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## The Market Transfer Effect in the Hawaiian Longline Fishery: Why Correlation Does Not Imply Causation

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# The Market Transfer Effect in the Hawaiian Longline Fishery: Why Correlation Does Not Imply Causation

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## 1. INTRODUCTION

A significant amount of discussion has surrounded the question as to whether the *market transfer effect* in the Hawaii longline swordfish fishery occurred during the US swordfish closure of 2001-2004, primarily due to the potential impact on sea turtle mortality. The market transfer hypothesis posits that any reduction in the US swordfish catch due to increased US regulation will result in increased catch by foreign fleets (Squires, 2013 and Pacific Fishery Management Council, 2013). If the market transfer hypothesis is correct—and if the foreign catch would *not* have otherwise increased—then the total number of sea turtle interactions by fishing fleets during this period may have increased, since foreign swordfish fleets typically have higher turtle bycatch rates than the Hawaii fleet (Bartram, Kaneko, and Kucey-Nakamura, 2010).

The starting point for the academic work in support of the market transfer effect during the Hawaii longline closure of 2001-2004 is a paper by Rausser et al. (2009): “Unintended Consequences: The Spillover Effects of Common Property Regulations.” In this paper, the authors claim to uncover evidence in support of the market transfer effect. They base their case on two main points: 1) while US fresh swordfish catch decreased due to the 2001-2004 closure, there was also an increase in fresh US swordfish imports (caught by foreign fleets) during this same period, and 2) the overall swordfish catch within the Eastern Pacific Ocean (EPO), where they believe the market transfer effect occurred, increased after the closure. The authors conclude that 2,882 additional turtles were killed worldwide because of the Hawaii longline swordfish fishery closure. More recent work by Chan and Pan (2016) reaches similar conclusions.

To our knowledge, no one has assessed the underlying assumptions that Rausser et al. and Chan and Pan rely on to reach their conclusions. Other studies have examined the market transfer effect in the Hawaii swordfish fishery (see Sarmiento, 2006, Bartram et al., 2010, Mukherjee, 2015, Squires et al., 2016), but all of them essentially accept the results from Rausser et al. and Chan and Pan.

Our analysis indicates that Rausser et al.’s and Chan and Pan’s conclusions about increased global turtle mortality are not robust, because while they provide evidence that demonstrates a correlation between the US closure and a market transfer effect, this correlation can be explained by other factors. They do not provide sufficient evidence to demonstrate that the Hawaii closure is the primary

factor that led foreign fleets to increase their swordfish catch. For the market transfer hypothesis to be robust, one must demonstrate that foreign fleets in the EPO increased their catch in response to the closure. This paper shows that there are other explanations for the increased swordfish catch not accounted for in these previous papers, in particular:

1. Spain significantly increased its catch during the 2001-2004 closure period and this increase likely accounted for the subsequently higher US swordfish imports.<sup>1</sup> However, as our paper indicates, the Spanish fleet expanded significantly during this period due to increased subsidies from the Spanish government and the European Union. This increased Spanish fishing capacity was completely independent of US regulations (and began before 2001), but its effects coincidentally overlap with the 2001-2004 closure.
2. While Spain's catch dipped after the closure ended, it quickly increased again, far surpassing the average during the 2001-2004 closure, indicating sufficient demand for Spanish catch independent of the US market. Furthermore, as discussed below, the demand for swordfish from countries besides the US is more than adequate to sustain the Spanish fleet. Put another way, because of the closure, the US happened to provide a convenient and temporary market opportunity for the Spanish fleet, but they subsequently found many more willing buyers.
3. In the case of swordfish, most proponents of the market transfer effect assume (explicitly or implicitly) that swordfish not caught by the US fleet in Hawaii will migrate to other fishing grounds, where

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<sup>1</sup> As Rausser et al. (2009) correctly point out, because fishing fleets often sell fish through foreign ports, it is very hard to determine exactly which swordfish from which fleets ended up as new US imports. Consequently, they only analyze changes at the regional level. The only country that fishes swordfish in the EPO region which significantly increased fresh swordfish exports to the US during 2001-2004 was Panama; however, Panamanian swordfish catch in the EPO from 2001-2004 averaged only 225 tons, while in 2003 and 2004 they exported over 1000 tons to the US (FAO Fisheries and Aquaculture Information and Statistics, 1998-2016 and NOAA, 2000-2004), indicating that much of this fish had to have come from another fleet. The most likely fleet that accounted for these increased swordfish exports to the US was Spain, which sold them through Panama.

