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# Realities of offering advice to governments on CITES

Lindsay Aylesworth ,*† Sarah J. Foster, and Amanda C.J. Vincent

Project Seahorse, Institute for the Oceans and Fisheries, The University of British Columbia, 2202 Main Mall, Vancouver, V6T1Z4, Canada

**Abstract:** What happens when those who provide conservation advice are required to take policy and management action based on that advice? Conservation advocates and scientists often try to prompt regulatory change that has significant implications for government without facing the challenge of managing such change. Through a case study, we placed ourselves in the role of the government of Thailand, facing obligations to seahorses (*Hippocampus* spp.) under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). These obligations include ensuring that its exports of seahorses do not damage wild populations. We applied a CITES-approved framework (which we developed) to evaluate the risks of such exports to 2 seahorse species. We used the framework to evaluate the pressures that put wild populations of the species at risk; whether current management mitigates the risk or offsets these pressures; and whether the species is responding as hoped to management policy. We based our analysis on information in published and grey literature, local knowledge, citizen science data, results of government research, and expert opinion. To meet CITES obligations, exports of both species would need to be prohibited until more precautionary adaptive management emerged. The risk of any exports of *Hippocampus trimaculatus* was above a tolerable level because of a lack of appropriate management to mitigate risks. In contrast, the risk of any exports of *Hippocampus kuda* could become tolerable if monitoring were put in place to assess the species' response to management. The process we developed for Authorities to determine risk in response to CITES guidelines was challenging to implement even without the need for government to consider social implications of conservation action. Despite the imperfections of our risk evaluation, however, it still served to support adaptive management. Conservationists need to keep implementation in mind when offering advice.

**Keywords:** assessment, fisheries, Hippocampus, sustainable trade, Thailand

Realidades al Ofrecerle Consejos sobre CITES a los Gobiernos

**Resumen:** ¿Qué ocurre cuando se requiere que quienes proporcionan consejos para la conservación realicen acciones políticas y de manejo basadas en aquellos consejos? Los científicos y partidarios de la conservación tratan con frecuencia de provocar cambios legislativos que tienen implicaciones significativas para el gobierno sin enfrentar el reto que implica manejar ese cambio. Mediante un estudio de caso, nos colocamos en el papel del gobierno de Tailandia, el cual enfrenta obligaciones con los caballitos de mar (*Hippocampus* spp.) bajo la Convención sobre el Comercio Internacional de Especies Amenazadas de Flora y Fauna Silvestre (CITES). Estas obligaciones incluyen asegurar que las exportaciones de caballitos de mar no causen daño a las poblaciones silvestres de este grupo. Aplicamos un marco de trabajo aprobado por CITES (el cual desarrollamos) para evaluar los riesgos de dichas exportaciones para dos especies de hipocampos. Usamos el marco de trabajo para valorar las presiones que ponen a las poblaciones silvestres de ambas especies en riesgo; si el manejo actual mitiga o compensa el riesgo de estas presiones; y si las especies están respondiendo como se esperaba a las políticas de manejo. Basamos nuestro análisis en información tomada de literatura publicada y de la literatura gris, del conocimiento local, los datos de la ciencia ciudadana, los resultados de investigaciones realizadas por el gobierno y de la opinión de expertos. Para cumplir con las obligaciones de CITES, las exportaciones de ambas especies necesitarían estar prohibidas hasta que existiera un manejo adaptativo más preventivo. El riesgo de cualquier exportación de *H. trimaculatus* quedó por encima de un nivel tolerable debido a la falta de un manejo apropiado para mitigar los riesgos. Como contraste, el riesgo de cualquier exportación de *H. kuda* podría volverse tolerable

*Address correspondence to Lindsay Aylesworth, email lindsay.aylesworth@gmail.com
†Current address: Oregon Department of Fish and Wildlife, 2040 SE Marine Science Drive, Newport, OR, 97365, U.S.A.
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si se realizaran monitoreos para evaluar la respuesta de la especie al manejo. Fue todo un reto implementar el proceso que desarrollamos para que las autoridades determinen el riesgo siguiendo la pauta de CITES incluso sin la necesidad de que el gobierno considerara las implicaciones sociales de la acción de conservación. Sin embargo, a pesar de las imperfecciones de nuestra evaluación de riesgo, todavía funcionó como apoyo para el manejo adaptativo. Los conservacionistas necesitan seguir considerando la implementación cuando ofrecen consejos.

