rooker, “Natal Homing,” 742, 744.

there are two stocks of bluefin tuna.<sup>84</sup> A new tagging study is underway in the eastern Atlantic and Mediterranean, which may provide greater knowledge of tuna migratory routes and behavior.<sup>85</sup>

Oceanography and population studies focus on changes in Mediterranean tuna catch over time and the potential mechanisms contributing to these shifts. A recent look at beach-seine and trap fisheries' data from the western Mediterranean and the Atlantic coasts of Portugal, Spain, and Morocco reveals long-term tuna catch fluctuations (100-120 years) with shorter cyclic variations (~20 years); the authors conclude that long-term variations are probably not due to overexploitation, but rather to environmental and biotic factors affecting recruitment and food availability.<sup>86</sup>

Using passive trap data, which reveals the “natal homing” of bluefin tuna, Addis et al. (2008) recently investigated environmental effects on Atlantic bluefin tuna catch in Sardinia.<sup>87</sup> Addis has been visiting the Carloforte *tonnara* since 1991, when he first did a scuba dive in the tuna trap and immediately gained interest in the biology and history of tuna. In their recent study, Addis et al. analyzed 148 years of catch data from three *tonnare* off southwest Sardinia to evaluate the effect of mining run-off and sea surface temperature on changing catch over time.<sup>88</sup> First, they hypothesize that mining run-off creates a “pulsing boundary ‘reflective’ effect for tuna migration schools on the in-shore trap of Porto Paglia, resulting in periodic oscillations of captures.”<sup>89</sup> While there have been over 2000 years of mining in Sardinia (initially lead, silver, and copper, and later on, zinc, and barium), the authors find that changes in tuna catch at Porto Paglia may be due to the beginning of large-scale mechanized mining in the 1880s. The mining run-off seems to coincide with catch reduction at the Porto Paglia *tonnara*, which was closest to the mine. Catch at Isola Piana, furthest from the mine, seems to have been unaffected by the run-off. Second, the authors find changes in catch season over time: tuna are spawning earlier, perhaps due to increased sea surface temperature, and therefore, catch is generally occurring sooner, in April or May rather than June.<sup>90</sup> Lastly, since the 1970s, a growth in the aluminum industry near the Portoscuso trap has created a new source of coastal anthropogenic pollution; the “red sludge” runoff resulted in the closure of Portoscuso’s *tonnara* trap for four years.<sup>91</sup>

The authors note that is “it is imperative to protect ancient fishing practices with a fisheries management and environmental policy based upon the application of rigorous science.”<sup>92</sup> Furthermore, they advocate continued use of the *tonnara* in the future to

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<sup>84</sup> Bert Ely et al., “Analyses of Nuclear IdhA Gene and mtDNA Control Region Sequences of Atlantic Northern Bluefin Tuna Populations,” *Marine Biotechnology* 4:6 (2002): 583; Jens Carlsson et al., 3345.

<sup>85</sup> Erika Viltz, “WWF Bluefin Tuna with tags to shed light on population decline,” Press release.

<sup>86</sup> Ravier and Fromentin, “Long-term Fluctuations.”

<sup>87</sup> Philippe Cury, “Obstinate Nature: An Ecology of Individuals. Thoughts on Reproductive Behavior and Biodiversity,” *Can. J. Fish. Aquatic. Sci.* 51 (1994): 1664; Philippe Cury et al., “Obstinate North Atlantic Bluefin Tuna (*Thunnus thynnus thynnus*): An Evolutionary Perspective to Consider Spawning Migration,” in *Proceedings of the ICCAT Tuna Symposium: part 1; Collective Volume of Scientific Papers*, ed. James S. Becket (Madrid: ICCAT, 1998), 239-47.

<sup>88</sup> Piero Addis et al., “Effects of Local Scale Perturbations in the Atlantic Bluefin Tuna (*Thunnus thynnus* L.) Trap Fishery of Sardinia (W. Mediterranean),” *Fisheries Research* 92 (2008): 242-54.

<sup>89</sup> *Ibid.*, 242.

<sup>90</sup> *Ibid.*, 248.

<sup>91</sup> *Ibid.*, 252.

<sup>92</sup> *Ibid.*, 243.

benefit tuna research. Future studies could look at the impact of boat traffic (noise pollution) and purse seine fleets on Atlantic bluefin tuna migration.<sup>93</sup> Additionally, investigating the survival rate of released undersized tuna (via tagging studies) and the socioeconomic costs to Carloforte as a result of a potential *tonnara* closure could also provide insights about the future of the community's fishery.

