

# U.S.-China Economic and Security Review Commission

Staff Research Report



**April 12, 2016**

## **China's Island Building in the South China Sea: Damage to the Marine Environment, Implications, and International Law**

**Author: Matthew Southerland, Policy Analyst, Security and Foreign Affairs**

**Acknowledgments:** The author thanks John W. McManus, Frank E. Muller-Karger, and Raul "Pete" Pedrozo for their helpful insights and reviews of early drafts. Their assistance does not imply any endorsement of this report's contents, and any errors should be attributed solely to the author.

**Disclaimer:** This paper is the product of professional research performed by staff of the U.S.-China Economic and Security Review Commission, and was prepared at the request of the Commission to support its deliberations. Posting of the report to the Commission's website is intended to promote greater public understanding of the issues addressed by the Commission in its ongoing assessment of U.S.-China economic relations and their implications for U.S. security, as mandated by Public Law 106-398 and Public Law 113-219. However, the public release of this document does not necessarily imply an endorsement by the Commission, any individual Commissioner, or the Commission's other professional staff, of the views or conclusions expressed in this staff research report.

---

## Table of Contents

Introduction .....	3
Damage to the Marine Environment .....	3
Implications .....	6
Did China’s Activities Violate International Law? .....	7

---

## Introduction

From December 2013 to October 2015, China built artificial islands with a total area of close to 3,000 acres on seven coral reefs it occupies in the Spratly Islands in the southern part of the South China Sea.\*<sup>1</sup> To build these islands, Chinese dredgers gathered and deposited sand and gravel on top of the reefs. Although the international community's primary focus regarding these activities has been on issues of sovereignty, security, and geopolitics, international observers have also sounded the alarm about the environmental consequences.<sup>2</sup> Leading marine scientists have commented on this issue, as have the government of the Philippines and the Commander of the U.S. Pacific Command.<sup>3</sup> Although dredging, land reclamation, and the building of artificial islands are not unique to China, the scale and speed of China's activities in the South China Sea, the biodiversity of the area, and the significance of the Spratly Islands to the ecology of the region make China's actions of particular concern.

China's reclamation activities far outpaced those of the other claimants in the South China Sea. In August 2015, the U.S. Department of Defense reported that Vietnam had reclaimed approximately 80 acres, Malaysia had reclaimed 70 acres, the Philippines had reclaimed about 14 acres, and Taiwan had reclaimed approximately 8 acres in the Spratly Islands.

The South China Sea is a highly biodiverse marine area.<sup>4</sup> According to one scientific paper, it is home to 571 species of reef coral; the Spratly Islands alone have 333 species of reef coral.<sup>5</sup> In contrast, the Caribbean has less than 65 reef coral species.<sup>6</sup> Moreover, a body of research by marine biologists dating back to the early 1990s indicates that currents carry young fish spawned in the Spratly Islands to coastal areas of the South China Sea, and that the coral reefs of the Spratly Islands may play a role in replenishing depleted fish stocks in those coastal areas.<sup>7</sup>

Prior to the commencement of China's dredging and island building in the Spratly Islands, the South China Sea's coral reefs were already under heavy stress. Coral loss due to bleaching, disease, and destructive fishing methods has occurred,<sup>8</sup> and these reefs, like others around the world, face threats from ocean acidification and rising sea levels.<sup>9</sup>

## Damage to the Marine Environment

China's island building in the South China Sea buried a large area of coral reefs. Chinese dredgers deposited sand and gravel on top of about 13 square kilometers (approximately five square miles) of coral reefs China occupies, a process that destroys the coral underneath.<sup>†</sup><sup>10</sup> Chinese activities associated with land reclamation on these reefs—such as creating access channels for ships or dredging harbors—also destroyed portions of them. For example, in dredging its deep-water harbor at Fiery Cross Reef (see Figure 1), Chinese dredgers would have destroyed coral and other organisms (assuming the reef had not already been damaged). Furthermore, Frank E. Muller-Karger, professor of biological oceanography and remote sensing in the College of Marine Science at the University of South Florida, explained to the *New York Times* that in the process of island building the sediment deposited on the reefs “can wash back into the sea, forming plumes that can smother marine life and could be laced with heavy metals, oil and other chemicals from the ships and shore facilities being built.”<sup>11</sup>

---

\* Infrastructure that China is building on these artificial islands includes airstrips, helipads, port facilities, and radars, among other things. USNI News, “Document: DNI Clapper Assessment of Chinese Militarization, Reclamation in South China Sea,” March 8, 2016. <http://news.usni.org/2016/03/08/document-dni-assessment-of-chinese-militarization-reclamation-in-south-china-sea>; Center for Strategic and International Studies, Asia Maritime Transparency Initiative, “Island Tracker.” <http://amti.csis.org/island-tracker/>.

<sup>†</sup> Although these coral reefs could partially recover, the sediment deposited on top would have to be washed away first, which could happen naturally if sea level rise continues to accelerate at the rate anticipated under current conditions. John W. McManus, *Offshore Coral Reef Damage, Overfishing and Paths to Peace in the South China Sea*, forthcoming.