**Palabras Clave:** evaluación, hipocampos, mercado sustentable, pesquerías Tailandia

**摘要:** 当要求保护的进言者采取相应政策和管理行动时, 会发生什么?在现实中, 环保倡导者和科学家常常试图推动对政府有重大影响的管理制度改革, 但却从未直接应对这些变化所带来的挑战。我们通过案例分析, 将自己置身于泰国政府的角色来执行《濒危野生动植物种国际贸易公约》 (CITES) 中保护海马 (*Hippocampus* spp.) 的义务, 包括确保泰国的海马出口不会危害野生种群。我们应用由本团队开发且 CITES 认可的框架, 评估了出口对两个海马物种的风险。这一框架评估了野生种群的致危因素; 当前的管理是否能减缓风险或抵消胁迫; 以及物种对管理政策的响应是否符合预期。我们还基于已发表文献及灰色文献中的信息、地方性知识、公民科学数据、政府研究结果和专家意见进行了分析。结果表明, 为履行 CITES 公约的义务必须禁止这两个物种的出口, 直到有更具预防性的适应性管理措施。由于缺少恰当的管理措施来减缓风险, 三斑海马 (*H. trimaculatus*) 的出口风险超出了可接受的水平。相比之下, 如果采取监测措施来评估管海马 (*H. kuda*) 对管理的响应, 则其出口的风险都可以接受。即便政府不需要考虑保护行动的社会影响, 我们根据 CITES 指导方针为当局制定的风险评估步骤也难以实施。虽然风险评估本身存在缺陷, 但它还是能够为适应性管理提供支持。此外, 保护主义者在进言献策时也应考虑实施的可行性。 **【翻译: 胡怡思; 审校: 聂永刚】**

**关键词:** 渔业, 海马, 可持续贸易, 泰国, 评估

## Introduction

Although conservationist scientists are constantly urging policy makers and resource managers to do better (Hamann et al. 2010; Young & Van Aarde 2011), it is much less common for them to make concrete suggestions, beyond urging monitoring for more data (EDF 2016). Moreover, they seldom put themselves in the place of the people and agencies tasked with implementing proposed policy changes. The result is intractable advice.

Implementation of natural resource policy is never easy given imperfect data, divergent stakeholder views, and limited budgets, but this is especially so with marine fisheries (Walters 2007; Salomon et al. 2011). Marine fisheries contribute substantially to domestic and international commerce (FAO 2018). They are sources of local pride because they are linked to cultural values, and livelihoods (Song et al. 2013). Yet, marine wildlife is increasingly threatened by fishing (Costello et al. 2012) to an extent that demands creative reconciliation of conservation with marine fisheries (Salomon et al. 2011).

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has relatively recently been used to secure sustainable exports of marine fishes (Vincent et al. 2014; Guggisberg 2016). Marine fishes are not usually considered wildlife or part of wildlife trade (Vincent et al. 2014), despite that trade policy measures help shape global patterns in fish supply and demand (Bellmann et al. 2015). However, CITES member countries must ensure their exports (and hence their fisheries leading to the export trade) do not damage wild populations for marine fishes listed in CITES Appendices (Vincent et al. 2014; Cochrane 2015). In this, countries are commonly in new territory, needing to ask their maritime and fisheries agencies to prioritize sustainability over production. Their challenge is particularly acute because national expertise in conservation and understanding of CITES policy and obligations exists primarily in environment or forestry agencies (Vincent et al. 2014).

A large part of CITES' potential to contribute to fisheries conservation comes through the requirements associated with an Appendix II listing (Vincent et al. 2014; Guggisberg 2016). Regulation of international trade of species, including very few marine fishes, under CITES occurs through listing in 1 of its 3 appendices (CITES 1973): Appendix I, end exports; Appendix II, regulate exports; or Appendix III, support national policy. Countries that trade in Appendix II species must prove, among other things, that exports do not harm wild populations. This is called a nondetriment finding (NDF) (CITES 1973). Member countries must overcome uncertainties about trade levels, population status, management options, and institutional issues associated with stakeholder involvement, financial resources, and capacity (Vincent et al. 2014). Countries are free to make their own decisions on how best to arrive at positive NDFs for listed Appendix II species (Foster & Vincent 2016). They can choose whether to follow proffered advice in the form of a general framework or a detailed checklist (Rosser & Haywood 2002; Mundy-Taylor et al. 2014; Foster & Vincent 2016). Most guidance is generic and intended to be relevant to many species and countries, each with different cultural situations, institutional limitations, and opportunities (Mundy-Taylor et al. 2014; Foster & Vincent 2016).

We focused on Thailand because it has been the world's largest exporter of seahorses and a focus of CITES action on behalf of these fishes. Since 2008 Thailand has undergone the CITES Review of Significant Trade (RST) process for 4 species (*Hippocampus kelloggi, Hippocampus kuda*, *Hippocampus spinosissimus*, and *Hippocampus trimaculatus*) to determine whether its exports of 3.0–6.5 million seahorses/year (Foster et al. 2016) were detrimental to wild populations. The RST asks countries to justify their NDFs and requires changes for countries that cannot do so for focal species. Because Thailand could not make positive NDFs for its large export volumes, Thailand's trade in these 4 species was considered to pose "urgent concern" (UNEP-WCMC 2012; CITES 2014). Thus, the CITES Animals Committee provided 10 actions Thailand would need to implement to continue exporting seahorses legally (CITES 2012). Thailand found this process difficult (A.V., personal communication), so we considered Thailand's responsibility from their perspective.

We sought to place ourselves, the providers of conservation advice, in the role of Thailand's CITES Authorities (government agencies) who are being asked to take advice on their implementation of CITES for seahorses. Throughout CITES' history with seahorses, virtually all scientific and technical advice on this taxon has come from Project Seahorse, the organization the International Union for the Conservation of Nature (IUCN) considers the global authority on seahorses and their relatives. We focused on the nonbinding NDF framework for seahorses, which we developed (Foster & Vincent 2016), informed by NDF frameworks for other species listed on Appendix II. We wanted our analysis to represent problems CITES Authorities may face with implementation of other CITES export regulations.