they will then be caught by foreign fleets. A growing body of evidence suggests, however, that swordfish tend to remain within the sub-regions of the EPO and are not as migratory as once thought. Therefore, the additional swordfish caught by the Spanish fleet are not the same swordfish that compete with the US fleets.

4. The likelihood that the market transfer effect occurred in the Western and Central Pacific Ocean (WCPO), as suggested by Chan and Pan (2016), is low. Countries that fish in this region include Australia, China, Chinese Taipei, Indonesia, Japan, Mexico, the Philippines, Republic of Korea, and the US. Chinese Taipei and the Philippines are the only countries that increased their swordfish landings during the 2001-2004 closure period. Chinese Taipei did not directly increase swordfish effort; they continued a seasonal coastal harpoon fishery between 2001 and 2004, and the bulk of their increase in swordfish landings can be attributed to the development of their tuna fisheries and a subsequent increase in swordfish bycatch. The Philippines only fish for swordfish using municipal vessels and primarily use single hook hand lines, which would not overlap with the part of the WCPO used by the Hawaii longline fishery nor very likely result in a large increase in turtle mortality.

Based on these findings, we conclude that there is insufficient evidence to suggest that the market transfer effect occurred in the Hawaii swordfish fishery during the closure of 2001-2004, and therefore insufficient evidence to suggest more turtles were killed. Furthermore, given that pelagic fish are a high value global commodity sought by many nations, the incentive to increase production by any one country or fleet is likely largely independent of the regulations of any other single country. There are many factors that influence catch which need to be examined, which is especially true for swordfish.

## **2. WHY THE SPANISH CATCH DRAMATICALLY INCREASED POST-2001**

EU domestic consumption of swordfish increased significantly post-2001 largely due to an outbreak of mad cow disease, as well as a large increase in subsidies to Spanish fishing fleets. Franz Fischler, the agricultural minister of the European Union, stated at a news conference in 2000, “Mad cow disease knows no borders but is moving from one member state to another” (Daley, 2000). In Spain, “the meat industry was severely affected, with slaughterhouses and meatpackers reporting a fall of 70 percent in animals produced for consumption” (Daley, 2000). The large drop in demand for beef after the outbreak created a search for alternative animal-based proteins to replace bovine sources. Following the announcements linking mad cow disease to degenerative brain disease, European consumers significantly reduced their consumption of beef. Consequently, beef producers reduced their herds, thereby removing cattle from the food chain (Perloff, 2014). Furthermore, in 2003 Jackie Hruby, US Meat Export Federation director for Europe, Russia, and the Middle East said: “The EU has a large and growing beef deficit expected to reach 450,000 metric tons in the next two years. This deficit comes from a decline in beef production and a recovery from beef consumption following the [mad cow disease] crisis in Europe a few years ago” (Kamenski, 2005).

This reduction in beef consumption throughout Europe produced a corresponding increase in demand for fish protein within the EU. During this same time, the European Union significantly increased subsidies to Spanish fishing fleets. All of this was completely independent of US policy in the Hawaii longline swordfish fishery.

The EU’s head of fisheries Valérie Lainé stated, “Politically [the fishing industry] is more important than any other industry” (Wilson, Cabra, and García, 2014). Starting in 2000 (the year preceding the Hawaii longline closure) and continuing through 2006, the EU gave Spain nearly half (46%) of its entire fishery subsidies (approximately \$1.7 billion) to maintain and increase their fleets. The Spanish government increased this subsidy by an additional \$675 million, bringing the total subsidies between 2000 and 2006 to \$2.39 billion (Greenpeace España, 2010). These subsidies were used for a large construction and modernization effort within the Spanish fleet. During this time, 50 new Spanish vessels were constructed,

all of them larger than 30 meters, whereas most vessels prior to this were less than 25 meters in length. These new, large-scale vessels were thus able to hold more fish and stay out at sea longer.