**Figure 1: China's Land Reclamation and Construction on Fiery Cross Reef,  
August 2014 to September 2015**

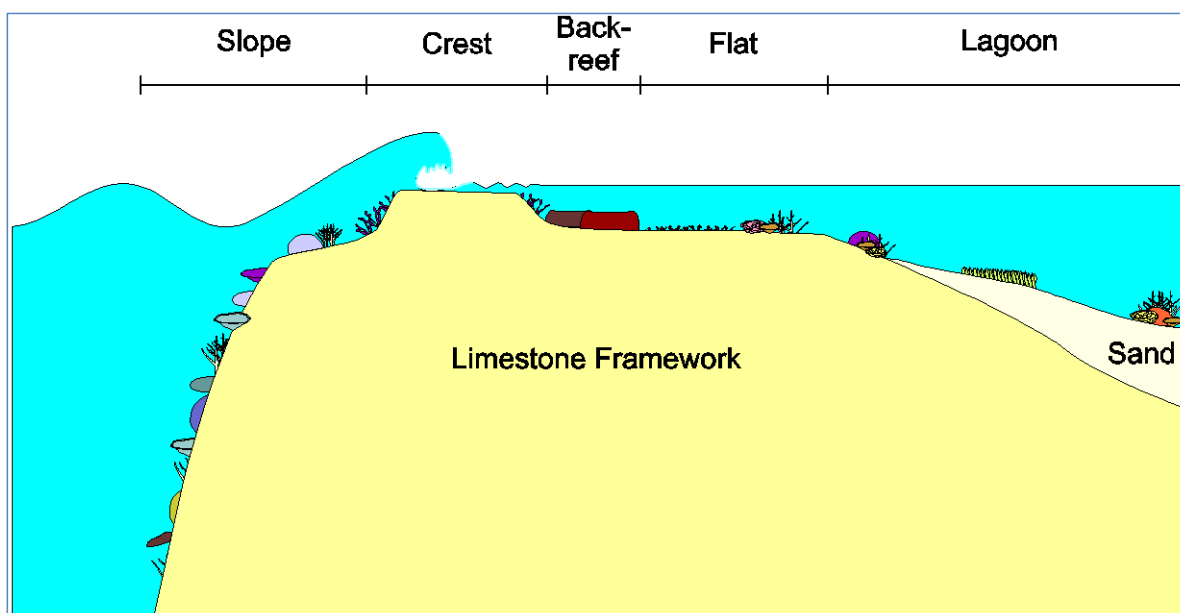


*Source:* Figure adapted from Center for Strategic and International Studies, Asia Maritime Transparency Initiative, “Fiery Cross Reef Tracker.” <http://amti.csis.org/fiery-cross-reef-tracker/>; Center for Strategic and International Studies, Asia Maritime Transparency Initiative, “Spratly Islands Update: Is Mischief Reef Next?” <http://amti.csis.org/new-imagery-release/>.

Chinese dredgers in the Spratly Islands extracted the sand and gravel from within the lagoons and reef flats of coral reef atolls\* at the land reclamation sites—a process known as shallow-water dredging (see Figure 2 for a diagram of an atoll and Figure 3 for satellite imagery of dredgers at Mischief Reef).<sup>12</sup> This shallow-water dredging removes not only sand and gravel, but also the ecosystems of the lagoon and the reef flat, important parts of a reef.<sup>13</sup> Moreover, dredgers stir up plumes of sand and silt that damage coral tissue and block sunlight from organisms such as reef-building corals, which cannot survive without it.<sup>14</sup>

\* An atoll is a circular or oval coral reef with a lagoon in the middle.

**Figure 2: Diagram of an Atoll**



Source: Diagram provided by John W. McManus.

In addition, Chinese dredgers may have gathered sand and gravel for the artificial islands from nearby atolls and other reefs in the Spratly Islands, although the Chinese government has not acknowledged that dredging at these reefs has occurred.<sup>15</sup> (It is difficult for outside observers to access the Spratly Islands. Obstacles to reaching the area have included opposition from the Chinese and Philippine governments to traveling there, the remoteness of the area, and the high cost of such trips.<sup>16</sup>) If this dredging occurred, and even if these reefs had not been previously damaged, they still may not fully recover for up to 10 to 15 years. That time frame could become longer if dredgers continue to disturb the reefs.<sup>17</sup> Sand and silt stirred up by dredgers settles on the coral, which can cause problems such as lowering coral growth rates, inhibiting coral reproduction, and increasing coral's susceptibility to disease.<sup>18</sup>

Satellite imagery can provide a powerful tool to analyze this problem because some dredgers leave arc-shaped marks in the sediment that can be visible in these images.<sup>19</sup> However, similar marks are made by the propellers of boats harvesting giant clams, which complicates the identification of damage caused by dredging.<sup>20</sup> Analysis of satellite imagery, news reports, videos, and other sources reveals that large-scale scarring of coral reefs from the harvesting of giant clams—an endangered species—in the Spratly Islands and the Parcel Islands has certainly occurred over the past few years; fishermen from China caused much of this damage.<sup>21</sup>

The Chinese Academy of Sciences South China Sea Institute of Oceanology, an institute that has conducted multiple research trips to the Spratly Islands over its history,<sup>22</sup> did not respond to questions submitted by the Commission staff about the environmental impact of China's dredging and island building.