## **Future of Italian Fisheries**

### *Tonnara* future

There is, as noted previously, a paradox of fishing in Sardinia: a cultural conflict between heritage, economic development and marine conservation. The future of the Sardinian *tonnara* depends on a number of factors, including economics, tourism, domestic and international tuna fishing policies, increasing scientific studies, and outreach. The Italian *tonnara* is, as seen, important for reasons beyond fish production: it has distinctive cultural and social aspects, which are manifest in the developing tourist industry that has sprung up around the folklore and gastronomy of this unique culture of fishing. *Tonnara* fishing has become an international tourist event; in 1996, over 2000 tuna were captured and the media brought widespread attention to the *tonnara*.<sup>94</sup> Tourists come to Carloforte from all over the world during the yearly “*Girotonno*” not only to learn about the *tonnara*, to taste local specialties, and to witness the *mattanza*: they may even pay to use scuba to dive underwater with the giant tuna in the nets, thus binding tourism ever closer to the traditional fishing culture of the island. Museums and archeological sites now teach visitors about *tonnare* in an effort to ensure the survival of the Carloforte community and Sardinian culture.<sup>95</sup>

Even though many policy makers and scientists perceive an overall Atlantic bluefin tuna crisis, *tonnara* fishing continues in no small part because of high demand in Italy and abroad. Sardinian tuna, when of the highest quality, are among the first to be bid for at the Tokyo fish auction.<sup>96</sup> As fuel costs increase (affecting fish shipping costs) and food trends evolve, there may one day be a potential decrease in Atlantic bluefin demand thus decreasing the ability of Sardinia's *tonnare* to remain profitable and open. Further increases in world consumer demand, however, would not guarantee their ability to survive, because overexploitation is expected to lead to a collapse of Atlantic bluefin tuna stocks which could quickly bring the *tonnare* to an end. Only through careful balancing of many different agendas – economic, environmental, and cultural – can the fishery continue to prosper in Sardinia and elsewhere in the Mediterranean.

Regional and international policies also play a role determining the future of *tonnare*. In the early 1980s, when the *tonnara* fishery slowed, a movement in Italy began to market *tonnara* tuna because of its uniqueness as a representation of the Mediterranean's rich history, tradition, and culture. In the 1990s, the *tonnara* resurgence helped the local Sardinian economy to recover from a recent decline in the number of mining jobs. The return of the *tonnara* was also due to a regional financing law which favored the tuna

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<sup>93</sup> Ibid., 252.

<sup>94</sup> Rubino, “La Pesca del Tonno,” 60-88.

<sup>95</sup> Ibid.

<sup>96</sup> Ibid.

sector.<sup>97</sup> Internationally, management of Atlantic bluefin tuna that migrate through and are caught in the Mediterranean is largely in the hands of the International Commission for the Conservation of Atlantic Tunas (ICCAT); the ICCAT regulates the fishery with two management units in the west and east Atlantic, which includes the Mediterranean Sea, separated by the 45°W meridian.<sup>98</sup> This division of the ICCAT is important because recovery plans, such as reduced total allowable catch for the western Atlantic bluefin tuna stock, may be ineffective if fish migrate across the Atlantic to eastern spawning grounds in the Mediterranean and are killed there under different and much higher quotas.<sup>99</sup> Both western and eastern bluefin tuna have shown reduced spawning stock biomass over time; however, as noted previously, fishing mortality continues increasing in the east Atlantic and Mediterranean.<sup>100</sup> In 2005, reported catches in the east Atlantic and Mediterranean were 35,671 metric tons (8,974 metric tons and 26,697 metric tons, respectively); underreporting and mortality above the quota are to be considered likely.<sup>101</sup> In 2007, the ICCAT stated that “a collapse of the eastern Atlantic bluefin tuna in the near future is a possibility given the 2006 stock assessment estimations of the SCRS (Standing Committee on Research and Statistics) of the fishing capacity of all fleets combined and current fishing mortality rates, unless adequate management measures are implemented and enforced.”<sup>102</sup> While the ICCAT recently reduced the Atlantic bluefin tuna catch quota, there is widespread debate about whether the quota cut is enough.<sup>103</sup> In fall 2009, the ICCAT further reduced the eastern Atlantic bluefin tuna quota to 13,500 metric tonnes for 2010; according to NOAA, this “is a marked improvement over the current rules, but it is insufficient to guarantee the long-term viability of either the fish or the fishery.”<sup>104</sup> The ICCAT tuna stock predictions do not bode well for the future of Carloforte’s *tonnara*.

In addition to international pressure to limit tuna fishing in the Mediterranean, an increase in scientific studies, such as recent investigations by Dr. Piero Addis and his students at the University of Cagliari, may play a key role in protecting the future of Carloforte’s *tonnara*. Dr. Addis provides invaluable outreach and exchange between academics and fishermen. For example, currently, he and his students are investigating local Atlantic bluefin tuna physiology and finding that as fish face stress in the *tonnara*’s “death chamber,” their body temperature rises on average 4°C.<sup>105</sup> Fishermen and the

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<sup>97</sup> Ibid.

<sup>98</sup> Block et al., “Migratory Movements, Depth Preferences,” 1310.

<sup>99</sup> Tag-A-Giant Foundation (TGF), “Timeline of bluefin tuna management at ICCAT,” Tag-A-Giant. <http://www.tagagiant.org/Policy.shtml>

<sup>100</sup> International Commission for the Conservation of Atlantic Tunas (ICCAT), *Report of the Standing Committee on Research and Statistics*, Madrid, October 1-5, 2007, 57, 65.