In line with the NDF framework, we assessed the risk to Thai seahorses from fishing, trade, and habitat destruction and evaluated the ability of existing management to mitigate the identified risks. We used this assessment to consider NDF options and what actions may be needed to improve management action and fill knowledge gaps. We explored what we would consider sufficient knowledge for countries to make an NDF under CITES. We also examined the implementation process, beginning with the initial CITES recommendations to Thailand based on our advice. Our analysis considered the context and data available as of 31 December 2015. On 1 January 2016, Thailand declared a suspension of seahorse exports until they were confident of making positive NDFs, and the policy landscape shifted.

## Methods

We ran through the NDF framework with the 2 (of 7) Thai seahorse species CITES identified as "urgent concern": *H. trimaculatus* in 2014 and *H. kuda* in 2012. These 2 species are the most susceptible to trawling and gillnet fishing and represent dominant offshore (*H. trimaculatus*) and inshore (*H. kuda*) seahorse species in Thai fisheries and trades (Aylesworth et al. 2018). This preselection allowed us to skip over sections 3 and 4.1 of the framework (Fig. 1).

As requested in the NDF framework (Fig. 1), we extracted all available information on the selected 2 species. Sources included published literature, grey literature, local knowledge, citizen science contributions, government research, and expert opinion (Foster & Vincent 2016). We incorporated data sets not explicitly requested in the NDF framework and included data that were available only at the genus level.

We documented and evaluated the risks to our 2 seahorse species by gathering data related to their fishery and trade and destruction of their habitat (sections 4.2–4.5) (Fig. 1 & Supporting Information). This information came from the Thai CITES Authorities, including documents submitted to the CITES Secretariat and relevant CITES Committees by Thailand in support of the RST process. We also consulted published literature (Google Scholar searchers) and local experts ($n = 150$) and drew on our own seahorse field research from 2013 and 2014 in Thailand (Supporting Information). We described pressures on the 2 species (section 4.2 of the framework) and assessed the risk of the various pressures on them (sections 4.3–4.5). We drew on the framework's suggestions in assigning the 4 categories of risk from fishing, trade, and habitat destructions: low, moderate, high, and unknown (Supporting Information).

We evaluated the capacity of existing management to mitigate the risks we identified, as recommended in section 5. To do so, we considered whether existing management was appropriate for the risks, being implemented, and effectively reducing identified pressures on seahorse populations to levels that did not damage wild populations (section 5) (Fig. 1). We based our evaluation on Thai marine management measures in place as of 31 December 2015 (DoF 2015) (Table 2 & Supporting Information). We evaluated the implementation of such management measures, defined as either stakeholders following the rules (compliance) or authorities taking action to ensure rules are followed (enforcement). The framework infers management effectiveness from evidence of stable or increasing (seahorse) population sizes over time. We did a second evaluation of appropriate management measures based on spatial overlap of sightings for the 2 species and known marine management measures. We used 3 data sources for observations of seahorses by species: DoF research trawls, scientific surveys, and citizen science contributions. We also used 3 data sets on management measures: Thai national parks, no-trawl zones, and seasonal closures (Supporting Information). If >70% of sightings for either species occurred in any 1 management area