**Figure 3: Dredging and Land Reclamation Operations at Mischief Reef, March 2015**



*Source: Center for Strategic and International Studies, Asia Maritime Transparency Initiative, “Mischief Reef Tracker.” <http://amti.csis.org/mischief-reef-tracker/#bwg1/29>.*

## Implications

Though information about the scope of the environmental damage caused by China’s dredging and land reclamation is limited, China’s island building activities in the Spratly Islands certainly have negatively impacted fisheries in the immediate areas of the reclamation sites. John W. McManus, professor of marine biology and ecology in the Rosenstiel School of Marine and Atmospheric Science at the University of Miami, explained to Commission staff that the sand and silt plumes created by dredging sand and gravel and depositing it on the coral reefs either would have killed fish or expelled them from the reefs. Most of the small expelled fish would have been eaten by open-water species as they left the protection of the reef and became exposed to predators. Though juvenile fish from other reefs that arrive via currents at the damaged reefs would survive if there were available hiding places (which are necessary for most small reef fish to inhabit a coral reef), many of the areas of reef suitable for hiding would have been filled by the artificial island. The end result would be fewer small reef fish inhabiting the reef as well as a reduced number of wide-ranging larger fish, such as large groupers and wrasses, which eat the small fish.<sup>23</sup>

While the area of coral reefs that have been buried at the seven occupied land features is small compared to the total area of shallow and deep reefs in the Spratly Islands (3,821 square kilometers or approximately 1,475 square miles),<sup>24</sup> the damage also could negatively impact the health of fisheries in the coastal areas of the South China Sea; this is because the coral reefs of the Spratly Islands are believed to play a role in the replenishment of depleted fish stocks in the South China Sea’s coastal areas.<sup>25</sup> Marine science indicates that currents carry the offspring of fish that spawn in the reefs to some of these areas and that a second generation could even migrate to southern Mainland China.<sup>26</sup> Further studies that quantify the contribution of the Spratly Islands’ coral reefs to the fish stocks in the South China Sea and examine potential Chinese dredging at unoccupied reefs are needed to assess the full impact of China’s island building on the South China Sea’s fisheries.

Fish are a critical food source for the coastal populations of Southeast Asia.<sup>27</sup> The fish stocks of the South China Sea already face the problem of overfishing, and damage to the spawning grounds of fish may increase the pressure on these fisheries.<sup>28</sup> If the larvae spawned in the coral reefs of the Spratly Islands make a significant contribution to

---

fish stocks in the coastal areas of the South China Sea, then the damage caused by China's island building activities may contribute to the food insecurity caused by overfishing and harm the livelihoods of fishermen in the region.

In addition, China's new artificial islands will almost certainly lead to increased Chinese fishing in the surrounding waters, which would put further pressure on fisheries in those areas. In 2015, a spokesperson for China's Ministry of Foreign Affairs said that among their other functions, these islands will support "fishery production and service," and China's National Development and Reform Commission announced the islands will provide fishing boats with shelter during storms, as well as repair and replenishment services.<sup>29</sup> Increased Chinese fishing activity in these waters also raises the risk of a clash between Chinese fishing boats and those of other claimant countries. Multiple instances of Chinese fishing boats ramming or otherwise harassing other vessels in the South China Sea have been reported.<sup>30</sup> China's practice of protecting its fishing boats with large coast guard vessels could further exacerbate this risk,<sup>\*</sup> particularly as the port facilities at China's artificial islands will allow those ships to dock to replenish supplies, enhancing their ability to operate in the area.

## Did China's Activities Violate International Law?

China's island building activities may have violated some of its environmental commitments under international law. According to the UN Convention on the Law of the Sea (UNCLOS), which China ratified, "states have the obligation to protect and preserve the marine environment."<sup>31</sup> Among its specific provisions related to the environment, UNCLOS requires states to "ensure that activities under their jurisdiction or control are so conducted as not to cause damage by pollution to other States and their environment."<sup>32</sup> States also are to take actions "necessary to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life."<sup>33</sup> Further, states are to "observe, measure, evaluate and analyze, by recognized scientific methods, the risks or effects of pollution of the marine environment" and to publish the results of these activities or give reports to international organizations.<sup>34</sup> In addition to UNCLOS, China is a party to the Convention on Biological Diversity, under which states have "the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction."<sup>35</sup>

In May 2015, the director general of the Department of Boundary and Ocean Affairs in China's Ministry of Foreign Affairs stated that China's island building had "gone through science-based evaluation and assessment, with equal importance given to construction and protection."<sup>36</sup> He added, "We have taken into full account issues of ecological preservation and fishery protection, followed strict environmental protection standards and requirements in the construction process, and adopted many effective measures to preserve the ecological environment."<sup>37</sup> However, the Chinese government has not published sufficient information about its assessment of the environmental impact