Spanish culture is rooted in fishing, and Spain continues to be the primary source for swordfish within the EU (Spanish Ministry for Agriculture, Food, and the Environment, 2013). Spain is the EU's largest fishing nation in terms of catch, tonnage, and global coverage, and contributed an average of 67% of total EU swordfish catch from 2000-2013 (FAO Fisheries and Aquaculture Information and Statistics, 1998-2016). Throughout the mad cow scare (and beyond), Spain played a key role in providing swordfish and other fish protein to the EU. The situation is summed up by University of Miami marine science adjunct professor and record-setting fisherman, Stephen Sloan, who in his book *Ocean Bankruptcy: World Fisheries on the Brink of Disaster* stated:

In the year 2001, with its mad-cow disease, foot-and-mouth disease, and anthrax scare in Europe, there was a greater demand for protein to replace all the cattle that were destroyed. The one great source left was the oceans, already under severe pressure in so-called normal times.

Sloan describes how under a 1999 agreement, the European Commission (EC) was set to deduct approximately 4,000 metric tons from the 1999 swordfish quota, reducing it from 14,000 to approximately 10,000 metric tons. Since swordfish bring about \$3.00 - \$4.00 per pound at the dock, this equated to an approximate \$30 million reduction in revenue. However, the EC ultimately ignored this recommendation and allowed swordfish to be exploited at the higher rates.

To summarize, two factors contributed to the increase in demand for swordfish in the EU after 2000: the shift to fish instead of livestock protein due to an outbreak of mad cow disease, and the corresponding increase in the fishing capacity of the Spanish fleet, driven by a large increase in subsidies. Neither of these factors had anything to do with the closure of the Hawaii longline swordfish fishery.

### **3. EPO CATCH BY COUNTRY FROM 2000-2013**

Of the 14 countries that fish for swordfish in the EPO, only four increased their catch by a significant amount (i.e., more than 500 tons) from 2001-2004 (compared to their 2000 levels): Chinese Taipei, Spain, Chile, and China. Figure 1 below shows the annual swordfish catch for these 4 countries from 2000-2013. The first thing to notice is the incredible volatility in swordfish catch from year to year, with individual fleet catches often changing by thousands of tons in either direction from any given year to the next. More importantly, if the market transfer effect hypothesis is valid, after 2004 the countries that had dramatically increased their catch during the closure would have experienced significant long-term reductions, given the increased US catch and the loss of US export markets. This is not what occurred.

While Spanish catch declined in 2005, it quickly rebounded during 2006-2008, before increasing significantly in 2009, falling in 2010, and once again skyrocketing in 2011 and 2013. The average Spanish swordfish catch from 2005-2013 was almost double the catch during 2001-2004 (8204 tons compared to 4802). In fact, none of the countries that experienced significant swordfish catch increases during the 2001-2004 closure period saw reduced average catch once the Hawaii fishery reopened in 2005; Chinese Taipei, China, and Chile all experienced significant average increases in swordfish catch in the EPO post-2004.

What the data clearly show is that the trend for swordfish catch in the EPO increased steadily from 2000-2013. Consequently, attributing any increased catch by non-Hawaii fleets during 2001-2004 to the Hawaii closure is inconsistent with the totality of the available data. Total swordfish catch from all 14 EPO countries, despite the yearly volatility, has steadily increased from 27,252 tons in 2000 to 44,977 in 2013, indicating that there is more than enough global demand and more than enough markets in which to sell swordfish, regardless of the regulations of any single country (FAO Fisheries and Aquaculture Information and Statistics, 1998-2016).



