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At loggerheads over international bycatch: Initial effects of a unilaterally imposed bycatch reduction policy

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ABSTRACT

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) is the primary law that codifies marine fisheries management in United States federal waters. The MSA was amended in 2006 with Section 610, an international provision that directs the Secretary of Commerce to unilaterally identify foreign nations engaged in the incidental capture (bycatch) of protected living marine resources (PLMRs) under specific conditions. In 2013 the United States identified Mexico for bycatch of a PLMR – the North Pacific loggerhead turtle – representing the first time a nation has been identified for bycatch under section 610. This paper evaluates the initial effects of the identification on loggerhead bycatch management efforts in Mexico and provides policy recommendations for improving the law and its implementation. In the wake of the unilateral identification, Mexico downplayed and denied the bycatch problem that their agencies had previously accepted and cancelled a bycatch research partnership between their federal fisheries science agency and U.S. researchers. Moreover, fishers invested in bycatch reduction and monitoring programs ceased to participate, jeopardizing their understanding of the problem and their co-development of bycatch solutions. However, the identification and subsequent consultation process ultimately resulted in Mexico implementing federal loggerhead bycatch regulations that are temporarily comparable with relevant U.S. measures. These regulations establish a temporary fisheries reserve (authorized for two years) that includes monitoring of bycatch, a loggerhead bycatch mortality cap, temporal and spatial restrictions on fishing gear and practices, and a closure of all finfish fisheries during the summer of 2016. As a result, turtle bycatch was likely substantially reduced in 2016, but at the cost of artisanal fishers' entire seasonal income. Policy recommendations are made, highlighting the need to: 1) better assess the socioeconomic, political, and environmental consequences associated with using the threat of trade sanctions to compel nations to reduce their bycatch; and 2) facilitate a more consistent consideration of bycatch data across nations such that the current policy does not create a disincentive for other nations to assess or report PLMR bycatch.

1. Introduction

Fishing effort has increased globally over the past few decades [1,56], with at least half of all fisheries either now fully exploited or overexploited [47,5,58]. In addition to overexploitation of many commercial stocks, the incidental capture of non-target organisms – commonly referred to as bycatch – can lead to population declines of vulnerable species, which in turn can alter ecosystem structure and function [21,55]. Bycatch can also damage gear, increase sorting time, and close fisheries or shift them into less profitable areas to protect non-target species [3].

In United States federal waters, the Magnuson-Stevens Fishery Conservation and Management Act (hereafter MSA) is the primary law that codifies marine fisheries management. In an effort to improve international fisheries management and prevent U.S. fisheries from being disadvantaged by domestic regulations to address bycatch, the U.S. Congress reformed the MSA in 2006, amending the High Seas Driftnet Fishing Moratorium Protection Act (Moratorium Protection Act) with Section 610(a)(1) (hereafter 610), an international provision that directs the Secretary of Commerce to identify foreign nations engaged in bycatch of protected living marine resources (PLMRs) [3,27]. Functionally, this responsibility is delegated to NOAA Fisheries [3]. PLMRs consist predominantly of cetaceans, pinnipeds, sea turtles, and sharks [26]. Listed species are either protected by U.S. law or

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international agreements and, with the exception of sharks, do not include species that are regulated under international fishery management organizations [27].

Pursuant to the MSA, the Moratorium Protection Act mandates the Secretary of Commerce to deliver a biennial report to Congress that identifies nations engaged in PLMR bycatch, defined as vessels engaged in bycatch of PLMRs that also lack a regulatory program that is comparable to that of the United States to address the PLMR bycatch [3,27]. Bycatch of PLMRs is defined as fishing from vessels of a nation, currently or within the calendar year preceding the biennial report to Congress, that results in bycatch of a PLMR that occurs on the high seas (i.e. in waters beyond any national jurisdiction) or bycatch of a PLMR shared with the United States but caught in waters beyond the exclusive economic zone of the United States [3,27].

Upon identification of a country engaged in PLMR bycatch, NOAA Fisheries – acting through or in consultation with the U.S. State Department – is directed to initiate a bilateral consultation process with the identified nation that details the requirements of the Moratorium Protection Act, offers help to mitigate bycatch, and communicates what is required to receive a "positive certification" [3,27]. Specifically, NOAA Fisheries is required to certify whether identified nations have: 1) adopted a bycatch regulatory program comparable to that of the United States (or implemented alternative management strategies that are analogous in effectiveness); and 2) established a management plan to assess stock status and enforce conservation efforts for the PLMR [27]. Following the consultation process, the certification process stipulates that the Secretary of Commerce evaluates all information and gives the identified country a positive or negative certification in the following biennial report to Congress. A positive certification indicates that the bycatch issue has been adequately addressed and the identified country has implemented comparable U.S. bycatch regulations, whereas a negative certification indicates that the identified country has failed to do so. If a nation receives a negative certification, the Secretary of Commerce subsequently recommends to the President of the United States measures to be taken against the country, which may include trade sanctions including denial of access to U.S. ports and import restrictions on fish or fish products [27]. The negative certification and subsequent recommendations to the President of the United States happen in two separate, sequential steps.

Prior to 2013, no nation had ever been identified for PLMR bycatch because of the inherent challenges of collecting and analyzing bycatch data over the short timeframe of one year. However, in its 2013 biennial report to Congress, the United States identified Mexico under section 610 of the Moratorium Protection Act for bycatch of an internationally shared PLMR – the North Pacific loggerhead turtle (*Caretta caretta*) – that occurred in a bottom-set net fishery off the Pacific coast of Baja California Sur, Mexico (BCS) in 2012. In practical terms, as identified under the MSA, Mexico had approximately two years beginning in January 2013 to demonstrate evidence of a U.S comparable loggerhead bycatch regulatory program to NOAA Fisheries. If these were found to be insufficient, Mexico would receive a negative certification and face potential trade sanctions.