<sup>101</sup> ICCAT, 65.

<sup>102</sup> ICCAT, 66.

<sup>103</sup> Andrew C. Revkin, “The (Tuna) Tragedy of the Commons,” *The New York Times*, November 26, 2008, Science section.

<sup>104</sup> National Oceanic and Atmospheric Administration (NOAA), “NOAA Issues statement on ICCAT Annual Meeting,” NOAA, November 16, 2009, [http://www.noaa.gov/stories2009/20091116\\_iccat.html](http://www.noaa.gov/stories2009/20091116_iccat.html).

<sup>105</sup> Simone Repetto, “Un’equipe di studiosi ha rilevato l’aumento di temperatura nei pesci imprigionati nella camera della morte. Tonni malati di stress da *mattanza*. Indagine dell’ateneo di Cagliari sulla loro capacità riproduttiva,” *La Nuova Sardegna*, July 12, 2008, p35.

owners at the Carloforte *tonnara* welcome the university researchers and eagerly await study results so that they can understand the fish even better.

### *Beyond tonnara*

In Sardinia and Italy, as we have seen, there is conflict over how to best manage marine resources: should the aim be to preserve culture and history, increase development, or protect the environment? On the one hand, rapid development, urban growth, and increasing tourism can have negative environmental consequences in Sardinia. As fishing technologies are modernized, moreover, traditional fishing craft and practices may disappear. In general, small coastal areas are losing their unique individuality as they fill with tourists and grow more homogenous.<sup>106</sup> On the other hand, cultural, scientific, and management innovations may yet preserve Italian and Mediterranean fisheries, such as that of Carloforte's *tonnara*.

For example, it may be possible to benefit the local economy (by increasing the tourism industry), maintain cultural heritage, and protect ecology through four solutions: sustainable fishing by artisanal fisheries, marine protected areas, "*pescaturismo*," and sustainable marketing. It is hypothesized that global artisanal fisheries, such as smaller scale tuna fishers, are more sustainable than larger industrial ones, such as tuna purse seiners, because small boats use fuel more efficiently and there is less bycatch.<sup>107</sup>

A second option is to protect fish and biodiversity through the implementation of marine protected areas (MPAs). Although these areas are still contentious, especially among many fishers, studies to measure the effectiveness of MPAs are increasing in the Mediterranean Sea.<sup>108</sup> In Italy, numerous MPA studies exist to determine where and how best to implement them.<sup>109</sup> Along Sardinia's coast, there are now five official MPAs, two marine national parks, one marine reserve, and one international marine sanctuary. In particular, the Tavolara-Punta Coda Cavallo marine protected area off northeast Sardinia is known for its strong enforcement, outreach, science, and conservation programs. However, lack of cultural acceptance and haphazard monitoring limit the success of many other Italian MPAs; many MPAs are called "paper parks" because on paper they are protected, but in reality they are no different than any other highly used marine area in Italy.<sup>110</sup> Perhaps with greater community involvement in implementation and enforcement, MPAs will become more effective: increase biodiversity, fish abundance and biomass (both within and beyond area boundaries – due to spillover), and therefore, enhance overall fishery sustainability.

A third potential conservation solution, unique to Italy, is called *pescaturismo*, a new type of ecotourism. Former fishermen bring tourists by boat to fishing areas to learn about artisanal fishing culture, but there is no actual commercial fishing. Fishermen earn

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<sup>106</sup> Gabriella Mondardini, "La piccolo pesca," 103-126.

<sup>107</sup> Jennifer Jacquet and Daniel Pauly, "Funding Priorities: Big Barriers to Small-scale Fisheries," *Conservation Biology* 22:4 (2008): 832.

<sup>108</sup> Paolo Guidetti and Eric Sala, "Community-wide effects of marine reserves in the Mediterranean Sea," *Marine Ecology Progress Series* 335(2007): 43.

<sup>109</sup> Ferdinando Villa et al., "Zoning Marine Protected Areas through Spatial Multiple Criteria Analysis: The case of the Asmara Island National Marine Reserve of Italy," *Conservation Biology* 16 (2002): 515.

<sup>110</sup> Paolo Guidetti et al., "Italian marine reserve effectiveness: Does enforcement matter?," *Biological Conservation* 141: 3 (2008): 699.

money by teaching tourists about their heritage and forgotten fishing traditions. In theory, unsustainable fishing is curtailed, and there are more coastal fish in the long-term. Additionally, with new regulations limiting fishing in marine protected areas, *pescaturismo* may provide an alternative income to displaced fishermen.<sup>111</sup>