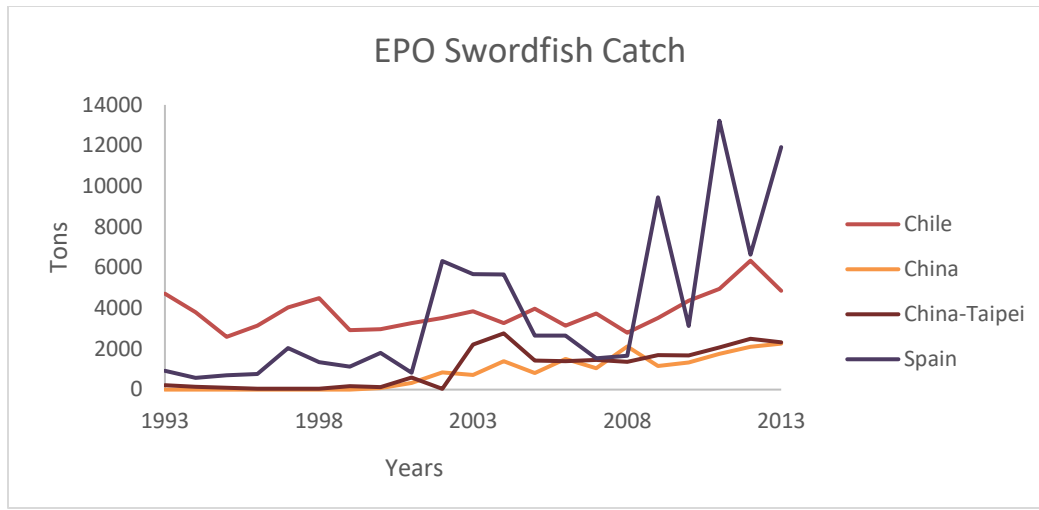


Figure 1. Swordfish catch in the EPO 1993-2013 (FAO Fisheries and Aquaculture Information and Statistics, 1998-2016).

#### 4. ADDITIONAL EVIDENCE: PACIFIC SWORDFISH STOCK DIFFERENTIATION

On page 27, Rausser et al. (2009) state:

Swordfish is a highly migratory species, and there are a small number of stocks in the Pacific. This would mean that the reduction of catch by Hawaiian fisheries would cause an increase in fish available to other fisheries, which would increase their catch per unit effort, and attract more fishers to the market. Third, the fishing grounds frequented by Hawaiian longliners are largely international waters, and longliners often travel thousands of miles in fishing expeditions. Therefore, any decrease in effort by Hawaiian fishers might be compensated by foreign fishers working the same fishing grounds.

As it turns out, however, swordfish in the Pacific Ocean very likely *do not* migrate (or migrate infrequently) across different fishery sub-regions. The Hawaii fleet operates solely in the Northern Pacific Ocean and Spanish fleets operate solely in the Southern EPO, so any fish that were not caught by Hawaii-based longline fishermen due to the closure would have to migrate into the waters frequented by

the Spanish fleets for the market transfer effect to have taken place (55428-00 STATE (INR/GGI); García-Cortés and Mejuto, 2005; Hinton and Maunder, 2011). Although the southeastern and central north Pacific (Hawaii region) are very similar, they are not the same fishing grounds and do not hold the same stock populations. Alvarado Bremer et al. (2006) have studied swordfish migratory patterns extensively and conclude that there are four distinct swordfish stocks: The Northwest, Northeast, Southwest, and Southeast. Figure 2 below shows several swordfish migration patterns tracked using telemetry tagging techniques in the Southeast region, none of which migrated out of the region over the course of the study (Abascal et al., 2010). This suggests that swordfish not caught by Hawaii longline fishermen do not migrate to other regional fisheries, such as those frequented by Spanish fleets.