---

<sup>\*</sup> Of further concern is the fact that China's maritime militia, which U.S. Naval War College associate professor Andrew S. Erickson and research fellow Conor M. Kennedy describe as a "dual-hatted force of specially registered fishing vessels with fisherman-soldier crews," is becoming increasingly active in the South China Sea. China is training the maritime militia to support the activities of China's naval and maritime law enforcement forces in the South China Sea. Andrew S. Erickson and Conor M. Kennedy, "China's Island Builders," *Foreign Affairs*, April 9, 2015. <https://www.foreignaffairs.com/articles/east-asia/2015-04-09/china-s-island-builders>; Andrew S. Erickson and Conor M. Kennedy, "China's Daring Vanguard: Introducing Sanya City's Maritime Militia," *Center for International Maritime Security*, November 5, 2015. <http://cimsec.org/chinas-daring-vanguard-introducing-sanya-citys-maritime-militia/19753>; Andrew S. Erickson and Conor M. Kennedy, "Trailblazers in Warfighting: The Maritime Militia of Danzhou," *Center for International Maritime Security*, February 1, 2016. <http://cimsec.org/trailblazers-warfighting-maritime-militia-danzhou/21475>; and Andrew S. Erickson and Conor M. Kennedy, "China's Maritime Militia," *CNA Corporation*, March 7, 2016. [https://www.cna.org/cna\\_files/pdf/Chinas-Maritime-Militia.pdf](https://www.cna.org/cna_files/pdf/Chinas-Maritime-Militia.pdf).

---

of the island building to ensure the truth of that assertion, nor does it appear China has provided additional information to any international organization.

In June 2015, China's State Oceanic Administration published an article describing measures taken in the process of building the artificial islands to minimize the impact on the marine ecosystem, including regular monitoring of the coral reefs' health during the island building. The article also includes an assertion that much of the building occurred on parts of the reefs with low coral cover or dead coral.<sup>38</sup> Regardless of the veracity of this assertion, the article does not address the following problem: Given the proper circumstances, coral could still grow on areas of reef with low coral cover or dead coral, but as long as there is an artificial island on those parts, coral will never grow there. In addition, as Edgardo D. Gomez, professor emeritus at the University of the Philippines Marine Science Institute, explained to Commission staff, "even reefs with low coral cover are ecologically valuable because the structure provides a substrate for many other organisms."<sup>39</sup>

In the ongoing case initiated by the Philippines at the Permanent Court of Arbitration in The Hague regarding China's claims and activities in the South China Sea, one of the Philippines' claims includes a statement that "China's occupation of and construction activities on Mischief Reef ... violate China's duties to protect and preserve the marine environment under [UNCLOS]."<sup>40</sup> In mid-2016, the arbitral tribunal is expected to rule on whether it has jurisdiction over this and seven other claims brought by the Philippines. It is also expected to rule on the merits of several other Philippine claims over which it has already determined it has jurisdiction.<sup>41</sup>

If the arbitral tribunal decides it has jurisdiction over this claim and rules in the Philippines' favor, it can direct the Chinese government to publish more information about the environmental impact of the island building and the results of monitoring activities conducted during the project. It can also direct the governments of China and the Philippines to form an independent committee of experts to assess the environmental impact of the island building and propose measures to mitigate additional damage.<sup>42</sup> Such a decision by an international tribunal occurred in 2003 in a case brought to the International Tribunal for the Law of the Sea by Malaysia against Singapore regarding Singapore's land reclamation in and around the Straits of Johor.<sup>43</sup> Among its other decisions, the tribunal required the two sides to form a group of experts to assess the environmental effects of the land reclamation.<sup>44</sup>

The Chinese government is unlikely to initially heed any rulings in the Philippines' favor by the tribunal.<sup>45</sup> Beijing has described its position on arbitration with the Philippines as one of "non-acceptance and non-participation."<sup>46</sup> However, such inaction in response to a ruling against China likely would harm China's reputation.<sup>47</sup> As a result, over the next few years the Chinese government might take some steps to ameliorate the fallout.<sup>48</sup> These steps could include measures—symbolic or substantive—that attempt to address concerns about environmental damage resulting from its island building. Even so, due to the utility of these outposts for enhancing China's situational awareness and ability to project military power in the South China Sea, it is unlikely the Chinese government will remove the sand and gravel that dredgers have deposited on these reefs.

Environmental degradation is just one of many implications of China's land reclamation in the South China Sea, which taken together illustrate Beijing's troubling attitude of general disregard for regional and international norms, laws, and the mature conduct expected of a major power. Beijing has demonstrated an apparent willingness to flout international law; militarize an already tense and contested area; eschew an established dispute management mechanism in favor of unilateral actions to consolidate a more powerful position vis-à-vis other claimants; and damage the environment in a region where food security is already threatened by overfishing. This runs counter to U.S. interests in peacefully resolving disputes according to law, refraining from actions that heighten tensions, and maintaining a healthy and productive marine environment.



