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Informing CITES Parties: Strengthening science-based decision-making when listing marine species

Kim Friedman[1,2] | Matias Braccini[3] | Matthew Bjerregaard-Walsh[4] | Ramón Bonfil[5] | Corey J. A. Bradshaw[6] | Stephen Brouwer[7] | Ian Campbell[8] | Rui Coelho[9] | Enric Cortés[10] | Wetjens Dimmlich[11] | Michael G. Frisk[12] | Irene Kingma[13] | Sophy R. McCully Phillips[14] | Colman O'Criodain[15] | Denham Parker[16] | Samuel Shephard[17] | Javier Tovar-Ávila[18] | Kotaro Yokawa[19]

[1]Food and Agriculture Organization of the United Nations (FAO), Rome, Italy

[2]The University of Western Australia Oceans Institute, Crawley, WA, Australia

[3]Centre for Fish and Fisheries Research, School of Veterinary and Life Sciences, Murdoch University, Murdoch, WA, Australia

[4]Exeter Marine, University of Exeter, Exeter, UK

[5]Océanos Vivientes A. C., CDMX, Coyoacán, Mexico

[6]Global Ecology, College of Science and Engineering, Flinders University, Adelaide, SA, Australia

[7]Oceanic Fisheries Programme, Pacific Community, Noumea, New Caledonia

[8]Project Aware, Bristol, UK

[9]IPMA - Portuguese Institute for the Ocean and Atmosphere, Olhão, Portugal

[10]National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Panama City, FL, USA

[11]Pacific Islands Forum Fisheries Agency, Honiara, Solomon Islands

[12]School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, NY, USA

[13]Dutch Elasmobranch Society, Amsterdam, Netherlands

[14]Centre for Environment, Fisheries and Aquaculture Science, Lowestoft, UK

[15]Wildlife Practice, World Wildlife Fund International, Nairobi, Kenya

[16]Fisheries Management Branch, Department of Agriculture, Forestry and Fisheries (DAFF), Cape Town, South Africa

[17]Inland Fisheries Ireland, Dublin, Ireland

[18]National Fisheries and Aquaculture Institute, Nayarit, Mexico

[19]Oceanography and Resources National Research, Institute of Far Seas Fisheries, Shizuoka, Japan

Correspondence
Kim Friedman, F602, Fisheries and Aquaculture Department, Marine and Inland Fisheries Branch, Food and Agriculture Organization of the United Nations (FAO), Vialle delle Terme di Caracalla, 00153 Rome, Italy.
Email: Kim.Friedman@fao.org

Abstract

International trade in vulnerable marine species is regulated once they are listed in CITES Appendices (the Convention on International Trade in Endangered Species of Wild Fauna and Flora). Parties to the Convention submit proposal(s) 150 days prior to the CITES Conference for voting on the inclusion of new species in Appendices I and II, making a case for why CITES listing criteria are met in each case. Before the vote, Parties receive advice from (a) the Food and Agriculture Organization of the United Nations, (b) the International Union for Conservation of Nature—TRAFFIC and (c) the CITES Secretariat, among others. This paper offers an expert review of listing processes, which are the subject of much debate in fishery and environment-protection communities, looking at two specific cases: silky shark (*Carcharhinus falciformis*,

Carcharhinidae) and bigeye thresher shark (*Alopias superciliosus*, Alopiidae). The reviewers determine that the evidence made available to voting Parties is substantial, but suffers from non-standard presentation across assessments. The best available data are not always presented or described transparently in relation to CITES criteria. An extension of the assessment period, as well as the opportunity to refute evidence, has been suggested as ways to support more informed and effective decision-making by CITES Parties, whose composition of delegations varies greatly in their experience of marine species management and trade. Experts welcomed a greater coherence of advice between fishery and non-fishery sources in the long term, and proposed a range of suggested improvements for the delivery of information and advice to CITES Parties.

KEYWORDS
abundance indices, extinction risk, reviews, shark, threatened species, trade

1 | INTRODUCTION

What constitutes a "conservation crisis" for the oceans? What some regard as evidence of imminent threat of extinction, others regard as justification for adaptive management. These contrasting views illustrate that defining the status of fish stocks involves more than amassing facts (Hilborn, 2006; Jennings, 2007; Kareiva, 2010; Parsons, Della Sala, & Wright, 2015). We also need to recognize the many unique perspectives, backgrounds and experiences that inform a person's views and objectives when such decisions are made, all of which influence the chances of reaching the consensus necessary for long-lasting and supported management (Akçakaya et al., 2000; Cummings, Converse, Smith, Morey, & Runge, 2018; Mace & Hudson, 1999; Regan et al., 2005; Walsh, Dicks, & Sutherland, 2015). Paraphrasing the words of a popular science commentator, Neil deGrasse Tyson, we need to ensure we use science and the scientific method in our decision-making processes, "… to ensure we are not fooled into thinking something is true when it is not, or not true, when it is" (Wudel, 2017).