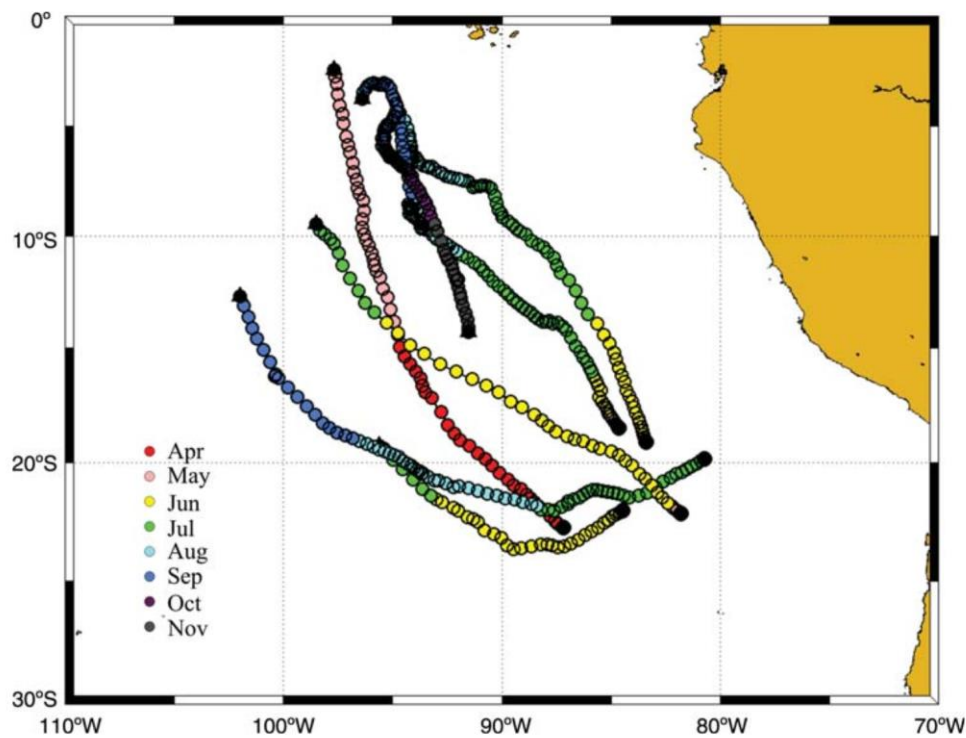


Figure 2. Map of Southeast Pacific swordfish (off the coast of Chile) migrations, by month, showing the swordfish moving northwest for autumn and then returning south for early spring, but remaining within the Southeast Pacific region (F.J. Abascal et al., 2009).

## 5. THE CHAN AND PAN STUDY

In 2012, NOAA issued Technical Memorandum NMFS-PIFSC-30 entitled, “Spillover Effects of Environmental Regulation for Sea Turtle Protection: The Case of the Hawaii Shallow-set Longline Fishery.” In this memorandum, Chan and Pan build upon the work of Rausser et al. to arrive at similar conclusions: that the 2001-2004 closure led to increased global turtle mortality. However, they arrive at this conclusion by contradicting one of Rausser et al.’s (2009) key claims: that the market transfer effect was likely isolated to the EPO. Instead, Chan and Pan claim that the market transfer effect also likely occurred in the WCPO, the predominant fishing grounds of the Hawaii longline fleet.

But just as Rausser et al. do not examine the many factors that contribute to swordfish effort by non-US fleets, and simply assume that any increase in swordfish catch is attributable to the closure alone, Chan and Pan also claim correlation is causation.

Their 2012 work was published in 2016 in *Marine Resource Economics* under a slightly different title, “Spillover Effects of Environmental Regulation for Sea Turtle Protection in the Hawaii Longline Swordfish Fishery.” The authors claim to find evidence of “production displacement”—lower US Pacific swordfish catch leading to higher non-US Pacific swordfish catch—because they find an inverse correlation between US Pacific swordfish catch and non-US Pacific swordfish catch after 2001. They then follow similar logic as Rausser et al. to conclude that this market transfer effect led to increased turtle mortality.

In essence, Chan and Pan simply show that US and non-US swordfish catch was uncorrelated between 1991-2000 (largely due to the high volatility of both US and non-US catch during this period—see Figure 3 below) and then correlated from 2001-2012, when US catch steadily declined and non-US catch continued its increase (which began in 1991). They attribute the post-2000 correlation to the change in US policy (the Hawaii closure), without a rigorous attempt to analyze the many other factors that could have also led to this change, most of which are completely independent of US regulation.