## Endnotes

- <sup>1</sup> U.S. Department of Defense, *Asia-Pacific Maritime Security Strategy*, August 20, 2015, 16. [http://www.defense.gov/Portals/1/Documents/pubs/NDA%20A-P\\_Maritime\\_Security\\_Strategy-08142015-1300-FINALFORMAT.PDF](http://www.defense.gov/Portals/1/Documents/pubs/NDA%20A-P_Maritime_Security_Strategy-08142015-1300-FINALFORMAT.PDF); USNI News, “Document: DNI Clapper Assessment of Chinese Militarization, Reclamation in South China Sea,” March 8, 2016. <https://news.usni.org/2016/03/08/document-dni-assessment-of-chinese-militarization-reclamation-in-south-china-sea>; and Sam LaGrone, “PACOM Harris: U.S. Would Ignore a ‘Destabilizing’ Chinese South China Sea Air Defense Identification Zone,” *USNI News*, February 26, 2016. <https://news.usni.org/2016/02/26/pacom-harris-u-s-would-ignore-a-destabilizing-chinese-south-china-sea-air-defense-identification-zone>.
- <sup>2</sup> James Borton and Nguyen Chu Hoi, “China’s Reclamations Harm Sea Life,” *Taipei Times*, September 11, 2015. <http://www.taipetimes.com/News/editorials/archives/2015/09/11/2003627420/1>.
- <sup>3</sup> Johnny Langenheim, “Preventing Ecocide in the South China Sea,” *Guardian*, July 15, 2015. <http://www.theguardian.com/environment/the-coral-triangle/2015/jul/15/preventing-ecocide-in-south-china-sea>; Oliver Holmes, “South China Sea Images Reveal Impact on Coral of Beijing’s Military Bases,” *Guardian*, September 17, 2015. <http://www.theguardian.com/world/ng-interactive/2015/sep/17/south-china-sea-images-reveal-impact-on-coral-of-beijings-military-bases>; Pia Ranada, “China Reclamation Poses P4.8-B Economic Loss for PH,” *Rappler* (Philippines), April 23, 2015. <http://www.rappler.com/nation/90878-china-west-philippine-sea-reclamation-fisheries-food-security>; and Harry Harris, “ASPEN Security Forum Remarks by Adm. Harris” (Aspen Security Forum, Aspen, CO, July 23, 2015). <http://www.pacom.mil/Media/News/tabid/5693/Article/610920/aspen-security-forum-remarks-by-adm-harris.aspx>.
- <sup>4</sup> Danwei Huang et al., “Extraordinary Diversity of Reef Corals in the South China Sea,” *Marine Biodiversity* 45:2 (June 2015): 157-168.
- <sup>5</sup> Danwei Huang et al., “Extraordinary Diversity of Reef Corals in the South China Sea,” *Marine Biodiversity* 45:2 (June 2015): 157-168; John W. McManus, *Offshore Coral Reef Damage, Overfishing and Paths to Peace in the South China Sea*, forthcoming.
- <sup>6</sup> Laretta Burke et al., “Reefs at Risk Revisited,” *World Resources Institute*, 2011. [http://www.wri.org/sites/default/files/pdf/reefs\\_at\\_risk\\_revisited.pdf](http://www.wri.org/sites/default/files/pdf/reefs_at_risk_revisited.pdf).
- <sup>7</sup> John W. McManus, “The Spratly Islands: A Marine Park Alternative,” *Naga, ICLARM Quarterly* 15:3 (1992): 4-8; John W. McManus, “The Spratly Islands: A Marine Park?,” *Ambio* 23:3 (1994): 181-186; M.C.A Ablan et al., “Meso-scale Transboundary Units for the Management of Coral Reefs in the South China Sea Area,” *Naga, WorldFish Center Quarterly* 25:3-4 (July-December 2002): 4-9; Jonathan T. Kool et al., “Connectivity and the Development of Population Genetic Structure in Indo-West Pacific Coral Reef Communities,” *Global Ecology and Biogeography* 20:5 (September 2011): 695-706; John W. McManus, *Offshore Coral Reef Damage, Overfishing and Paths to Peace in the South China Sea*, forthcoming; and Johnny Langenheim, “Preventing Ecocide in the South China Sea,” *Guardian*, July 15, 2015. <http://www.theguardian.com/environment/the-coral-triangle/2015/jul/15/preventing-ecocide-in-south-china-sea>.
- <sup>8</sup> Terry P. Hughes, Hui Huang, and Matthew A. L. Young, “The Wicked Problem of China’s Disappearing Coral Reefs,” *Conservation Biology* 27:2 (2012): 261, 265.
- <sup>9</sup> Johnny Langenheim, “Preventing Ecocide in the South China Sea,” *Guardian*, July 15, 2015. <http://www.theguardian.com/environment/the-coral-triangle/2015/jul/15/preventing-ecocide-in-south-china-sea>.
- <sup>10</sup> John W. McManus, “Spratly Islands Importance, Damage, and Options for Peace” (Conference on “Sustainable Usage of the Oceans” at Johns Hopkins University School of Advanced International Studies, October 19, 2015); Center for Strategic and International Studies, Asia Maritime Transparency Initiative, “Island Tracker.” <http://amti.csis.org/island-tracker/>.
- <sup>11</sup> Derek Watkins, “What China Has Been Building in the South China Sea,” *New York Times*, February 29, 2016. <http://www.nytimes.com/interactive/2015/07/30/world/asia/what-china-has-been-building-in-the-south-china-sea-2016.html?ref=asia&r=0>.
- <sup>12</sup> John W. McManus, “Spratly Islands Importance, Damage, and Options for Peace” (Conference on “Sustainable Usage of the Oceans” at Johns Hopkins University School of Advanced International Studies, October 19, 2015); Greg Torode, “‘Paving Paradise’: Scientists Alarmed over China Island Building in Disputed Sea,” *Reuters*, June 25, 2015. <http://www.reuters.com/article/us-southchinasea-china-environment-insig-idUSKBNOP50UB20150625>; and Johnny Langenheim, “Preventing Ecocide in the South China Sea,” *Guardian*, July 15, 2015. <http://www.theguardian.com/environment/the-coral-triangle/2015/jul/15/preventing-ecocide-in-south-china-sea>.
- <sup>13</sup> Johnny Langenheim, “Preventing Ecocide in the South China Sea,” *Guardian*, July 15, 2015. <http://www.theguardian.com/environment/the-coral-triangle/2015/jul/15/preventing-ecocide-in-south-china-sea>; John W. McManus, *Offshore Coral Reef Damage, Overfishing and Paths to Peace in the South China Sea*, forthcoming; and John W. McManus, “Spratly Islands Importance, Damage, and Options for Peace” (Conference on “Sustainable Usage of the Oceans” at Johns Hopkins University School of Advanced International Studies, October 19, 2015).
- <sup>14</sup> R.C. Highsmith et al., “Survival of Hurricane-Generated Coral Fragments and a Disturbance Model of Reef Calcification/Growth Rates,” *Oecologia* 46:3 (1980) 322-329; Christina Larson, “China’s Island Building Is Destroying Reefs,” *Science* 349:6255 (September 25, 2015): 1434; and John W. McManus, Professor of Marine Biology and Ecology, Rosenstiel School of Marine and Atmospheric Science, University of Miami, interview with Commission staff, February 2, 2016.
- <sup>15</sup> Frances Mangosing, “Justice Carpio: China Destroyed 17 Reefs in the Spratlys,” *Inquirer.net* (Philippines), July 29, 2015. <http://globalnation.inquirer.net/126703/justice-carpio-china-destroyed-17-reefs-in-spratlys>.
- <sup>16</sup> Rupert Wingfield-Hayes, “Flying Close to Beijing’s New South China Sea Islands,” *BBC*, December 14, 2015. <http://www.bbc.com/news/magazine-35031313>; Grace Chua, “Science and Politics in the South China Sea,” *Hakai Magazine* (Canada), November 10, 2015. <http://www.hakaimagazine.com/article-short/science-and-politics-south-china-sea>.