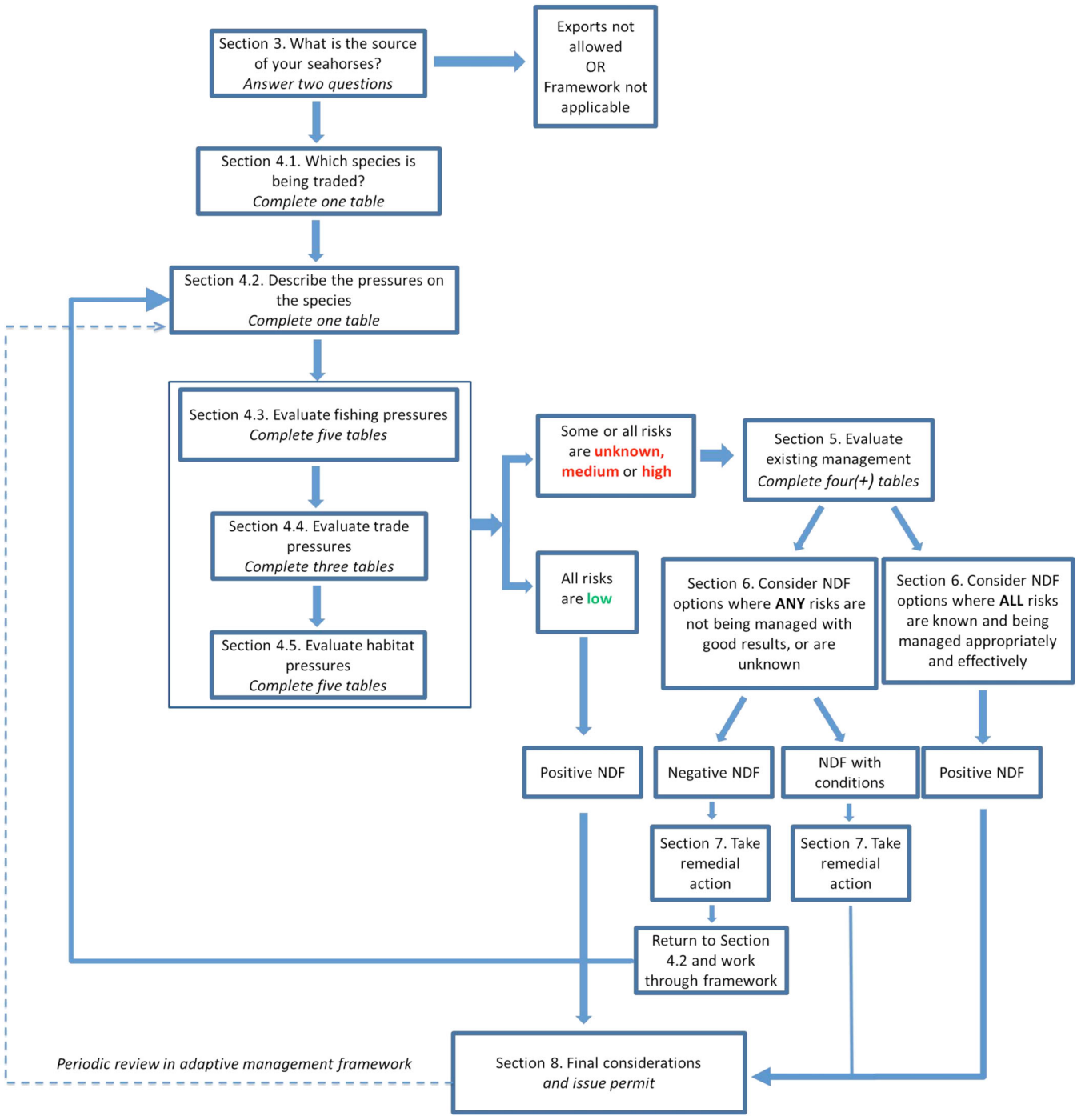


*Figure 1. Flow chart describing the nondetriment finding (NDF) framework for seahorses. Section numbers are sections of the NDF framework. From Foster and Vincent (2016), reprinted with permission from Project Seahorse.*

or in all management areas combined, we deemed management appropriate. Our rationale was that effectively managing areas with >70% of the sightings could reduce the population risk of extinction from vulnerable to near threatened on the IUCN Red List (IUCN 2012).

We put ourselves in the position of the Thai CITES Authorities and tried to determine whether we could make a positive, conditional, or negative NDF (section 6) (Fig. 1) (Foster & Vincent 2016) based on general practice. In this context, a positive NDF can be made when all the risks are known and are being managed appropriately and effectively (Mundy-Taylor et al. 2014; Foster & Vincent 2016). An NDF with conditions would allow for precautionary levels of exports while risks are reduced, gaps in management are addressed, or quality of information is improved (Mundy-Taylor et al. 2014; Foster & Vincent

2016). An NDF with conditions might be assigned when at least 1 appropriate management measure is in place but improvements on enforcement and data on effectiveness are needed. A negative NDF could be made when risks are not being managed with good results or are unknown (Mundy-Taylor et al. 2014; Foster & Vincent 2016).

We explored the guidance and advice in support of adaptive management that emerged from section 7. Using the framework to inform a national action plan for seahorses (section 7), we considered how to improve management and fill knowledge gaps. Where risks were not being managed with good results or were unknown, we identified 3 key management approaches for each species that were essential to moving forward and creating an action plan (section 7). These were based on which of the many options were the most pressing, the most tractable, and already required through another policy commitment (e.g., Aichi). Such selection criteria were intended to focus implementation efforts and encourage pragmatism.

We did not address the final steps before issuing a permit (section 8). Our end was determination of whether permits should be issued, not how they might materialize.

## Results

We found 5 sources of data on fisheries, 6 sources of data on trade, and 30 sources of data on habitat (Supporting Information). Information on fisheries and trade primarily emerged from research prompted by the RST recommendations (CITES 2012), whereas most information on habitat came from published literature. We found 10 sources of data on appropriate management responses and enforcement (Supporting Information). We were unable to find any information on the effectiveness of marine management measures for seahorses as inferred by long-term monitoring of trades, catches, or populations.

### Management Measures

Six existing management responses were appropriate to address pressures on seahorses in general in Thailand. None were developed specifically for seahorses, but their implementation should help mitigate pressures on seahorses. The 4 management responses appropriate to fisheries pressures (mostly nonselective gear) included limited entry, marine protected areas, and spatial and temporal gear restrictions (Supporting Information). A new national fisheries management plan addressed illegal fisheries and trade (Supporting Information). To address habitat destruction, management responses were marine protected areas, spatial gear restrictions, and habitat restoration (Supporting Information).