There are only two fisheries that increased their swordfish catch in the WCPO during the closure: Chinese Taipei and the Philippines. Neither is likely to have been impacted by the Hawaii closure. In the WCPO, Chinese Taipei primarily caught swordfish as bycatch from their tuna fisheries, which experienced a

significant increase in vessels after 1996, apart from a small-scale seasonal coastal harpoon fishery (Fisheries Agency Council of Agriculture, 2007). In the case of the Philippines, swordfish landings occurred in the municipal rather than commercial fishery, primarily using hand lines; these small fishing vessels operated entirely in the inshore area and did not overlap with the commercial region of the WCPO frequented by the Hawaii longline swordfish fishery (Lewis, 2005). In addition, the single hook hand lines are considered ecosystem-friendly and have very low incidence of turtle mortality, unlike the non-discriminatory longlines used by Hawaiian vessels (Cochrane and García, 2009). If there were an incidental increase in swordfish landings in this fishery due to the 2001-2004 closure, it would not have resulted in increased turtle mortality.

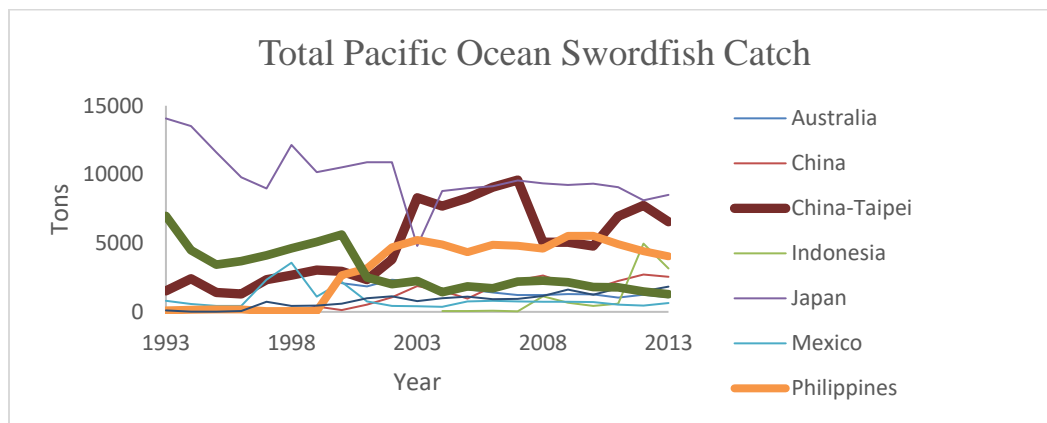


Figure 3. Total Pacific Ocean swordfish catch by country (FAO Fisheries and Aquaculture Information and Statistics, 2017).

To summarize, Chan and Pan expand Rausser et al.'s analysis to include the WCPO, and they find a correlation between US and non-US swordfish catch in the WCPO in the post-2000 time period (see Figure 4 below), but this does not signify a causal link. Just as in the case of the Spanish fleets, many other factors could have contributed to increases in non-US catch in the WCPO besides the closure, including increased subsidies in the fisheries or the construction of a larger fleet that was built in the lead up to 2001. In addition, if foreign fleets increased their catch in response to the closure from 2001-2004, we would expect to witness a decrease in catch after 2004 when the Hawaii fishery reopened, but the opposite occurred; non-US catch continued to increase in the WCPO through 2007.