- <sup>17</sup> John W. McManus, “Spratly Islands Importance, Damage, and Options for Peace” (Conference on “Sustainable Usage of the Oceans” at Johns Hopkins University School of Advanced International Studies, October 19, 2015); John W. McManus, *Offshore Coral Reef Damage, Overfishing and Paths to Peace in the South China Sea*, forthcoming.
- <sup>18</sup> P.L.A. Erfteemeijer et al., “Environmental Impacts of Dredging and Other Sediment Disturbances on Corals: A Review,” *Marine Pollution Bulletin* 64 (2012) 1737-1765; F.J. Pollock et al., “Sediment and Turbidity Associated with Offshore Dredging Increase Coral Disease Prevalence On Nearby Reefs,” *PLoS ONE* 9:7 (2014); and John W. McManus, *Offshore Coral Reef Damage, Overfishing and Paths to Peace in the South China Sea*, forthcoming.
- <sup>19</sup> John W. McManus, *Offshore Coral Reef Damage, Overfishing and Paths to Peace in the South China Sea*, forthcoming; Victor R. Lee, “Satellite Imagery Shows Ecocide in the South China Sea,” *Diplomat* (Japan), January 16, 2016. <http://thediplomat.com/2016/01/satellite-images-show-ecocide-in-the-south-china-sea/>.
- <sup>20</sup> Victor R. Lee, “Satellite Imagery Shows Ecocide in the South China Sea,” *Diplomat* (Japan), January 16, 2016. <http://thediplomat.com/2016/01/satellite-images-show-ecocide-in-the-south-china-sea/>.
- <sup>21</sup> Victor R. Lee, “Satellite Imagery Shows Ecocide in the South China Sea,” *Diplomat* (Japan), January 16, 2016. <http://thediplomat.com/2016/01/satellite-images-show-ecocide-in-the-south-china-sea/>.
- <sup>22</sup> Science.china.com.cn, “Chinese Academy of Sciences South China Sea Institute of Oceanology: Science is Saving Coral Reefs,” July 17, 2013. Staff translation. [http://science.china.com.cn/2013-07/17/content\\_29450006.htm](http://science.china.com.cn/2013-07/17/content_29450006.htm); M.X. Zhao et al., “Coral Communities of the Remote Atoll Reefs in the Nansha Islands, Southern South China Sea,” *Environmental Monitoring and Assessment* 185 (2013): 7381-7383; and Chinanews.com, “Chinese Academy of Sciences ‘Experiment-3’ Scientific Research Ship Begins Spratly Island Area Cruise,” August 23, 2012. Staff translation. <http://www.chinanews.com/gn/2012/08-23/4129621.shtml>.
- <sup>23</sup> John W. McManus, Professor of Marine Biology and Ecology, Rosenstiel School of Marine and Atmospheric Science, University of Miami, interview with Commission staff, March 22, 2016.
- <sup>24</sup> John W. McManus, *Offshore Coral Reef Damage, Overfishing and Paths to Peace in the South China Sea*, forthcoming.
- <sup>25</sup> John W. McManus, “The Spratly Islands: A Marine Park Alternative,” *Naga, ICLARM Quarterly* 15:3 (1992): 4-8; John W. McManus, “The Spratly Islands: A Marine Park?,” *Ambio* 23:3 (1994): 181-186; M.C.A. Ablan et al., “Meso-scale Transboundary Units for the Management of Coral Reefs in the South China Sea Area,” *Naga, WorldFish Center Quarterly* 25:3,4 (July-December 2002): 4-9; and John W. McManus, *Offshore Coral Reef Damage, Overfishing and Paths to Peace in the South China Sea*, forthcoming.
- <sup>26</sup> John W. McManus, “The Spratly Islands: A Marine Park Alternative,” *Naga, ICLARM Quarterly* 15:3 (1992): 4-8; John W. McManus, “The Spratly Islands: A Marine Park?,” *Ambio* 23:3 (1994): 181-186; M.C.A. Ablan et al., “Meso-scale Transboundary Units for the Management of Coral Reefs in the South China Sea Area,” *Naga, WorldFish Center Quarterly* 25:3,4 (July-December 2002): 4-9; Jonathan T. Kool et al., “Connectivity and the Development of Population Genetic Structure in Indo-West Pacific Coral Reef Communities,” *Global Ecology and Biogeography* 20:5 (September 2011): 695-706; and John W. McManus, *Offshore Coral Reef Damage, Overfishing and Paths to Peace in the South China Sea*, forthcoming.