All management measures could address human pressures on Thailand's seahorses. There was purported limited entry for all gears that catch seahorses (DoF 2015). National parks (marine protected areas) in Thailand encompassed substantial amounts of seahorse habitat; 25% of national waters included 75% of Thailand's coral reefs and 71% of its seagrass beds (DoF 2015). However, implementation and enforcement were a consideration (see below). Thailand officially banned trawling within 3–5 km along all coasts and implemented 3 seasonal closures to protect spawning stock and juvenile fish, closures that would also benefit seahorses (DoF 2015). Thailand had also developed 96 artificial reefs with the stated aims of preventing trawling and restoring fish habitats (DoF 2015), although these could increase fishing pressure elsewhere.

### Management Implementation

Appropriate management was in place but, evaluating its implementation (i.e., compliance or enforcement) proved challenging because of conflicting data. The majority of data for limited entry, national parks, and spatial and temporal gear restrictions indicated that many fishers did not comply with these measures (Supporting Information), leading us to decide that these were not well implemented. However, unpublished data from the Thai Department of Fisheries enforcement office showed limited enforcement for marine fisheries generally. A new fisheries management plan was enacted in late 2015 with the goal of increasing fisheries enforcement and compliance. Its objectives included improving management efforts and establishing tracking systems, check-points at ports, and improved data collection and management (Supporting Information). We confirmed the number of artificial reef units and their geospatial locations, but the conservation value of such reefs to seahorses was unknown.

### Management Effectiveness

A dearth of monitoring data (in water, onboard, port-side) meant we had to consider effectiveness of marine management measures for seahorses unknown (Supporting Information).

### Results specific to H. trimaculatus

We judged risk high for *H. trimaculatus* in 11 categories (7 fisheries, 3 trade, and 1 habitat) (risk levels defined in Supporting Information). High-risk fisheries pressures included capture in many different fishing gears, but specifically in otter and pairs trawls and gillnets. Catch was sex-biased (indicator of overfishing), and local knowledge indicated declines in catch per unit effort. High-risk trade pressures included many uses of *H. trimaculatus* in trade; illegal, unreported, and unregulated (IUU) fishing and trade, and large price increases. High risks from habitat

**Table 1. Summary of spatial overlap of marine management measures and sightings of *H. trimaculatus* and *H. kuda*.**

| | *Sightings (%)* | |
|---|---|---|
| *Management measure* | H. trimaculatus *(n = 556 sightings)* | H. kuda *(n = 38 sightings)* |
| National parks | 2 | 8 |
| No-trawl zones | 3 | 100 |
| Seasonal closures | 2 | 74 |
| Total inside all management combined | 6 | 100 |

destruction came primarily from marine-based activities (e.g., tourism, shipping, dredging). Seahorse bycatch in gillnets, land-based activities, climate change, and declines in indicators of habitat function posed moderate risks. Capture in purse seines and pushnets, catch under length at maturity, and habitat specialization posed low risks. No categories had unknown risk (Supporting Information).

No existing management measures mitigated risks for *H. trimaculatus* (section 5). Only 6% of 556 sightings of *H. trimaculatus* occurred inside all managed areas combined (Table 1), and 2% of sightings occurred in national parks or areas with seasonal fishing closures (Fig. 2 & Supporting Information). Just 3% of sightings occurred in the no-trawl zones (spatial gear-restricted area) (Fig. 3 & Supporting Information). Moreover, for seahorses, limited entry and habitat restoration would only be appropriate when combined with national parks or spatial gear restrictions (Supporting Information). The only appropriate means to mitigate the fisheries risks for *H. trimaculatus* was through implementation of the Marine Fisheries Management Plan of Thailand, but its enforcement and effectiveness were unknown (Table 2 & Supporting Information).

We assigned a negative NDF for *H. trimaculatus*. The dearth of management measures to mitigate the risks for this offshore species meant that, were we the government of Thailand, we would not be able to justify ongoing trade (an NDF with conditions) for this species.

The most pressing problem facing *H. trimaculatus* was unmanaged and unregulated capture in trawling gears. We would need to know more about how catches and pressures varied spatially to deduce whether existing national parks and no-trawl zones—if implemented—would serve this species or if additional management would be needed. Such information could be obtained through portside monitoring or onboard logbooks. Thailand is already committed to implementation of a new fisheries management plan to reduce IUU fishing and trade. Continuing efforts to limit entry and increase enforcement measures should help ensure nonselective fishing is addressed. Portside monitoring for seahorses would support adaptive management by helping to identify effectiveness of management actions and ongoing adverse effects from fishing over time.