The fourth and most widely accepted marine conservation tool is the marketing of sustainable seafood, such as through the Italian Slow Fish movement or global Marine Stewardship Council. Companies can encourage consumers to make wise seafood choices through outreach and education and, thus, decrease overexploitation. In Italy, the “Slow Food” movement was started in order to preserve traditional Italian cultural traditions related to farming, cooking, and dining practices. Because of Slow Food’s success, “Slow Fish” began as an allied movement to promote marine conservation through wise seafood choices. Consumers may be persuaded to subscribe to Slow Fish practices for a number of reasons, which are not limited just to sustainability, ethics, or economics.<sup>112</sup> Every two years, Slow Food and the Liguria Region host a popular Slow Fish Festival in Genoa, which builds public awareness through an international trade fair promoting sustainable fishing.<sup>113</sup> Over time, through Slow Fish’s publicity and outreach, Ligurian fishermen have become more supportive of the festival and nearby MPAs at Portofino and Cinque Terre.<sup>114</sup> Slow Fish increases consumer awareness, tourism, and local fish purchasing, while aiming for the “protection of fisheries and the right of local, small-scale fishers, of current and future generations, to fish, for a living and for food.”<sup>115</sup> According to Chuenpagdee and Pauly, overexploitation of marine resources may therefore be avoided through consideration of future generations, cost analysis, economic incentives, education and outreach, as well as support for local governance.<sup>116</sup>

### *Relevance to Sardinia*

As this article has shown, anthropological and scientific studies reveal how Sardinia’s economics and culture depend on a healthy marine environment. In his novel *Sea and Sardinia*, D.H. Lawrence provides a vivid (if fictional) account of the daily customs and colorful characters that he encountered in Sardinia during a visit to the island in 1921. Lawrence explains Sardinians’ fondness for and connection to the Mediterranean Sea, describing strange “weird marine monsters” sold at the fish market, salt heaps at Trapani (in Sicily), strictly fish menus, and the symbolic importance of the sea for the locals.<sup>117</sup>

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<sup>111</sup> Gaetano Zoccali. “Che Pesci prendere?,” in *Via del Gusto*, May 2007, in *Slow Fish 2007, Genova, May 4-7, 2007, Press review: selected articles*, ed. Paola Nano (Bra, Italy: Slow Food, 2007).

<sup>112</sup> In fact, articles promoting Slow Fish are found in a range of magazines, from focusing on the latest fashion and health trends to promoting ecological sustainability and supporting local businesses. See *Slow Fish 2007, Genova, May 4-7, 2007, Press review: selected articles*, ed. Paola Nano (Bra, Italy: Slow Food, 2007).

<sup>113</sup> Zoccali, “Che pesci prendere?”.

<sup>114</sup> Elena Marino, “Aspettative, progetti, collaborazione,” *Slowfood26*, May, 2007, 82-84.

<sup>115</sup> Ratana Chuenpagdee and Daniel Pauly. “Slow Fish: Creating New Metaphors for Sustainability,” in *Report and documentation of the International Workshop on the Implementation of international fisheries instruments and factors of unsustainability and overexploitation in fisheries*, compilers J. Swan and D. Greboval, Siem Reap, Cambodia, 13-16 September 2004. FAO Fisheries Report, 782. (Rome: FAO, 2005), 78.

<sup>116</sup> Chuenpagdee, “Slow Fish,” 78.

<sup>117</sup> David Herbert Lawrence, *Sea and Sardinia* (London: Penguin Books, 1921), 39, 65.

Nevertheless, despite a historically strong connection with the sea, today many Sardinians continue to emigrate off the island to search for work. As modernization and emigration accelerate, there is uncertainty about how long the Sardinian-sea connection will last. Additionally, the potential collapse of the bluefin tuna stock in the Mediterranean may have unforeseen economic and sociocultural effects not only on Carloforte's *tonnara*, but also on the wider island community and on Italian fishing culture in general. For example, the collapse of the cod fishery in the 1990s along the Grand Banks of Newfoundland had severe social and economic impact on local fishing villages. Cod became so rare that it was no longer commercially viable to fish. Small local fish-processing plants went bankrupt and closed; in 1992, a moratorium on fishing the northern cod stock put 30,000 fishermen out of work.<sup>118</sup> Some fishers transferred over to the blackback fishery, which legalized the capture of cod as bycatch, creating yet another fishery management challenge.<sup>119</sup> Now, many of the original cod fishing towns are picturesque (yet cod-less) villages, filled with shops for tourists, and serving as museums to the fishing days.<sup>120</sup>

### *Relevance to the Mediterranean and beyond*

There is a consistent push for economic development in Sardinia and across the Mediterranean basin. Along the coast, tourism and "cementification" are increasing, while in the sea, biodiversity, large fish populations, and ecosystem health are decreasing.<sup>121</sup> Through advances in technology, industrialized fishing has grown and the "race to fish" has accelerated, likely pushing the Atlantic bluefin tuna stocks closer and closer towards collapse. If the spawning stock gets critically low and the entire fishery fails, job loss could be huge: an estimated 1,700 commercial and 10,000 recreational boats target bluefin tuna in the Mediterranean.<sup>122</sup> Furthermore, there are many cascading ecosystem consequences due to the decline of large predator fish.<sup>123</sup> A trend, called "fishing down marine food webs", is growing in the Mediterranean and around the world: as larger fish are removed, smaller and smaller fish are being caught every year, which is one symptom of unsustainable fishing.<sup>124</sup>

Over the past decade, the health and sustainability of global fisheries and oceans have increasingly gained attention from scientists, mass media and the fish industry. In 2006, concern about the fisheries crisis flared when scientists projected the global collapse of all taxa currently fished by the year 2048, threatening not only the critical loss of global marine biodiversity, but a reduction in the ocean's ability to provide ecosystem services.<sup>125</sup> On the other hand, despite recent press about the crisis of Atlantic bluefin

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<sup>118</sup> Mark Kurlansky, *Cod: A Biography of the Fish that Changed the World* (New York: Walker and Company, 1997), 183, 186-87.