2. Study objectives and methodology

The purpose of this paper is to present the events leading to and following the U.S. identification of Mexico for bycatch of the North Pacific loggerhead turtle. Specifically, we: 1) outline the interaction between loggerhead turtles and Mexico's small-scale bottom-set net fisheries; 2) highlight collaborative and fisher-led loggerhead bycatch management programs that were enacted over the past decade at BCS; 3) summarize the outcomes of the identification, consultation, and certification process, including Mexico's regulatory measures (both proposed and established) and the corresponding U.S. certification decisions for each set of regulations; 4) compare loggerhead bycatch assessment, collaborative and community-based loggerhead bycatch mitigation efforts, and federal loggerhead bycatch regulations in Mexico prior to and following the identification, with an evaluation of the initial benefits of the identification relative to the costs; and 5) provide policy recommendations for improving the identification and consultation process of the law and its implementation.

We draw on our collective experience working at BCS on fisheries, PLMRs including loggerheads, community-based conservation, and sea turtle bycatch reduction technologies (HP, JS), as well as our broader work on fishers' perceptions of bycatch and modified or alternative gear, marine policy, and section 610 of the MSA (LJ). We additionally draw on a bycatch research partnership we (JS, HP) and U.S. partner collaborators launched in 2012 with Mexico's National Fisheries Science Institute (INAPESCA), the federal agency that conducts fisheries research in Mexican waters, to assess loggerhead bycatch and develop solutions to reduce it.

We applied a case study approach that focused on retrospective analysis of information initially gathered for non-research purposes, supplemented with a purposeful document analysis and clarifying conversations [60]. In addition to reviewing publicly available documents from Mexico and the United States, we rely on direct on-the-ground observations we made in Mexico prior to and following the identification as well as information we gathered from key stakeholder contacts including local fishers, government officials, scientists, and conservation practitioners. Information gathered from these stakeholder contacts are based on confidential conversations we held following the identification. Given that the identification represented a controversial, rapidly developing, and highly volatile issue, we held these conversations in confidence and promised all stakeholders complete confidentiality; consequently, we did not record individual responses and applied strict internal standards so that we only present information we are confident would not impact individuals or the process between the United States and Mexico. To help assure reliability of the information, we sought to corroborate information from multiple sources. We analyzed this information with a critical qualitative examination to determine themes that presented themselves through repetition and logical consistency [60].

3. Context

3.1. North Pacific loggerhead turtle and Mexico's bottom-set net fisheries

North Pacific loggerhead turtles nest exclusively in Japan, where their developmental migrations take them into the North Pacific basin and from which some recruit into Mexican coastal waters [4,18]. In particular, the Gulf of Ulloa along the Pacific coast of BCS (see [39] for map of study area) is a highly productive foraging hotspot with the highest known concentrations of North Pacific loggerheads [39,51,59], most of which are large juveniles [40] of high demographic importance [10,11].

Intense bottom-set net fisheries operate in and around the loggerhead hotspot from Puerto Adolfo Lopez-Mateos as well as several seasonal fishing encampments [39,40]. In shallow waters (5–30 m, 0–5 km offshore), fishers primarily target California halibut (*Paralichthys californicus*) and grouper (*Mycteroperca* sp.), while in deeper waters (32–65 m, 5–15 km offshore) they target grouper (*Mycteroperca* sp.) and snapper (*Lutjanus* sp.), although other demersal fish are caught opportunistically in both areas (see [43] for a comprehensive list). The overlap of these fisheries with the hotspot results in among the highest recorded sea turtle bycatch rates worldwide [15,20,39,40]. These fisheries result in high mortality because: a) the high turtle density; b) the nets' large mesh size; and c) the nets are tended to only once every 20–48 h, causing many entangled turtles to drown [39]. The resulting mortality is of international concern because the North Pacific loggerhead turtle population was recently uplisted to endangered under

the U.S. Endangered Species Act [28] as well as identified as one of the world's most endangered sea turtle populations [57].

3.2. Collaborative and community-based loggerhead bycatch assessment and reduction efforts in Mexico

The community-based conservation program Proyecto Caguama ("Project Loggerhead", hereafter 'ProCaguama') was initiated in 2003 to assess and mitigate loggerhead bycatch while maintaining fisher livelihoods, the latter of which is important because small-scale fisheries are the primary source of revenue in the coastal communities of BCS [42]. ProCaguama adapted Grupo Tortuguero's conservation mosaic model for successfully reducing sea turtle poaching to address bycatch by empowering a network of fishers, researchers, managers, and community members to develop fisher-led bycatch reduction solutions [42].

Although regulatory approaches have reduced bycatch of sea turtles in some fisheries (e.g. see Hawaiian longline fleet, [14]), ProCaguama concluded that bycatch reduction solutions in the isolated small-scale fisheries at the loggerhead hotspot would require direct participation and buy-in of local fishers due to weak governance in the region. In particular, ProCaguama recognized the need to inspire and empower local fishers to develop their own solutions to reduce loggerhead bycatch [42]. In 2004 ProCaguama began partnering directly with fishers by convening workshops and running experimental trials to design, test, and implement bycatch solutions in the loggerhead hotspot [41–42].

In 2005 ProCaguama developed a tri-national fisheries learning exchange (FLE) with participants from Japan, Mexico, and Hawaii to share bycatch challenges and develop mitigation solutions [44]. During a FLE workshop in 2007, a local fisher leader from BCS declared that his fleet would stop fishing bottom-set longlines in the hotspot that were killing hundreds of loggerheads and transition his fleet to more turtle-friendly gear [42,44]. Subsequently, on September 25, 2007, the bottom-set longline fleet that operated in the hotspot officially retired their longline gear [42,44]. The fleet transitioned to small-mesh surface nets, sparing an estimated hundreds of loggerheads per year from 2007 onwards [40,42,44].

In 2007 ProCaguama and its partners partnered with local fishers at the loggerhead hotspot to test the effects of removing the buoys from float lines of conventional bottom-set nets (termed "buoyless nets") on turtle bycatch, target catch and composition, and market value [43]. In 136 controlled sets of net pairs from 2007 to 2009, buoyless nets reduced mean turtle bycatch rates by 68% while maintaining target catch rates and composition [43].