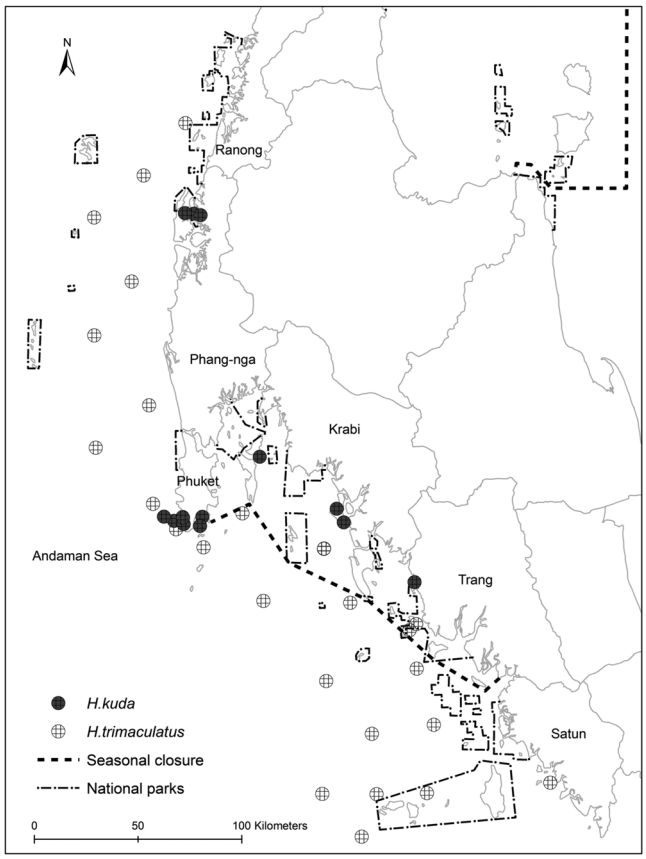


*Figure 2. National parks and seasonal closures on the Andaman coast of Thailand and locations of* H. kuda *and* H. trimaculatus *observations from research trawls, scientific surveys, and citizen science contributions in relation to the no-trawl zones. Approach used to generate data sets and map detailed in Supporting Information. Additional maps of seahorse and management locations on the Gulf Coast of Thailand detailed in Supporting Information.*

### Results specific to *H. kuda*

We judged risk to *H. kuda* as high in 8 categories (4 fisheries, 3 trade, 1 habitat) (Supporting Information). High-risk fisheries pressures included capture in a large diversity of fishing gears, including gillnets, catch under length at maturity (indicator of overfishing), and local fisher reported declines in catch per unit effort. High-risk trade pressures included many uses in trade, IUU fishing and trade, and large price increases over time. High-risk habitat destruction came primarily from marine-based activities (e.g., tourism, shipping, dredging). Gillnet bycatch, land-based activities, climate change, and declines

**Table 2. Fishing gears and management measures stemming from the Marine Fisheries Management Plan of Thailand (DOF 2015) relevant to *H. trimaculatus* and *H. kuda*.**

| *Risk* | *Gear* | *Management measures* | *Enforcement* | *Effectiveness* |
|---|---|---|---|---|
| High | otter trawl | gear restriction, spatial | unknown | unknown |
| | | gear restriction, temporal | unknown | unknown |
| | | habitat restoration | yes | unknown |
| High | pair trawl | gear restriction, spatial; | unknown | unknown |
| | | gear restriction, temporal | unknown | unknown |
| | | habitat restoration | yes | unknown |
| High | gillnet | gear restriction, temporal | unknown | unknown |
| Low | purse seine | gear restriction, temporal | unknown | unknown |
| Low | pushnet | gear restriction, spatial | unknown | unknown |
| | | gear restriction, temporal | unknown | unknown |
| | | habitat restoration | yes | unknown |

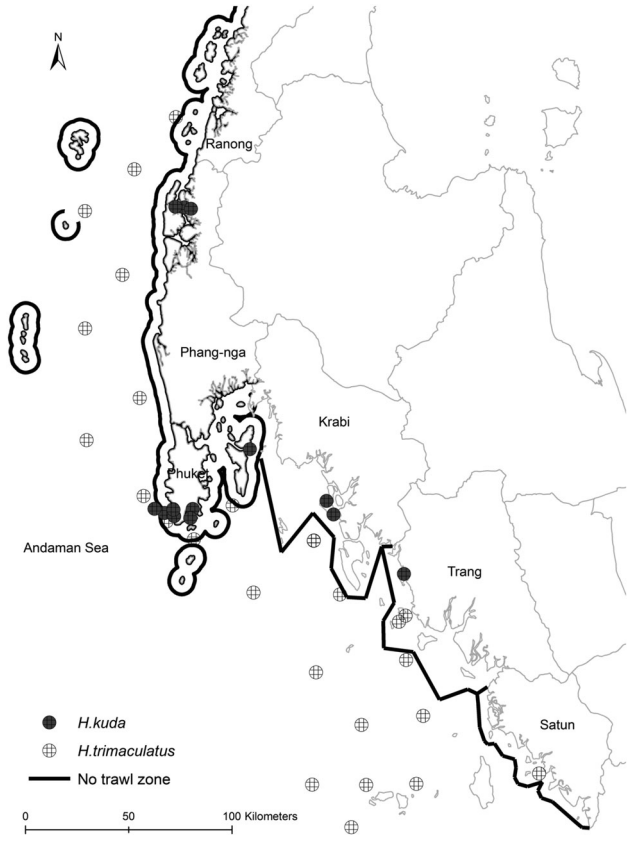


*Figure 3. No-trawl zones on the Andaman coast of Thailand and locations of* H. kuda *and* H. trimaculatus *observations from research trawls, scientific surveys, and citizen science contributions in relation to the no-trawl zones. Approach used to generate data sets and map detailed in Supporting Information. Additional maps of seahorse and management locations on the Gulf Coast of Thailand detailed in Supporting Information.*

in indicators of habitat function were moderate risks. Low risk fisheries pressures included catchability in fishing gears generally, capture in otter and pair trawls, capture in pushnets, and sex bias in capture. No categories had unknown risk (Supporting Information).