<sup>119</sup> Kurlansky, *Cod: A Biography*, 188.

<sup>120</sup> Kurlansky, *Cod: A Biography*, 188, 231.

<sup>121</sup> "Med's Moment Comes," *The Economist*, July 10, 2008.

<sup>122</sup> WWF Mediterranean, *Bluefin Tuna in the Mediterranean*, 4.

<sup>123</sup> Ransom A. Myers and Boris Worm, "Rapid Worldwide Depletion of Predatory Fish Communities," *Nature* 423 (2003): 280.

<sup>124</sup> Daniel Pauly et al., "Fishing Down Marine Food Webs," *Science* 279:5352 (1998): 860.

<sup>125</sup> Boris Worm et al., "Impacts of Biodiversity Loss on Ocean Ecosystem Services," *Science* 314:5800 (2006): 787.

tuna catch, deciding whether to curb its fishing is controversial for cultural, political, and economic reasons. To save these extraordinary fish must we ignore the lucrative global commercial demand and halt fishing in the Mediterranean? Would this in fact destroy ancient local fishing traditions, such as Sardinian *tonnare*, or would it potentially ensure their existence in the future? There is no clear answer to this debate. However, it may still be possible for this great Mediterranean fishery to avoid becoming just a romantic relic of the past, if local, regional, national, and international authorities act to protect Sardinia's unique fishing heritage now.

## Bibliography

- Addis, Piero, Dean, John M., Pesci, Paola, Locci, Ivan, Cannas, Rita, Corrias, Stefano and Angelo Cau. "Effects of Local Scale Perturbations in the Atlantic Bluefin Tuna (*Thunnus thynnus* L.) Trap Fishery of Sardinia (W. Mediterranean)." *Fisheries Research* 92 (2008): 242–54.
- Angotzi, F. *L'industria delle tonnare in Sardegna*. Pongetti Editore, 1901. In Addis et al. "Effects of Local Scale Perturbations in the Atlantic Bluefin Tuna (*Thunnus thynnus* L.) Trap Fishery of Sardinia (W. Mediterranean)." *Fisheries Research* 92 (2008): 242-54.
- Block, Barbara A., Dewar, Heidi, Blackwell, Susanna B., Williams, Thomas D., Prince, Eric D. Farwell, Charles J., Boustany, Andre, Teo, Steven L. H., Seitz, Andrew, Walli, Andreas and Douglas Fudge. "Migratory Movements, Depth Preferences, and Thermal Biology of Atlantic Bluefin Tuna." *Science* 293:5533 (2001): 1310-1314.
- Block, Barbara A., Teo, Steven L. H., Walli, Andreas, Boustany, Andre, Stokesbury, Michael J. W., Farwell, Charles J., Weng, Kevin C., Dewar, Heidi and Thomas D. Williams. "Electronic tagging and population structure of Atlantic bluefin tuna." *Nature* 434 (2005): 1121-27.
- Boustany, Anthony M., Reeb, Carol A., and Barbara A. Block. "Mitochondrial DNA and Electronic Tracking Reveal Population structure of Atlantic Bluefin Tuna (*Thunnus thynnus*)." *Marine Biology* 156:1 (2008): 13-24.
- "ICCAT Tuna Quota Reductions Not Enough: Environmentalists." *Bridges Trade BioRes* 8:21 (2008). <http://ictsd.net/i/news/biores/34718/> (accessed November 28).
- Caddy, John F and Pere Oliver, "Some Future Perspectives for Assessment and Management of Mediterranean Fisheries for Demersal and Shellfish Resources and Small Pelagic Fish." In *Resource and Environmental Issues Relevant to Mediterranean Fisheries Management, GFCM/FAO Studies and Reviews*, no. 66, edited by JF Caddy 19-60. Rome: FAO, 1996.
- Carlsson, Jens, McDowell, Jan R., Diaz-Jaimes, Pinardo, Carlsson, Jeanette E. L., Boles, Sandra B., Gold, John R., and John E. Graves. "Microsatellite and Mitochondrial DNA Analyses of Atlantic Bluefin Tuna (*Thunnus thynnus thynnus*) Population Structure in the Mediterranean Sea." *Molecular Ecology* 13 (2004): 3345-56.
- Catarci, Camillo. *The Seafood Market in Italy. GLOBEFISH Research Programme vol. 92*. Rome: FAO/Globefish, 2008.
- Chuenpagdee, Ratana and Daniel Pauly. "Slow fish: Creating new metaphors for sustainability." In *Report and documentation of the International Workshop on the Implementation of international fisheries instruments and factors of unsustainability and overexploitation in fisheries*, compiled by J. Swan and D. Greboval, 69-82, Siem Reap, Cambodia, 13-16 September 2004. FAO Fisheries Report, no. 782. Rome: FAO, 2005.
- Cury, Philippe. "Obstinate Nature: An Ecology of Individuals. Thoughts on Reproductive Behavior and Biodiversity." *Can. J. Fish. Aquatic. Sci.* 51 (1994): 1664-73.
- Cury, Philippe, Anneville, Orlane, Bard, Francois Xavier, Fonteneau, Alain and Claude Roy. "Obstinate North Atlantic Bluefin Tuna (*Thunnus thynnus thynnus*): An Evolutionary Perspective to Consider Spawning Migration." In *Proceedings of the*