Despite the strong potential of buoyless nets, ProCaguama continued to work with local fishers to develop solutions that would reduce loggerhead bycatch while also improving the sustainability of fishing for target species. In particular, ProCaguama began working with local fishers in 2010 to test the socioeconomic feasibility of replacing bottom-set nets with hook and line gear of zero turtle bycatch [41]. In 2012 we (HP, JS), along with U.S. partner collaborators, began an international research partnership with Mexico's INAPESCA to assess bycatch of North Pacific loggerheads in the bottom-set net fleets at BCS and to test modified and alternative turtle-friendly gear.

4. U.S. identification of Mexico for PLMR bycatch

4.1. Events prior to and following identification

From 2007–2011, loggerhead bycatch in the Gulf of Ulloa was being mitigated by local fisher leaders who voluntarily switched to more turtle-friendly fishing gear in the loggerhead hotspot (see references above). However, in 2012 strandings of presumably bycaught and discarded turtles increased dramatically at the shoreline adjacent to the loggerhead hotspot. During July and August of 2012, 438 loggerhead carcasses were found along the 43 km index beach that borders the loggerhead hotspot [29], with over 1,000 carcasses encountered during the 2012 summer alone [24]. Concurrently, a collaborative research cruise led by INAPESCA captured 88 loggerheads in bottom-set nets fished in the hotspot during six days of fishery research trials [15,29]. We surmise that a nationwide elasmobranch moratorium enacted during the summer of 2012 [48] drove shark fishermen that normally fish surface set gear to switch to bottom-set nets and target halibut in the hotspot, likely leading to higher fishing effort with bottom-set nets and subsequent loggerhead mortality. In their subsequent report describing the results of the research cruise that captured 88 loggerheads in six days, INAPESCA stated "the available information on the incidental capture of sea turtles in the region known as the Gulf of Ulloa in the peninsula of Baja California Sur indicates that immediate action is necessary in the modification of fishing gear used by the artisanal fleet to avoid bycatch without affecting fisheries production" ([15], *translated by authors*).

Based on the official INAPESCA report [15] along with the strandings reported from Mexico's Federal Attorney for Environmental Protection, NOAA Fisheries contacted Mexico in December 2012 to request more information on the high level of mortality and to determine if Mexico had a regulatory program in place to manage bycatch of loggerhead turtles in their bottom-set net fisheries [29]. Mexico sent a detailed reply to NOAA Fisheries highlighting the activities of their federal agency that oversees fisheries management (i.e. CONAPESCA), but did not provide explicit information on regulatory measures to address loggerhead bycatch [29].

Due to the high level of strandings and bycatch rates observed during the INAPESCA cruise, coupled with the absence of any harmful algal blooms or pollution events in this area at the time that could have caused increased sea turtle mortality, the United States identified Mexico for PLMR bycatch in its January 2013 biennial report to Congress [29] (Box 1). We believe that this decision was clearly legally justified given the high strandings and unprecedented bycatch observed on the index beach and during the INAPESCA research cruise, respectively.

The United States notified Mexico of its identification decision through a diplomatic note from the State Department and a letter sent by NOAA Fisheries' [33,34]. NOAA Fisheries noted in the 2013 biennial report to Congress that they did not believe Mexico had regulatory measures comparable in effectiveness to U.S. regulations for managing bycatch of the North Pacific loggerhead [29]. CONAPESCA was the primary agency within Mexico involved in the consultation [34], and a detailed list of key bilateral communications during the consultation period can be found at [34].

Shortly following the identification, Mexican federal officials downplayed and denied the bycatch problem, attributing the loggerhead mortality to implausible and unsubstantiated causes such as biointoxication from macroalgae [46,49] rather than the fisheries bycatch in local fleets that their agencies had previously accepted [15,45]. During 2013 and 2014, Mexico commissioned and funded a diverse array of investigators to evaluate alternative potential causes of loggerhead mortality in the region. This expensive, multidisciplinary undertaking concluded essentially that in addition to bycatch, loggerhead mortality in the region could include disease and other natural causes [7].

We speculate that Mexico's initial denial of the previously accepted bycatch problem may have occurred because it did not deem the identification to be valid. In the past, the United States has employed unilateral environmental policies that impose trade sanctions irrespective of whether they fall within the letter or spirit of the General Agreement on Tariffs and Trade (GATT) obligations, so nations must assess the validity of these threats [13]. Mexico had reason to doubt the validity of the identification because the United States previously imposed a trade embargo against them for bycatch of protected megafauna that was overruled by a GATT panel (see tuna-dolphin

Box 1.Summary of events prior to and following the U.S. identification of Mexico for bycatch of the North Pacific loggerhead turtle under section 610 of the Moratorium Protection Act.

Events in Mexico leading to identification.

- Mexico issues a nationwide elasmobranch moratorium during the summer of 2012 [48], and shark fishermen that normally fish surface set gear switch to bottom-set nets in the loggerhead hotspot to target halibut.
- 438 loggerhead carcasses of presumably bycaught and discarded turtles wash ashore along the 43 km index beach that borders the loggerhead hotspot during July and August of 2012 [29].
- Concurrently, a July 2012 research cruise led by INAPESCA captures 88 loggerhead turtles during six days of fishery research trials in bottom-set nets fished in the hotspot [15].
- Transfer effect from surface set gear to bottom-set nets likely contributes to record bycatch.

Identification of Mexico for PLMR bycatch by United States.

- In its January 2013 biennial report to Congress, the United States identifies Mexico for failure to manage bycatch of the North Pacific loggerhead turtle, citing the high strandings and bycatch coupled with the lack of pollution or harmful algal blooms [29].

Post-identification and consultation phase.