We deemed Thailand's designated spatial and temporal gear restrictions could—if well implemented—mitigate risks for *H. kuda* (Table 2 & Supporting Information). All 38 sightings of *H. kuda* occurred inside at least 1 of the marine management areas (Table 1). Just 8% of sightings occurred within national parks, but this may reflect limited sampling effort in these areas (Fig. 2 & Supporting Information). All sightings for *H. kuda* occurred in designated no-trawl zones (Fig. 3 & Supporting Information), and 74% of sightings were in areas with seasonal fishing closures, which specifically address gillnets, the main fishing pressure on this species (Fig 2. & Supporting Information). It is possible that current distribution reflects sampling bias or a reduced area of occupancy (sensu IUCN Red List) because of fishing effort, but it at least indicates some level of protection, which was clearly lacking for *H. trimaculatus*. Because limited entry and habitat restoration were combined with national parks or spatial gear restrictions, these measures also addressed risks (Table 2 & Supporting Information). The new Fisheries Management Plan theoretically could provide an appropriate response to fisheries risks for *H. kuda* (Supporting Information), although information on its enforcement and effectiveness remains unknown.

We made an NDF with conditions for *H. kuda.* Because many management measures had the potential to mitigate the risks for this inshore species, but there was a lack of data to determine its effectiveness, we believed trade in *H. kuda* could continue only with annual portside monitoring efforts and adaptive management. Such monitoring and associated responses would allow evaluation of existing management and identification of unmanaged risk. These efforts could supplement on-going monitoring for other marine species at select sites for both commercial and small-scale gears. Were we the government of Thailand, we would set trade at precautionary levels (e.g., quota capped at the mean volume of the number of exports over the last 5 years) until results from

monitoring became available and could inform management decisions.

The most pressing issue facing *H. kuda* was capture in gillnets. Although gillnets are regulated in Thailand, regulations have not been developed for seahorses. The numerous small-scale gillnet fisheries in Thailand are monitored through fisher self-reporting. A national action plan that included encouraging gillnet fishers to record their seahorse catches when documenting other catch would provide useful data to evaluate risks to *H. kuda.* The most tractable action would be to fully implement management measures aimed at reducing threats to habitat, primarily focusing on better enforcement of protected areas and underwater monitoring of seahorse populations to inform adaptive management.

## Discussion

As conservationists, trying our hand at national implementation of an international wildlife trade treaty added to our respect for government challenges with implementation. Because our original advice (NDF framework) had been designed to serve as guidance not a prescription—it had to be applicable to many situations—the effectiveness of its implementation depended heavily on national opinion and interpretation. It is common for advice in multilateral agreements to be vague, including when implementing CITES for terrestrial species (Castello & Stewart 2010; Smith et al. 2011), both to allow it to be applied to many situations and to avoid appearing to dictate to national governments. Countries are expected to deploy what data they can access to reach best possible decisions, hopefully while collecting more information to support adaptive management. We followed their lead, moving on with implementation in spite of imperfect data (Smith et al. 2011). We focused on reproducible ways to evaluate the data in hand and on identifying management options that were most pressing, tractable, or required by other commitments (Bottrill et al. 2008). Such a pragmatic approach allowed us to complete the NDF process for our 2 case study seahorse species, despite imperfect data sets, just as countries are required to do. Nonetheless, it was indeed somewhat challenging to make a series of decisions about progressing with poor data through a rather generic framework.

Our experience with making CITES NDFs was filled with judgment calls—based on our collective level of expertise and risk tolerance—as would be the case for any country working through this process (Mundy-Taylor et al. 2014; Foster & Vincent 2016; Friedman et al. 2018). We identified 4 steps in the NDF process where judgment was particularly important: deciding how data fit into the various categories; assessing risk based on available information; evaluating conflicting data; and determining the NDF outcome. Government would further have the challenge of integrating socio-economic considerations into its decisions, which we did not tackle (Rice & Legacè 2007). Thanks to our close ties with the CITES scientific and management Authorities in Thailand, we accessed a substantial amount of data that might not otherwise have been publicly available. Even so, and given our extensive expertise—cumulatively working on seahorses for 63 years and members of the IUCN Seahorse Specialist Group (www.iucn-seahorse.org)—making a CITES NDF for these 2 seahorse species was challenging.

We found that our process for making an NDF for 2 marine fishes was dependent on presence of appropriate management and understanding its effectiveness, yet this is seldom documented for CITES Appendix II species (Smith et al. 2011). Marine management measures and monitoring in Thailand were focused on other species, priority habitats, and economically important fisheries (DoF 2015). Such challenges may be common for newly listed Appendix II fishes, or other non-target, low-value, or data-poor species (Costello et al. 2012). However, an Appendix II listing for sharks and rays improved national level species governance including existing regulations (Friedman et al. 2018). Our work similarly demonstrates how CITES may help advance national fisheries management while furthering species conservation (Vincent et al. 2014; Friedman et al. 2018). In playing the role of government, we were forced to examine a suite of measures, guidelines and designations in a holistic manner and to consider their effectiveness.