- <sup>27</sup> U.S. China Economic and Security Review Commission, *Hearing on China’s Relations with Southeast Asia*, oral testimony of Meredith Miller, May 13, 2015.
- <sup>28</sup> Oliver Holmes, “South China Sea Images Reveal Impact on Coral of Beijing’s Military Bases,” *Guardian*, September 17, 2015. <http://www.theguardian.com/world/ng-interactive/2015/sep/17/south-china-sea-images-reveal-impact-on-coral-of-beijings-military-bases>; Greg Torode, “‘Paving Paradise’: Scientists Alarmed over China Island Building in Disputed Sea,” Reuters, June 25, 2015. <http://www.reuters.com/article/us-southchinasea-china-environment-insig-idUSKBNOP50UB20150625>.
- <sup>29</sup> China’s National Development and Reform Commission, *National Development and Reform Commission Draws up a Plan for the Construction of Civilian Infrastructure on the Islands and Reefs in the Spratly Islands*, June 17, 2015. Staff translation. [http://www.ndrc.gov.cn/xwzx/xwfb/201506/t20150617\\_696335.html](http://www.ndrc.gov.cn/xwzx/xwfb/201506/t20150617_696335.html); Open Source Enterprise, “Transcript of PRC FM Spokesman News Conference 9 April 2015,” April 9, 2015. ID: CHO2015040928753011.
- <sup>30</sup> Andrew S. Erickson and Conor M. Kennedy, “China’s Maritime Militia,” *CNA Corporation*, March 7, 2016. [https://www.cna.org/cna\\_files/pdf/Chinas-Maritime-Militia.pdf](https://www.cna.org/cna_files/pdf/Chinas-Maritime-Militia.pdf); Andrew S. Erickson and Conor M. Kennedy, “China’s Daring Vanguard: Introducing Sanya City’s Maritime Militia,” *Center for International Maritime Security*, November 5, 2015; Jeremy Page, “Vietnam Accuses Chinese Ships,” *Wall Street Journal*, December 3, 2012. <http://www.wsj.com/articles/SB10001424127887323717004578157033857113510>; Bloomberg, “Vietnam Says Chinese Boat Harassed Survey Ship; China Disputes,” June 9, 2011. <http://www.bloomberg.com/news/articles/2011-06-05/china-reassures-its-neighbors-after-clashes-over-claims-in-south-china-sea>; and CNN, “Pentagon Says Chinese Vessels Harassed U.S. Ship,” March 9, 2009. <http://www.cnn.com/2009/POLITICS/03/09/us.navy.china/index.html>.
- <sup>31</sup> UN Convention on the Law of the Sea, “Part 12: Protection and Preservation of the Marine Environment.”
- <sup>32</sup> UN Convention on the Law of the Sea, “Part 12: Protection and Preservation of the Marine Environment.”
- <sup>33</sup> UN Convention on the Law of the Sea, “Part 12: Protection and Preservation of the Marine Environment.”
- <sup>34</sup> UN Convention on the Law of the Sea, “Part 12: Protection and Preservation of the Marine Environment.”
- <sup>35</sup> Convention on Biological Diversity, “Article 3: Principle.”
- <sup>36</sup> China’s Ministry of Foreign Affairs, *An Interview on China’s Construction on the Nansha Islands and Reefs*, May 27, 2015. [http://www.fmprc.gov.cn/mfa\\_eng/zxxx\\_662805/t1267264.shtml](http://www.fmprc.gov.cn/mfa_eng/zxxx_662805/t1267264.shtml).
- <sup>37</sup> China’s Ministry of Foreign Affairs, *An Interview on China’s Construction on the Nansha Islands and Reefs*, May 27, 2015. [http://www.fmprc.gov.cn/mfa\\_eng/zxxx\\_662805/t1267264.shtml](http://www.fmprc.gov.cn/mfa_eng/zxxx_662805/t1267264.shtml).
- <sup>38</sup> Feng Aiping and Wang Yongzhi, “The Island and Reef Expansion Project in the Spratly Islands Has Not Impacted the Coral Reef Ecosystem,” China’s State Oceanic Administration website, June 10, 2015. Staff translation. [http://www.soa.gov.cn/xw/dfdwtd/jgbm\\_155/201506/t20150610\\_38318.html](http://www.soa.gov.cn/xw/dfdwtd/jgbm_155/201506/t20150610_38318.html).
- <sup>39</sup> Edgardo D. Gomez, Professor Emeritus, University of the Philippines Marine Science Institute, interview with Commission staff, March 4, 2016.