- Mexican government officials initially downplay and deny the bycatch problem that their agencies had previously accepted and agreed to act upon.
- INAPESCA cancels bycatch research partnership with U.S. researchers in June 2013, including planned trials to test turtle-friendly fishing gear and practices in the hotspot.
- Fishermen (10 crews) cease participating in bycatch reduction trials, pilot studies to improve economic and environmental performance of fisheries, and an electronic monitoring pilot program designed to certify that their fishing was bycatch-free, jeopardizing long-term collaborative bycatch assessment and reduction progress.
- In December of 2014, Mexico's Ministry of Environment and Natural Resources (SEMARNAT) proposes a plan to establish a loggerhead wildlife refuge in the Gulf of Ulloa to be administered by Mexico's CONANP, the national parks agency [50].
- U.S. grants Mexico extension of the January 2015 deadline, delaying its certification determination until May 2015 to allow time for Mexico to develop a management plan for the refuge [34].
- On April 10, 2015, Mexico's federal fisheries management agency (CONAPESCA) replaces SEMARNAT's proposed loggerhead refuge by establishing a temporary partial fishery reserve in the Gulf of Ulloa [8].
- In August of 2015, NOAA determines that Mexico's regulatory program is not comparable in effectiveness to applicable U.S. bycatch regulations and issues Mexico a negative preliminary certification [34].
- On June 23, 2016, CONAPESCA strengthens the temporary fisheries reserve with new loggerhead bycatch regulations (authorized for two years) that expanded upon and replace the 2015 measures and include a temporary closure of the Gulf of Ulloa to all finfish fishing [9].
- On July 22, 2016, U.S. President Obama and Mexico President Peña Nieto meet in Washington, DC; following the meeting, the White House issues a statement that includes the announcement of Mexico's commitment to continue strengthening its loggerhead bycatch regulations in the Gulf of Ulloa [36].
- In September of 2016, NOAA determines that Mexico's strengthened 2016 regulations are comparable in effectiveness to relevant U.S. bycatch measures and subsequently issues Mexico a positive certification [36].

case; [38]), although it is unknown if this was the rationale for the initial denial.

4.2. Initial effects of identification on collaborative and community-based loggerhead bycatch assessment and reduction efforts in Mexico

In the wake of the unilateral identification, we observed three major setbacks to the collaborative approach to solve the loggerhead bycatch problem that we surmise stem from the identification: 1) a loss of collaborative trust with local fishers participating and invested in bycatch assessment and reduction trials; 2) concealment of bycatch events by fishers; and 3) the cancellation of a recently established bycatch research partnership between Mexico's INAPESCA and U.S. researchers.

Following the identification, conservation practitioners from ProCaguama and Grupo Tortuguero who were working in Puerto Lopez Mateos were aggressively criticized by other fishers, one of them was physically assaulted, and several received death threats. Consequently, ProCaguama suspended indefinitely the at-sea component of its community-based conservation work to protect practitioners and researchers.

During ProCaguama's decade-long community-based conservation work, local fishers had acknowledged their high bycatch and were motivated to reduce it due to their new understanding of the Pacific-wide impacts of their bycatch combined with the high handling and gear-loss costs they incurred from turtles being entangled in their nets ([44, 42]). The reversal in Mexico's official government stance regarding bycatch – from accepting and working to mitigate it prior to the identification to publicly downplaying and denying it thereafter – conferred the tacit message that the bycatch fishers struggled with was fabricated or was no longer their responsibility. Fishers' perception of their bycatch subsequently changed from a problem that they were causing and working to solve to one that no longer existed. We surmise that this shift occurred because state and federal officials told fishers that official government research indicated there was no evidence of a bycatch problem [46,49].

We observed a loss of trust with local fishers participating and invested in collaborative bycatch management programs following the identification. In 2013, fishers (10 crews) partnering with ProCaguama on bycatch reduction trials and on pilot studies to improve environmental and economic performance of fisheries ceased to participate due to peer pressure to not appear as traitors to the fishing sector.

These same fishers also backed out of an electronic monitoring pilot program in partnership with ProCaguama designed to prove that their fishing was bycatch-free due to peer pressure because those fishers not using turtle friendly gear and practices would be implicated.

The identification also led to the concealment of loggerhead bycatch by fishers who presumably became more cautious about their bycatch when faced with international scrutiny. Following the identification, fishers reportedly began opening loggerhead carcasses at sea to inhibit their stranding, as evidenced by direct reports from fishers and also from carcasses observed with the plastron cut open during systematic shoreline surveys from 2013 onward. Prior to the identification this practice was never observed in several thousand loggerhead carcasses encountered since 2003, although it has been occasionally observed in green turtles (*Chelonia mydas*). Green turtles are a prized delicacy in the region and are sometimes butchered on board, but loggerheads are rarely consumed due to their oily texture and strong flavor ([22,23,52,53,54]). Additional concealment of bycatch events occurred when the Mexican Government began testing electronic monitoring systems in 2015. Fishers were instructed to never show turtles in front of the camera and to cut them out of the net at the bow while still in the water and out of sight, to avoid documentation of turtle bycatch.

In June of 2013, INAPESCA cancelled a research partnership that included partner investigators from U.S. academic institutions, local fisher leaders, ProCaguama, and Grupo Tortuguero. The initial goal of this partnership was to assess bycatch and develop solutions including modifications to bottom-set nets and practices. The cancellation was particularly damaging to bycatch reduction efforts because it came a month before planned trials in the hotspot to test alternative fishing gear and practices, including fish traps designed to yield zero turtle bycatch. More broadly, the cancellation effectively halted collaboration between INAPESCA scientists and U.S. researchers who specialized in fisheries, PLMRs including loggerheads, and sea turtle bycatch reduction technologies. The unfinished collaboration resulted in a lost opportunity to develop important knowledge, capacity, and bycatch solutions.