We found that spatial data, often overlooked in CITES NDF literature (Rosser & Haywood 2002), were critical in evaluating the potential for existing management to offset species risk, especially given the lack of data on management effectiveness. Our analysis of spatial overlaps between species observations and management areas helped us differentiate possible outcomes for the 2 species. Even where spatial distribution data are not available for particular species per se, they can commonly be cobbled together, as here for seahorses and for sharks in Costa Rica (Clarke et al. 2018). Species distribution can often be inferred from local knowledge (Thornton & Scheer 2012) and is relatively cheap to generate (Aylesworth et al. 2017). Such efforts matter because many current ocean management strategies are spatial (Chape et al. 2005; NOAA 2014). Overlaying spatial data on species distribution and management gets to the core of the NDF process—which essentially comes down to whether management is in place to mitigate risks to listed species (Foster & Vincent 2016).

The conditional NDF was a valuable tool for our focal seahorse species, given that management measures were in place but data on management effectiveness were lacking. Similar to the SMART management criteria (specific, measurable, assignable, realistic, time-related [Doran 1981]), conditional NDFs must have clearly defined provisions, actors and timelines (Foster & Vincent

2016). For *H. kuda,* our conditions would include the establishment of long-term monitoring to evaluate how populations are faring under the management regime. Such monitoring could be accomplished through regular port sampling by the Thai Department of Fisheries or monitoring of wild populations in management areas by the Thai Department of Marine and Coastal Resources, the agency responsible for marine national parks (Foster et al. 2014; Loh et al. 2014). However, the advice from the NDF framework for seahorses should have indicated the importance of funding to implement CITES Appendix II listings and how to meet such costs especially where they exceed the value of a resource.

In our guise as government agents, we could avoid an urge to fall into management inaction, common when data are lacking and next steps are unclear, by applying conservation triage procedures (Bottrill et al. 2008). Identifying actions for each species that responded to the most pressing, tractable, and already prescribed management commitments enabled us to maintain momentum with the NDF process for seahorses, as for any species requiring conservation action (Mundy-Taylor et al. 2014). For example, even given uncertainty about management implementation and effectiveness, the greatest risk for both seahorse species clearly came from certain fishing gears. As a matter of domestic policy, increasing enforcement efforts to ensure these gears are constrained in time and space would be important in reducing pressure on wild populations of seahorses and other species. Increased enforcement of these gears is a pragmatic goal because it is a priority under the new Fisheries Management Plan and so would deploy available resources effectively (Bottrill et al. 2008). As ever with most species, improved implementation of existing national laws would offer seahorses some relief from fisheries and habitat related pressures.

Once an NDF has been made, a country must decide how to respond to that positive, conditional or negative finding, balancing conservation with fisheries and trade goals (Salomon et al. 2011; Guggisberg 2016). After making a negative NDF CITES countries have often suspended exports (through bans or zero quotas) to avoid violating their duty under the Convention (Foster et al. 2019). However, the real issue from a conservation perspective is what a country does after it suspends trade. Do management, data collection, and monitoring relevant to export regulation improve in a timely fashion or is no further attention paid to the species? If the latter, then the intent of CITES is undermined, even where the legality is not. In the case of species obtained in bycatch, like seahorses, ongoing capture in nonselective gear may mean that export suspensions do very little to help a country move toward eventual sustainable exports. Further complicating matters, suspensions often drive trade underground rather than stopping it (Foster et al. 2019). That said, Thailand responded to the RST process—and the country's limited progress on recommendations—by announcing just such a suspension of exports for all seahorse species on 1 January 2016, even in the face of continued heavy bottom trawling and associated seahorse bycatch (CITES 2016).

The policy and management path to sustainability involves finding creative solutions that move societies, spaces, and species toward sustainable management (Meffe & Viederman 1995). Rarely do conservationists place themselves in the role of policy maker or government actors tasked with implementing policy changes. Our attempt in this direction confirmed the importance of moving forward despite imperfect data, in a documented and justified way that allows for future adaptive management (Meffe & Viederman 1995). Most conservation studies inevitably call for more data (Hamann et al. 2010; Young & Van Aarde 2011) in a failed quest for perfect advice (Johannes 1998). Yet government does not have the luxury of waiting until such an unlikely scenario emerges and must plunge forward with imperfect knowledge. It is only when conservationists tackle implementation that we realize taking a dose of our own medicine poses real challenges. Greater respect for these challenges, meaningful consultation with managers, and a pause for reflection before making recommendations might go a long way toward bridging the gap between science and policy.

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## Supporting Information

Data sets used to evaluate pressures and risk on 2 seahorse species (Appendix S1), risk assessment criteria (Appendix S2), potential management responses (Appendix S3), and data sets available to evaluate management

measures in Thailand (Appendix S4) methods and data sets used to identify spatial overlap of management measures and seahorses (Appendix S5), maps from spatial overlap analysis (Appendix S7), and evaluation of data, risk, management, enforcement, and effectiveness for H. trimaculatus (Appendix S6) and H. kuda (Appendix S8) are available online. The authors are solely responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

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