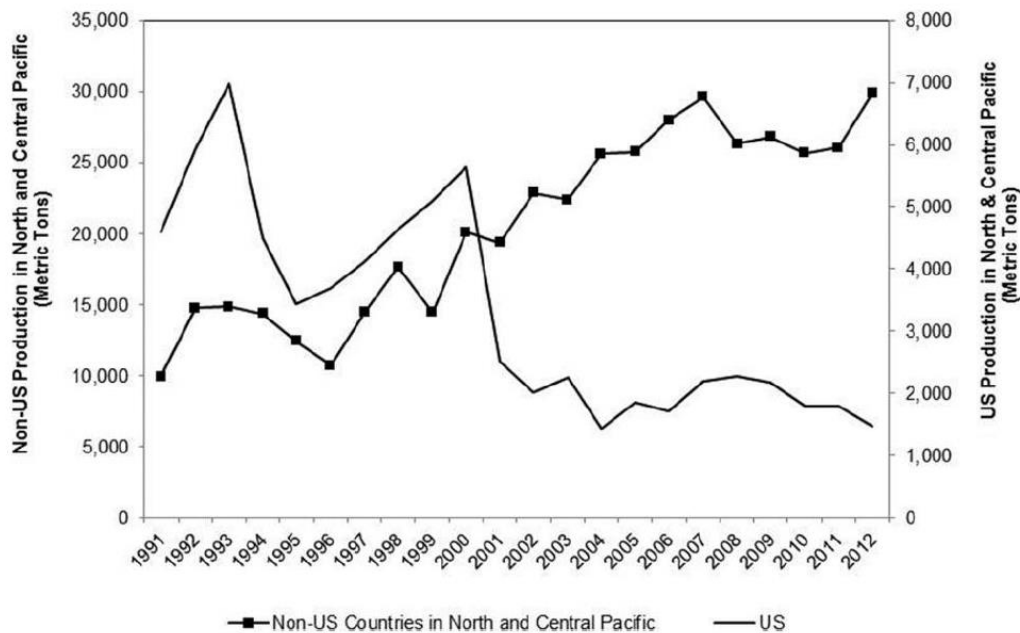


Figure 4. US and non-US Swordfish Production in the North and Central Pacific Ocean, 1991–2012 (FAO, 1998-2016).

## 6. SUMMARY AND CONCLUSION

For the market transfer hypothesis to be robust in the case of the Hawaii longline swordfish closure of 2001-2004, one must demonstrate that foreign fleets in the EPO and WCPO increased their catch in response to the closure. This paper demonstrates that there is insufficient evidence to support such a claim. While there is a negative correlation between non-US swordfish catch and US catch after 2000, there are several other reasonable explanations for this correlation. In particular, the significant increase in the Spanish fleet's swordfish catch was directly related to increases in EU and Spanish fleet subsidies independent of the Hawaii closure. In addition, the increase in EU demand for swordfish occurred at a time when European consumers significantly decreased their beef demand due to concerns about mad cow disease.

Even if Spain temporarily increased its swordfish exports to the US from 2001-2004, these fish would most likely have been sold elsewhere had the Hawaii swordfish fishery not been closed. Since the Hawaii swordfish fishery reopened in

2005, Spain's swordfish catch has continued to increase, far surpassing its 2001-2004 average. Other countries that have increased their catch significantly during the closure include Chinese Taipei, China, and Chile, which all fish in either the EPO, WCPO, or both. Similar to Spain, none of these countries decreased their catch after the reopening of Hawaii's fishery in 2004, as predicted by the market transfer effect. Additionally, in the WCPO, the only two countries to increase their swordfish catch in the region between 2001-2004—Chinese Taipei and the Philippines—either did not specifically increase swordfish effort (Chinese Taipei), or only continued to fish for swordfish using municipal vessels and hand lines within their own Exclusive Economic Zone (Philippines).

Finally, recent scientific studies of swordfish migration patterns suggest that these fish do not migrate freely within the EPO region, as previously thought, but instead tend to stay within the sub-regions that are frequented by different fleets that do not necessarily compete for the same fish.

In conclusion, a more thorough evaluation of the available data indicates that there are many plausible explanations for the increase in non-US swordfish catch during the 2001-2004 Hawaiian closure, and therefore, there is insufficient evidence to claim that the closure is the underlying driver. Consequently, there is insufficient evidence to conclude that the market transfer effect occurred. We find no robust evidence to suggest that future restrictions or expansions of the Hawaii fishery will cause a corresponding net change in turtle bycatch by foreign vessels.

In our judgment, US policymakers should base domestic fisheries regulations on the impacts to US fisheries and the resources contained within them, not on hypothesized impacts on foreign fishing fleets. Furthermore, long-term efforts to reduce sea turtle bycatch must involve strengthening regulations in countries that have much weaker standards than the US. The potential for strong global turtle bycatch standards is bolstered by the results of NOAA Fisheries' Northeast Distant Fishery Experiment's efforts to reduce turtle bycatch rates in the Hawaii swordfish fishery, which ultimately led to its reopening in 2005 (Watson, Foster, Epperly, and Shah, 2004). NOAA tested various hooks and bait types, and demonstrated that reducing turtle bycatch in the swordfish fishery is both technically and economically feasible. With assistance from the US, these practices could be adopted by foreign fleets, leading to truly sustainable global bycatch standards.

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