5. Mexico's loggerhead bycatch regulatory programs and corresponding U.S. certification decisions

5.1. Initial regulatory programs and negative certification decision

On December 5, 2014, Mexico's Ministry of Environment and Natural Resources (SEMARNAT) proposed a draft regulatory program in an attempt to develop bycatch regulations comparable to that of the United States. The program included plans to establish a loggerhead wildlife refuge in the Gulf of Ulloa, spanning 1,989,391 ha, under the General Wildlife Act to be administered by Mexico's CONANP, the national parks agency [50]. The plan assured that the program would be adopted by April 1, 2015 [34]. Although it is unclear why Mexico eventually proposed a regulatory program to protect loggerheads following their downplaying and denial of the problem, we surmise that as the certification deadline loomed it became clearer that the threat of a trade embargo was genuine. Based on SEMARNAT's promising proposal, the United States granted Mexico an extension of the January 2015 deadline and, in the 2015 Biennial Report to Congress, delayed its certification determination until May 2015 to allow time for a management plan for the refuge to be developed and approved. Subsequently, the certification decision was further delayed because NOAA did not receive Mexico's adopted regulations until April 10, 2015 [33,34], in which CONAPESCA replaced SEMARNAT's loggerhead wildlife refuge with a new regulatory program [8].

CONAPESCA's regulatory program established a temporary partial fishery reserve in the Gulf of Ulloa ([8]; see [34] for synopsis). Specific regulations pertaining to CONAPESCA's temporary partial fishery reserve included: 1) a loggerhead mortality cap of 90 turtles for commercial vessels which, if met, would result in the suspension of gillnets and longlines from May through August of that year; 2) gear modifications and restrictions on gillnets, longlines, and traps in a designated restricted area within the reserve; 3) a requirement for 30% of vessels to have on-board scientific observers and up to 70% of vessels to have video surveillance in conjunction with satellite monitoring of vessels to evaluate catch and bycatch; 4) sea turtle safe handling and release techniques; and 5) recreational fishing restrictions and a provision for coastal fishing for domestic consumption [34]. Both the reserve and restricted area were to remain in effect for 2 years, and the gear restrictions for the restricted area were not to go into effect until 6 months following the implementation of the regulations (i.e. October 2015) [34]. It is unclear, however, why Mexico replaced their initial plan developed by SEMARNAT, which directs the preservation of species and habitats in Mexico and houses CONANP, with a plan by CONAPESCA, which is commissioned to manage and maximize the economic returns of fisheries.

On August 14, 2015, NOAA Fisheries determined that CONAPESCA's 2015 regulations were not comparable with relevant U.S. measures and notified Mexico of their decision to issue a negative certification in the addendum to the 2015 Biennial Report to Congress [34]. In determining their negative preliminary certification decision, NOAA compared Mexico's proposed regulatory program with loggerhead bycatch measures in the Hawaii shallow-set longline and California drift gillnet fishery, the only two U.S. Federal fisheries known to interact with North Pacific loggerheads [34]. The Hawaiian shallow-set longline regulatory program requires 100% observer coverage on vessels, a bycatch cap of 34 loggerhead interactions that requires immediate closure of the fishery in a fishing season if reached, requirements on carrying and using specific equipment for handling and releasing sea turtles and specific procedures to undertake if a turtle is hooked or entangled, and restrictions on gear, bait, and fishing locations [30]. Similarly, the California drift gillnet fishery recently adopted a 2-year bycatch cap of 2 loggerheads for the duration of the fishing season with anticipated target observer coverage of 30% in 2016 and 2017, and 100% coverage in 2018 [31,32,35]. The fishery also employs gear restrictions and a time-area closure to protect loggerheads (i.e. “Pacific loggerhead conservation area”) from 1 June through 31 August during forecasted or concurrent El Niño conditions off the Southern California coast [31,32,35].

In their certification decision, NOAA noted the following deficiencies in Mexico's regulatory program: 1) the reserve and restricted area and associated regulations were both limited in their spatial scope; 2) restrictions on fishing gear only addressed mesh size and not other factors (e.g. net length, soak time); 3) no specific management measures to reduce loggerhead bycatch from September to April were provided, beyond the gear mitigation measures in the restricted area; 4) the limited 2-year duration of the plan and Mexico's lack of information about how they would manage loggerhead bycatch when the plan expired in 2017; 5) uncertainty regarding how the fishery could be closed if/when the 90 loggerhead mortality threshold is reached because the regulations do not require bycatch reporting in real-time; 6) lack of post-interaction mortality assessment of bycaught loggerheads, which is likely to result in an underestimation of actual mortality; 7) the mortality cap only applies to loggerheads taken in the reserve, but gillnet vessels are known to operate outside of the reserve; 8) concerns that the reserve may incentivize fishing outside its borders where there are no regulations, potentially redistributing bycatch impacts; and 8) the observer and enforcement programs and how they would be implemented were not sufficiently described, and it was unclear how the observer program would support the implementation of the mortality limit [34].

5.2. Enhanced regulatory program and positive certification decision

In response to the negative certification decision, Mexico published a revised regulatory program on June 23, 2016, entitled “Agreement

Establishing a Fishing Sanctuary Reserve and New Measures to Reduce the Possible Interaction between Fishing Activities and Sea Turtles in the West Coast of Baja California Sur" ([9]; see [36] for synopsis). The 2016 regulations (authorized for two years) strengthened and replaced the 2015 regulations by: 1) expanding the spatial and temporal scope of the reserve (where the bycatch cap and monitoring occur) and restricted area (where the gear restrictions apply), ensuring that bycatch regulations now encompass a majority of the Gulf of Ulloa; 2) suspending all finfish fishing in the reserve during the summer of 2016 in order to temporarily end loggerhead bycatch in the Gulf of Ulloa and support research to determine the causes of strandings on nearby beaches; 3) stipulating that if the bycatch mortality cap of 90 loggerheads is reached all fisheries known to interact with turtles will be suspended for the duration of the calendar year, with no delay in implementation; 4) mandating electronic monitoring of fishing and bycatch in the absence of an onboard observer; and 5) strengthening gear regulations to restrict soak time of gillnets to six continuous hours in the restricted area in addition to regulating mesh size [36]. Following the announcement of these enhanced regulations, the United States determined that Mexico established a loggerhead regulatory program comparable to relevant U.S. measures, and issued Mexico a positive certification determination in the Second Addendum to the 2015 Biennial Report to Congress [36].