- ICCAT Tuna Symposium: part 1; Collective Volume of Scientific Papers, edited by James S. Becket, 239-247. Madrid: ICCAT, 1998.
- The Economist*, "Med's Moment Comes." July 10, 2008, [http://www.economist.com/displayStory.cfm?story\\_id=11703160&fsrc=nwlbtfwfree](http://www.economist.com/displayStory.cfm?story_id=11703160&fsrc=nwlbtfwfree) (accessed July 10 2008).
- Ely, Bert, Stone, D.S, Bremer, A.J.R., Dean1, J.M., Addis, P., Cau, A., Thelen, E.J., Jones, W.J., Black, D.E., Smith, L., Scott, K., Naseri, I. and J.M. Quattro. "Analyses of Nuclear 1dhA Gene and mtDNA Control Region Sequences of Atlantic Northern Bluefin Tuna Populations." *Marine Biotechnology* 4:6 (2002): 583-88.
- FAO Fisheries and Aquaculture Department. *National Fishery Sector Overview: Italy Fishery and Aquaculture Country Profile*. (Rome: FAO, 2005), [http://www.fao.org/fishery/countrysector/FI-CP\\_IT/en](http://www.fao.org/fishery/countrysector/FI-CP_IT/en) (accessed March 1, 2008).
- Fromentin, Jean-Marc and Joseph E. Powers. "Atlantic Bluefin Tuna: Population Dynamics, Ecology, Fisheries and Management." *Fish and Fisheries* 6 (2005): 281-306.
- General Fisheries Commission for the Mediterranean. *Report of the 10<sup>th</sup> session of the Scientific Advisory Committee*. Nicosia, Cyprus, October 22-26, 2007, FAO Fisheries Report, no. 856 (Rome: FAO, 2008): 109-14.
- Guidetti, Paolo, Milazzo, Marco, Bussotti, Simona, Molinari, Andrea, Murenu, Matteo, Pais, Antonio, Spano, Nunziacarla, Balzano, Raffaella, Agardy, Tundi, Boero, Ferdinando, Carrada, Giancarlo, Cattaneo-Vietti, Riccardo, Cau, Angelo, Chemello, Renato, Greco, Silvestro, Manganaro, Antonio, Notarbartolo di Sciarra, Giuseppe, Russo, Giovanni Fulvio and Leonardo Tunesi. "Italian Marine Reserve Effectiveness: Does Enforcement Matter?" *Biological Conservation* 141:3 (2008): 699-709.
- Guidetti, Paolo and Enric Sala. "Community-wide Effects of Marine Reserves in the Mediterranean Sea." *Marine Ecology Progress Series* 335 (2007): 43-56.
- Gutierrez, Michele. "Pescatori e parchi marini." In *Pesca e pescatori in Sardegna. Mestieri del mare e delle acque interne*, edited by Gabriella Mondardini Morelli and Giovanni Lilliu. 227-251. Milan: Silvana, 1997.
- International Commission for the Conservation of Atlantic Tunas (ICCAT). *Report of the Standing Committee on Research and Statistics*. Madrid, October 1-5, 2007. [http://www.iccat.int/Documents/Meetings/Docs/SCRS\\_REPORT\\_ENG\\_ALL\\_OCT\\_16.pdf](http://www.iccat.int/Documents/Meetings/Docs/SCRS_REPORT_ENG_ALL_OCT_16.pdf) (accessed November 30, 2008)
- The Japan Times Online*, "Final Curtain for Tuna?" Opinion-Editorial section. January 12, 2009, <http://search.japantimes.co.jp/cgi-bin/ed20090112a2.html> (accessed February 27, 2009).
- Jacquet, Jennifer and Daniel Pauly. "Funding Priorities: Big Barriers to Small-scale Fisheries." *Conservation Biology* 22:4 (2008): 832-35.
- Kurlansky, Mark. *Cod: A Biography of the Fish that Changed the World*. New York: Walker and Company, 1997.
- Lawrence, David Herbert. *Sea and Sardinia*. London: Penguin Books, 1921.
- Maggio, Theresa. *Mattanza: Love and Death in the Sea of Sicily*. Cambridge, MA: Perseus Publishing, 2000.
- Marino, Elena. "Aspettive, progetti, collaborazione." *Slowfood26* (May 2007): 82-84.