- 
- <sup>40</sup> Permanent Court of Arbitration in The Hague, *Ninth Press Release: Arbitration between the Republic of the Philippines and the People's Republic of China*, November 30, 2015. <http://www.pcacases.com/web/sendAttach/1524>.
- <sup>41</sup> Center for Strategic and International Studies, Asia Maritime Transparency Initiative, "Arbitration on the South China Sea: Rulings from The Hague." <http://amti.csis.org/ArbitrationTL/index.html>.
- <sup>42</sup> Robert Williams, "A Secret Weapon to Stop China's Island Building: The Environment?" *National Interest*, April 20, 2015. <http://nationalinterest.org/feature/secret-weapon-stop-chinas-island-building-the-environment-12672>.
- <sup>43</sup> International Tribunal for the Law of the Sea, *Case Concerning Land Reclamation by Singapore in and around the Straits of Johor (Malaysia V. Singapore)* (Provisional Order), October 8, 2003. [https://www.itlos.org/fileadmin/itlos/documents/cases/case\\_no\\_12/12\\_order\\_081003\\_en.pdf](https://www.itlos.org/fileadmin/itlos/documents/cases/case_no_12/12_order_081003_en.pdf); Robert Williams, "A Secret Weapon to Stop China's Island Building: The Environment?" *National Interest*, April 20, 2015. <http://nationalinterest.org/feature/secret-weapon-stop-chinas-island-building-the-environment-12672>.
- <sup>44</sup> International Tribunal for the Law of the Sea, *Case Concerning Land Reclamation by Singapore in and around the Straits of Johor (Malaysia V. Singapore)* (Provisional Order), October 8, 2003. [https://www.itlos.org/fileadmin/itlos/documents/cases/case\\_no\\_12/12\\_order\\_081003\\_en.pdf](https://www.itlos.org/fileadmin/itlos/documents/cases/case_no_12/12_order_081003_en.pdf); Robert Williams, "A Secret Weapon to Stop China's Island Building: The Environment?" *National Interest*, April 20, 2015. <http://nationalinterest.org/feature/secret-weapon-stop-chinas-island-building-the-environment-12672>.
- <sup>45</sup> Mingjiang Li, "Possible Consequences of the Philippines' South China Sea Arbitration Case," *Center for Strategic and International Studies, Asia Maritime Transparency Initiative*, December 17, 2015. <http://amti.csis.org/possible-consequences-of-the-philippines-south-china-sea-arbitration-case/>.
- <sup>46</sup> China's Ministry of Foreign Affairs, "Foreign Ministry Spokesperson Hong Lei's Regular Press Conference on February 29, 2016," February 29, 2016. [http://www.fmprc.gov.cn/mfa\\_eng/xwfw\\_665399/s2510\\_665401/2511\\_665403/t1344004.shtml](http://www.fmprc.gov.cn/mfa_eng/xwfw_665399/s2510_665401/2511_665403/t1344004.shtml); Xinhua (English edition), "China Says Arbitral Tribunal's Ruling on South China Sea 'Null and Void,'" October 30, 2015. [http://news.xinhuanet.com/english/2015-10/30/c\\_134767443.htm](http://news.xinhuanet.com/english/2015-10/30/c_134767443.htm).
- <sup>47</sup> Center for Strategic and International Studies, Asia Maritime Transparency Initiative, "An Interview with Paul Reichler, Lead Counsel for the Philippines in its Case against China," December 9, 2015. <http://amti.csis.org/interview-with-paul-reichler-lead-counsel-for-the-philippines-in-its-case-against-china/>; Robert Williams, "A Secret Weapon to Stop China's Island Building: The Environment?" *National Interest*, April 20, 2015. <http://nationalinterest.org/feature/secret-weapon-stop-chinas-island-building-the-environment-12672>.
- <sup>48</sup> Center for Strategic and International Studies, Asia Maritime Transparency Initiative, "An Interview with Paul Reichler, Lead Counsel for the Philippines in its Case against China," December 9, 2015. <http://amti.csis.org/interview-with-paul-reichler-lead-counsel-for-the-philippines-in-its-case-against-china/>.