Although the 2016 regulations are only authorized for two years [9], the United States noted that Mexico has pledged their commitment to maintain loggerhead conservation and bycatch reduction measures in the Gulf of Ulloa after the plan expires [36]. Following a July 2016 presidential meeting between Mexico President Peña Nieto and U.S. President Obama, President Peña Nieto announced that Mexico would continue to strengthen their efforts to protect loggerheads in the Gulf of Ulloa from fisheries interactions [36]. As a next step, Mexico will plan to engage the United States to conduct joint research on post-interaction mortality of bycaught loggerheads [36].

6. Preliminary assessment of Mexico's loggerhead bycatch regulations and prior collaborative and community-based bycatch assessment and reduction efforts

We compare loggerhead bycatch assessment, collaborative and fisher-led loggerhead bycatch reduction programs, and federal loggerhead bycatch regulations in Mexico prior to and following the identification to help evaluate its initial effects on loggerhead conservation (Table 1). Taking into account the qualitative nature of our assessment, we discuss the benefits of the identification relative to the costs we observed in terms of loggerhead bycatch assessment and reduction.

On the positive side, the identification and subsequent consultation process caused Mexico to eventually establish federal loggerhead bycatch regulations, representing a major advance in protection for loggerheads. Prior to these regulations, loggerheads were only broadly protected under a complete moratorium on the take of sea turtles and eggs employed throughout Mexico since 1990 [2]. Nevertheless, the effectiveness of the new regulations on reducing loggerhead bycatch remains to be seen and will depend on CONAPESCA's capacity to and prioritization of operating and enforcing the fisheries reserve. However, while Mexico pledged their commitment to maintain loggerhead conservation efforts after the current regulations expire, it is unclear what, if any, measures will be implemented. Notably, the short duration of CONAPESCA's agreement, coupled with a lack of information on how bycatch will be managed once the plan expires, were listed by NOAA as one of their reasons for determining that Mexico's 2015 proposed regulations were not comparable to relevant U.S. measures [34]. The positive certification is thus surprising because Mexico's 2016 regulations do not provide permanent protection for loggerheads. Moreover, only dead turtles count against Mexico's bycatch cap of 90 loggerheads per year, whereas all loggerheads captured in the Hawaii shallow-set longline fishery count against their cap, which is based on the number of "interactions" between turtles and fishing gear regardless of whether bycaught turtles are uninjured, injured, or dead [37].

On the negative side, the initial effects of the identification and subsequent threat of trade sanctions jeopardized bycatch reduction programs that fisher leaders had voluntarily helped develop over the past decade, which were inherently vulnerable to begin with due to the sensitive nature of switching gear and practices [17]. As previously noted, from 2007 to 2011 ProCaguama and its partners made strong progress towards mitigating loggerhead bycatch in the Gulf of Ulloa by working with local fisher leaders to voluntarily switch to more turtle-friendly fishing gear and techniques in the loggerhead hotspot, including hook and line, small-mesh surface nets, and buoyless nets [41–44]. This progress was further hindered by the cancellation of an international collaboration between U.S. researchers and INAPESCA aimed at testing and developing additional alternative turtle-friendly gear and practices.

Although bycatch assessment and mitigation associated with the federal regulations will clearly need to be evaluated before any conclusions on their effectiveness can be drawn, the collaborative and community-based approach achieved: 1) increased awareness by local fishers of their bycatch impacts including a tri-national fisheries learning exchange with participants from Japan, Mexico, and Hawaii [44]; 2) independent, peer reviewed bycatch and stranding rates [19,20,39,40]; 3) an international collaboration between U.S. researchers and Mexican federal fisheries scientists aimed at developing joint bottom-up and top-down bycatch solutions that, in its first year, tested modified bottom-set nets and yielded a government report with documented bycatch rates [15]; and 4) fisher-led bycatch reduction solutions including modified and turtle-friendly gear [41–44].

In particular, bycatch mitigation solutions developed by the collaborative and community-based approach generated likely reductions in bycatch. For example, ProCaguama fisher partners who participated in the buoyless net trials fished 30–50% less net per day (4–6 versus the usual 6–12 nets fished/day) and caught 67% fewer turtles in the buoyless nets that they fished from 2007 to 2009 [43], thus likely sparing an estimated greater than 100 loggerhead turtles over the course of those trials alone. Moreover, the 12 fisher partners who participated in hook and line trials and who normally would have fished bottom-set nets were able to eliminate turtle bycatch altogether during the course of these trials from 2009 to 11 [41]. In addition, more than 80% of the 20 participating fishers in the buoyless net trials reported that they would switch to buoyless nets (E. Caballero-Aspe, unpublished data). The high adoption following these trials can be attributed to the participatory research approach employed by [41–44], which has been found to be an integral component for achieving bycatch reduction in actual fisheries [16,17,6]. From 2009 onward, all of the boats in the Santa Rosa bottom-set longline fleet had converted to turtle-safe gear, and 5–6 of the 30–60 boat Lopez Mateos bottom-set net fleet were fishing with buoyless nets and another 3–4 with hook and line, although fleet size can vary widely in any given season depending on fishing conditions. Based on previously published estimates of seasonal fleet-wide bycatch rates in the bottom-set longline fishery in the Gulf of Ulloa (1885 ± 286 turtles per season, [40]), we estimate that the collaborative approach achieved likely bycatch reductions in the range of approximately 1,599 – 2,171 turtles per fishing season in the fleet. Similarly, based on previously published estimates of seasonal fleet-wide bycatch rates in the bottom-set net fishery (830 ± 102 turtles per season, [40]), assuming a 67% reduction in the number of turtles caught using buoyless nets [43], we estimate that the collaborative approach achieved likely bycatch reductions in the range of approximately dozens to hundreds of loggerheads per fishing season in the set net fleet.

In addition to impacts to loggerhead conservation, the closure of all finfish fishing in the Gulf of Ulloa during the summer of 2016 eliminated the seasonal income of thousands of fishers and their

Table 1
Comparison of quality of loggerhead bycatch management efforts in Mexico prior to and following the U.S. identification of Mexico for bycatch of the North Pacific loggerhead turtle under section 610 of the Moratorium Protection Act. *Encompasses the consultation process.