- McCarthy, Michael. "Last Chance to Save the Tuna?" *The Independent*, June 24, 2008, Environment Nature section. <http://www.independent.co.uk/environment/nature/last-chance-to-save-the-tuna-852826.html> (accessed June 25, 2008)
- Mondardini Morelli, Gabriella. *Gente di mare in Sardegna. Antropologia dei saperi, dei luoghi e dei corpi*. Nuoro: Istituto Superiore Regionale Etnografico, 1997.
- Mondardini Morelli, Gabriella. "La piccola pesca." In *Pesca e pescatori in Sardegna. Mestieri del mare e delle acque interne*, edited by Gabriella Mondardini Morelli and Giovanni Lilliu, 103-126. Milan: Silvan, 1997.
- Montaigne, Fen. "Still Waters: The Global Fish Crisis." *National Geographic*, April 2007, Feature Article. <http://ngm.nationalgeographic.com/2007/04/global-fisheries-crisis/montaigne-text> (accessed February 25, 2009)
- Monterey Bay Aquarium. "Bluefin Tuna in Trouble." Seafood Watch Section, [http://www.montereybayaquarium.org/cr/cr\\_seafoodwatch/sfw\\_sushi\\_tuna.aspx](http://www.montereybayaquarium.org/cr/cr_seafoodwatch/sfw_sushi_tuna.aspx) (accessed February 27, 2009).
- Mura, Loredana. "La pesca nel diritto internazionale e comunitario." In *Pesca e pescatori in Sardegna. Mestieri del mare e delle acque interne*, edited by Gabriella Mondardini Morelli and Giovanni Lilliu, 220-221. Milan: Silvana, 1997.
- Myers, Ransom A. and Boris Worm. "Rapid Worldwide Depletion of Predatory Fish Communities." *Nature* 423 (2003): 280-283.
- National Oceanic and Atmospheric Administration (NOAA). "NOAA Issues statement on ICCAT Annual Meeting." NOAA. November 16, 2009, [http://www.noaanews.noaa.gov/stories2009/20091116\\_iccat.html](http://www.noaanews.noaa.gov/stories2009/20091116_iccat.html) (accessed November 17, 2009).
- Pauly, Daniel, Villy Christensen, Johanne Dalsgaard, Rainer Froese, and Francisco Torres, Jr. "Fishing Down Marine Food Webs." *Science* 279:5352 (1998): 860-63.
- Pomeroy, Robin. "Italian campaign plans mass "vote" against GM food." *Reuters*, October 3, 2007, <http://www.reuters.com/article/environmentNews/idUSL0311973520071003> (accessed November 30, 2008).
- Porcu, Leide. "The Way We Deal With Harsh Reality: The Rhetorics of Stealing, Selling, Hoarding and Humor in the Fish Market of Cagliari." Ph.D. diss., Columbia University, 2002.
- Popham, Peter. "The Savior of Sardinia." *The Independent*, July 7, 2007, News World Europe section. <http://www.independent.co.uk/news/europe/the-saviour-of-sardinia-456278.html> (accessed February 28, 2008).
- Ravier, Christelle and Jean-Marc Fromentin. "Long-term Fluctuations in the Eastern Atlantic and Mediterranean Bluefin Tuna Population." *ICES Journal of Marine Science* 58, no. 6 (2001): 1299-1317.
- Revkin, Andrew C. "The (Tuna) Tragedy of the Commons." *The New York Times*, November 26, 2008, Science section. <http://dotearth.blogs.nytimes.com/2008/11/26/the-tuna-tragedy-of-the-commons/?emc=eta1> (accessed November 27, 2008).
- Repetto, Simone. "Un'equipe di studiosi ha rilevato l'aumento di temperatura nei pesci imprigionati nella camera della morte. Tonni malati di stress da *mattanza*. Indagine