Before Identification			*After Identification			
	Pre–2012	2012	2013	2014	2015	2016
Loggerhead bycatch assessment	Collaborative approach finds highest globally reported bycatch at 0.037 turtles per 100 m net per 24 h[a], estimated with reported fishing effort levels and Monte Carlo simulations to incorporate uncertainty[a]	International collaboration between U.S. researchers yields government report by INAPESCA which finds record high bycatch at 1.96 turtles per 100 m net per 24 h; report calls for immediate action to avoid bycatch without affecting fisheries production[b];	Unknown[c]; carcasses reportedly butchered at sea to conceal bycatch; 10 crews cease participating in community-based pilot program to test electronic monitoring[d]	No known government assessment; carcasses reportedly butchered at sea to conceal bycatch[d]	Confidential government assessment; carcasses reportedly butchered at sea to conceal bycatch; fishermen instructed to cut turtles out of net when CONAPESCA began testing electronic monitoring devices[d]	Confidential government assessment; all finfish fishing suspended in reserve during summer of 2016 to temporarily end loggerhead bycatch[e]
Collaborative and community-based loggerhead bycatch reduction programs	NGO coordinated and fisher-led bycatch reduction solutions, including trinational fisheries learning exchange[f] and development of turtle-friendly[f,g] and modified gear[h], likely sparing > 2,000 loggerheads from 2007 to 2011[d]	INAPESCA and U.S. researchers partner to test bycatch reduction solutions, including modified and turtle-friendly gear, promising joint bottom-up and top-down solutions[b,d]	Bycatch partnership between INAPESCA and U.S. researchers cancelled[d]; ProCaguama suspends at-sea component of its community-based loggerhead conservation program[d]; 10 crews cease participating in community-based bycatch reduction trials and pilot studies to improve fisheries performance[d]	None[d]	None[d]	None[d]
Federal loggerhead bycatch regulations	No specific regulations; however, Mexico has maintained a complete moratorium on the take of sea turtles and eggs since 1990[i]	No specific regulations; however, Mexico has maintained a complete moratorium on the take of sea turtles and eggs since 1990[i]	No specific regulations; however, Mexico has maintained a complete moratorium on the take of sea turtles and eggs since 1990[i]	Loggerhead wildlife refuge proposed by SEMARNAT to be administered by Mexico's CONANP, the national parks agency[j]	CONAPESCA replaces proposed SEMARNAT refuge by establishing a temporary partial fisheries reserve and restricted area; regulations include a loggerhead bycatch mortality cap of 90 turtles/yr with observer requirements, restrictions on gear, and sea turtle safe handling and release techniques[k]	CONAPESCA strengthens 2015 regulations; new measures (authorized for two years) suspend all finfish fishing in reserve during summer of 2016, expand spatial and temporal scope of reserve, expand temporal duration of closure if mortality cap is reached, strengthen gear restrictions, and mandate electronic monitoring of bycatch in absence of observers[e]

[a] Peckham et al. [40].
[b] INAPESCA [15].
[c] CONANP et al. (2014) [7].
[d] See text for details.
[e] Registro Federal de México [9] (see [36] for synopsis).
[f] Peckham et al. [44].
[g] Peckham et al. [41].
[h] Peckham et al. [43].
[i] Aridjis [2].
[j] SEMARNAT [50].
[k] Registro Federal de México [8] (see [34] for synopsis).

families. It is unclear why Mexico enacted such a sweeping measure given that bycatch interactions were limited to certain gears only when fished in the loggerhead hotspot, which constitutes a small subset of the overall fishing effort in the Gulf of Ulloa and thus affected many more fishers than necessary. While fisher livelihoods may not be relevant under section 610, the closure caused severe economic hardship for all artisanal fleets in the Gulf of Ulloa, likely jeopardizing fishers' willingness to participate in future voluntary bycatch mitigation efforts.

7. Policy recommendations

Based on the lessons learned from this case, we offer the following policy recommendations to improve the identification and consultation process of section 610. These recommendations are broadly applicable to future identifications of other nations and can help inform other unilaterally imposed conservation policies.

1. *Potential consequences stemming from identification decisions, particularly with respect to collaborative, on-the-ground conservation efforts and socioeconomic impacts on fisheries, should be thoroughly assessed.* Although the loggerhead bycatch regulatory program marks a major advance in protection for loggerheads in Mexico, the identification and threat of trade sanctions compromised a decade's worth of progress to raise awareness among fishers and work with them to reduce their bycatch. The identification also resulted in Mexico temporarily closing the Gulf of Ulloa to all finfish fishing, eliminating more than 1,000 families' important seasonal income. The United States should therefore give careful consideration to potential socioeconomic, political, and environmental effects and tradeoffs associated with using the threat of trade sanctions. In particular, policy recommendation number four (below) provides a strong starting point for how the United States could better assess, and work to mitigate, potential consequences. In cases where an identification is deemed likely to harm people and/or existing collaborative or community-based efforts, those responsible should strive to ensure that management measures safeguard fisher well-being and work to ensure the continuity of partnerships and programs.
2. *The law should facilitate a more equitable and consistent consideration of bycatch data across nations by mandating the pursuit of bycatch reporting requirements in international fora to ensure that more nations continue to assess and report PLMR bycatch.* The United States has long been a global leader in encouraging bycatch mitigation in international fisheries. However, inadequate funding and the lack of an explicit congressional mandate for proactive efforts have limited this work. Currently, the MSA only mandates that the United States seek to address international bycatch through international fishery management organizations or treaties reactively in response to fishing practices of an identified nation resulting in PLMR bycatch [3]. Without a mandate to proactively seek to address international bycatch in general, it is difficult to prioritize pursuing bycatch provisions in international fora, especially in light of limited budgets and competing issues that are mandated to be pursued. Establishing comprehensive fisheries and bycatch reporting requirements for members of regional fisheries management organizations (RFMO's) or other international organizations and agreements would provide more representative bycatch data from more nations that could be considered for identification. Currently, reporting of bycatch data is often voluntary for RFMO's, and data collection are usually not standardized for those RFMO's that do collect bycatch data [29,33]. Consequently, nations without bycatch data are not as scrutinized in comparison to nations such as Mexico that report their bycatch data. More uniform reporting of bycatch data between nations would help level the playing field and prevent nations reporting their bycatch from being inequitably singled out for 610 identification.
3. *Congress should re-evaluate the 12-month timeframe for which bycatch data can be considered in the identification process.* A 2013 bill introduced before the 113th Congress (S.269) proposed to expand the identification timeframe from one to three years for section 610, but it was never passed. The short timeframe of 12 months limits the capacity to identify nations to rare circumstances, such as this case, in which bycatch data unexpectedly becomes available. Extending the timeframe to two or three years would make section 610 a policy that could be used more broadly given the ubiquitous nature of PLMR bycatch in coastal fisheries worldwide. Bycatch and discard data for PLMRs usually take at least two or three years to become publically available due to the difficulty associated with collecting and analyzing these data, including the need to consolidate data from logbooks and observer reports [3]. In the case of Mexico it took a “perfect storm” to trigger an identification. For example, even though the high loggerhead mortality [12,19,25] and extensive bycatch problem [39,40] at BCS were well documented before 2012, the data were never available within the 12-month identification window.