- dell'ateneo di Cagliari sulla loro capacità riproduttiva.” *La Nuova Sardegna*, July 12, 2008, p35.  
<http://www.unica.it/pub/7/show.jsp?id=5368&iso=574&is=7#tonno> (accessed November 30, 2008)
- Rooker, Jay R., Secor, David H., De Metrio, Gregorio, Schloesser, Ryan, Block, Barbara A. and John D. Neilson. “Natal Homing and Connectivity in Atlantic Bluefin Tuna Populations.” *Science* 322 (2008): 742-44.
- Rubino, Salvatore. “La Pesca del Tonno.” In *Pesca e pescatori in Sardegna. Mestieri del mare e delle acque interne*, edited by Gabriella Mondardini Morelli and Giovanni Lilliu, 60-88. Milan: Silvana, 1997.
- SeafoodSource.com, “Oceana: Bluefin Tuna Fishing Continues in Mediterranean,” June 24, 2008, News SeaFood Business section. [http://www.seafoodsource.com/NST-1-50059662/story.aspx?utm\\_source=seafoodsource&utm\\_medium=email&utm\\_campaign=enewsletter&ocuid=NTU2Mjg4OA==m9K0LuAO47w=&r=t](http://www.seafoodsource.com/NST-1-50059662/story.aspx?utm_source=seafoodsource&utm_medium=email&utm_campaign=enewsletter&ocuid=NTU2Mjg4OA==m9K0LuAO47w=&r=t) (accessed June 25, 2008).
- Tag-A-Giant Foundation (TGF). “Timeline of Bluefin Tuna Management at ICCAT.” Tag-A-Giant. <http://www.tagagiant.org/Policy.shtml> (accessed November 30, 2008).
- Tyndale, John Warre. *The Island of Sardinia. Vol. I*. London: S&J Bentley, Wilson and Flex, 1857.  
[http://books.google.com/books?id=akYOAAAAQAAJ&pg=PA178&lpg=PA178&dq=Porto+Paglia++tonnara+history&source=web&ots=e2X63TSxFY&sig=WpGdlc8Q9dMhJSiMedc-20-HQU&hl=en&sa=X&oi=book\\_result&resnum=1&ct=result#PPR1,M1](http://books.google.com/books?id=akYOAAAAQAAJ&pg=PA178&lpg=PA178&dq=Porto+Paglia++tonnara+history&source=web&ots=e2X63TSxFY&sig=WpGdlc8Q9dMhJSiMedc-20-HQU&hl=en&sa=X&oi=book_result&resnum=1&ct=result#PPR1,M1)
- United Nations Environment Programme Mediterranean Action Plan for the Barcelona Convention. “Italy and UNEP/MAP agree on initiatives to protect the Mediterranean.” 2007.  
<http://www.unepmap.org/index.php?module=news&action=detail&id=17> (accessed December 17, 2008).
- Viltz, Erika. “WWF Bluefin Tuna with Tags to Shed Light on Population Decline.” World Wildlife Fund, August 14, 2008, Press release.  
<http://www.worldwildlife.org/who/media/press/2008/WWFPresbluefintunatags.html> (accessed November 30)
- Villa, Ferdinando, Tunesi, Leonardo and Tundi Agardy. “Zoning Marine Protected Areas Through Spatial MultipleCriteria Analysis: The case of the Asmara Island National Marine Reserve of Italy.” *Conservation Biology* 16 (2002): 515-526.
- World Wildlife Fund Mediterranean. *Race for the Last Bluefin: Capacity of the Purse Seine Fleet Targeting Bluefin Tuna in the Mediterranean Sea and Estimated Capacity Reduction Needs*. Rome: WWF Mediterranean, March, 2008.  
[http://assets.panda.org/downloads/med\\_tuna\\_overcapacity.pdf](http://assets.panda.org/downloads/med_tuna_overcapacity.pdf) (accessed November 28, 2008).
- World Wildlife Fund Mediterranean. *Bluefin Tuna in the Mediterranean: Frequently Asked Questions*. Rome: WWF Mediterranean, 2008.  
[http://assets.wwf.ch/downloads/faq\\_bluefin\\_tuna\\_wwf\\_med\\_2008.pdf](http://assets.wwf.ch/downloads/faq_bluefin_tuna_wwf_med_2008.pdf) (accessed December 2, 2008).
- Worm, Boris, Edward B. Barbier, Nicola Beaumont, J. Emmett Duffy, Carl Folke, Benjamin S. Halpern, Jeremy B. C. Jackson, Heike K. Lotze, Fiorenza Micheli,

Stephen R. Palumbi, Enric Sala, Kimberley A. Selkoe, John J. Stachowicz, and Reg Watson. "Impacts of Biodiversity Loss on Ocean Ecosystem Services." *Science* 314: 5800 (2006): 787-90.

Wright, James. "ICCAT Cuts Bluefin Quota; U.S. Says It's Not Enough," *SeafoodSource.com*, November 25, 2008, SeaFood Business section. [http://www.seafoodsource.com/NST-1-50145769/story.aspx?utm\\_source=seafoodsource&utm\\_medium=email&utm\\_campaign=newsletter&ocuid=NTU2Mjg4OA%3D%3D-m9K0LuAO47w%3D&r=t](http://www.seafoodsource.com/NST-1-50145769/story.aspx?utm_source=seafoodsource&utm_medium=email&utm_campaign=newsletter&ocuid=NTU2Mjg4OA%3D%3D-m9K0LuAO47w%3D&r=t) (accessed November 25, 2008).

Wright, James. "Tough Break for Tuna," *SeafoodSource.com*, December 1, 2008, SeaFood Business section. <http://www.seafoodsource.com/NST-2-50148258/Tough-Break-for-Tuna.aspx> (accessed December 13, 2008).

Zaccagnini, Margherita. "Le migrazioni dei pescatori in Sardegna." In *Pesca e pescatori in Sardegna. Mestieri del mare e delle acque interne*, edited by Gabriella Mondardini Morelli and Giovanni Lilliu, 60-88. Milan: Silvana, 1997.

Zoccali, Gaetano. "Che pesci prendere?" In *Via del Gusto*, May, 2007, in *Slow Fish 2007, Genova, May 4-7, 2007, Press review: selected articles*, edited by Paola Nano. Bra, Italy: Slow Food, 2007.