   In addition, extending the timeframe for which data can be considered may also mean that more and better data could be considered, and that these data could go through the various vetting and verification processes that many fisheries management agencies apply. Having longer time series, for instance two or three years of data, would also reduce the need to rely on preliminary or experimental data. For example, the data used to identify Mexico almost certainly would have been stronger, which likely would have made it more difficult for Mexico to deny the problem. Although the INAPESCA bycatch study used to identify Mexico was representative of the actual fishery (i.e. trials in the same location with the same gear and practices as local fisheries), experimental trials are often conducted under conditions different from target fisheries.
4. *The identification and consultation process should provide NOAA Fisheries with more resources to better engage identified nations, including culturally appropriate liaising to better engage national experts and officials in the timely development of solutions.* Although it is possible that any threat of trade sanctions could elicit a similar response (i.e. denial) in other countries regardless of how they were communicated, we believe steps can be taken to minimize or preclude the denial response. For example, discussions between nations could be tailored to the culture and circumstances of potential identified nations. Drawing on the history of practice for the more frequently used and similar section 609 identification process for Illegal, Unreported, and Unregulated (IUU) fishing, NOAA Fisheries’ current process of discourse with identified nations is not individualized, meaning that communication of identification decisions is essentially the same between nations.

   Although the United States was working with extremely limited resources and no prior implementation experience with this particular provision, we believe that they may have been able to engage CONAPESCA more creatively. One way of motivating change in the official stance in Mexico and elsewhere is by applying what is known as the “white glove” approach, through which actors are honored into taking a certain course of action. In essence, a tangible reward is given in advance of behavioral change, reducing uncertainty and increasing the known benefit of a supportive stance. However, approaches like this are clearly context dependent. In order for NOAA Fisheries to craft culturally and socio-politically appropriate approaches to identification communications and strategies, they would need the support of relevant experts. Currently, this level of expert support and human resources, especially as it pertains to fisheries, exceeds what is allotted through NOAA Fisheries and the State Department for the identification and consultation process.

   An example of a helpful resource would be an international policy or cultural liaison deeply familiar with the identified fishery who acts as a liaison to analyze the socioeconomic and political

ramifications of a potential identification, including ways to explain the process better and circumvent possible problems. In Mexico, the identification affected a large number of families that depend on local fisheries, and such a process could have helped build trust, ease tension, and avoid confusion. Liaisons that are fluent in the language and culture of the identified nation could explain the process to government officials and fisher leaders and discuss ways to move forward, which would help bring legitimacy and also engage stakeholders early in the process. Having a liaison would also afford NOAA Fisheries the opportunity to better understand and evaluate potential effects on existing conservation efforts. Furthermore, the identification communication itself could suggest specific potential measures to avoid a negative certification. These activities would help create a strategy that is more adaptive and affords increased flexibility and understanding of actions on the ground.

8. Conclusions

The unilateral identification of Mexico under section 610 has brought widespread domestic and international attention to the loggerhead bycatch problem at BCS. Although Mexico had previously acknowledged the bycatch problem and was ostensibly working towards solving it, it is unknown if or when actual bycatch regulations would have been established. To that end, the identification succeeded in producing Mexican bycatch policy that otherwise may not have been established, highlighting the power of linking bycatch problems with international trade sanctions.

To date, however, the identification resulted in a loss of collaborative trust and social capital between local fishers and conservation practitioners that has reduced the quality of both bycatch assessment and collaborative bycatch reduction programs in Mexico. The identification also resulted in Mexico closing all finfish fisheries during the summer of 2016, which eliminated the seasonal income of thousands of fishers and likely jeopardized their future stewardship of turtles and other vulnerable species. Nevertheless, it is unreasonable to expect that the identification and subsequent bilateral consultation process would produce immediate conservation gains, and it is not our intention to suggest that unilaterally imposed measures are necessarily inferior to bottom-up approaches.

It will be imperative to assess the efficacy of the regulatory program at reducing loggerhead bycatch and to compare bycatch reduction levels achieved from the regulatory program to those previously achieved by collaborative and community-based efforts both in the intermediate and long-term. The long-term effectiveness of the identification will likely depend largely on whether Mexico retains or modifies, as well as enforces, their regulations. If the regulations are allowed to expire after two years, as is currently planned, and no further measures are implemented, the initial costs incurred on collaborative and community-based bycatch programs as well as the socioeconomic costs to the region's fishers will need to be carefully scrutinized against any reduction in turtle mortality from the two years of management that resulted from the identification. Congress, NOAA Fisheries, and the wider stakeholder community must all work together to improve the international bycatch provision. Further consideration and research will be needed to determine how this case may have affected other countries' willingness to collect and make data available that could be used in future identifications.

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