A pertinent example of such a process is achieving consensus in the identification of threatened or near-threatened fish populations—an essential precursor to subsequent interventions designed to avert population collapses and species extinctions. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) can potentially support this task because it is a legally binding framework helping 183 Parties: 182 countries and the European Union regulate international trade of threatened or near-threatened species that are listed in its Appendices. Under current practice, CITES Parties have the opportunity to submit proposals to amend the CITES Appendices (listing new species or changing existing listings) every three years, listings that largely prohibit (Appendix I) or require international trade to be legal, sustainable and documented (Appendix II) prior to sanctioning international trade (Guggisberg, 2016; Vincent, Sadovy de Mitcheson, Fowler, & Lieberman, 2013). For a full and complete description of CITES Appendix I and II arrangements, refer to CITES (2019) advice. In addition to actions taken at CITES Conferences of Parties, the Convention also foresees

the possibility of intersessional amendments to the Appendices via postal procedure (Art. XV 2 of the CITES Convention), although for marine species none has been recorded to date. Listing of a species within a CITES Appendix places limits on international trade that could further endanger that species in the wild (Brown & Swails, 2005).

At the Seventeenth CITES Conference of Parties held in Johannesburg, South Africa, in 2016, seven proposals to include commercially exploited aquatic species in CITES Appendix II were submitted and considered. We will consider two of these: silky shark *Carcharhinus falciformis* (proposal 42) and bigeye thresher shark *Alopias superciliosus* (proposal 43) from the Carcharhinidae and Alopiidae, respectively. Before CITES Parties vote on whether to list commercially exploited species under Appendix II, the CITES Secretariat, as required under article XV 2b of its Convention text, seeks advice from mandated intergovernmental bodies for fisheries, for example, the Food and Agriculture Organization of the United Nations and Regional Fisheries Management Organizations (CITES, 2016a; Guggisberg, 2016), on whether pre-agreed CITES criteria have been met. A memorandum of understanding between FAO and the CITES Secretariat (CITES, 2006) provides a framework for this cooperation, as do the terms of reference adopted by the FAO's 194 Member States (FAO, 2016) that outlines the procedure for FAO provision of expert advice.

Although advice from the FAO is a mandated component in the listing assessment process that comprises part of the official meeting documentation of the subsequent CITES Conferences of Parties, at least four different assessment/advice reports are prepared for the consideration of CITES Parties: (a) advice from the proponents (proposals), (b) a report from the FAO Expert Advisory Panel for the Assessment of Proposals to Amend CITES Appendices (termed "FAO Expert Panel"), and (c) an IUCN-TRAFFIC (Wildlife Trade Monitoring Network) analysis. The CITES Secretariat then uses the information provided by Parties, statutory consultees like FAO, and any further sources of advice (provided by organizations like IUCN-TRAFFIC and others) to help formulate (d) the Secretariat's advice to Parties (termed CITES advice). These assessments present arguments on whether the species in question meets the specified listing criteria (CITES, 2016a), and the CITES Secretariat also puts forward a recommendation to Parties relating to whether a listing is warranted in their opinion. As is evident from the range of advice provided, the process is informed by a broad range of information providers.

Between 2003 and 2017 (including CITES Conferences of Parties 13–17), CITES Parties have lodged 31 proposals recommending the listing of commercially exploited aquatic species in CITES Appendices I or II. The FAO Expert Panel, comprising fisheries management, trade and species experts, concluded that 52% of these met CITES listing criteria, while the CITES Secretariat recommended listing for 77%. The CITES Secretariat recommendations for listing thus exceeded those of the FAO Expert Panel by 25% (Table 1). Furthermore, since its inception at CITES Conferences of Parties 15, the IUCN-TRAFFIC's advice has typically assessed the status of commercially exploited aquatic species as being at a higher risk of extinction than that deemed by the FAO Expert Panel (IUCN, 2011; IUCN & TRAFFIC, 2016; see Table 1). These differences are apparent despite the FAO Expert Panel, IUCN-TRAFFIC and CITES Secretariat all prioritizing a scientific approach, having access to nearly identical information while assessing species using the same CITES criteria (CITES, 2016a; see later for different interpretations of the Conventions criteria for proposals made against Annex 2a, paragraph B of the CITES Convention).

The number of commercially exploited marine species added to the CITES Appendices has increased in recent years (Vincent et al., 2013; Table 1). Several instances where listings were adopted or rejected despite scientific advice to the contrary have led to a debate on the effectiveness and utility of the advisory process that informs decisions to place species under CITES regulation (Cochrane, 2015; Fan et al., 2015). Cochrane (2015) noted that revision of CITES listing criteria at the thirteenth meeting of the CITES Conference of Parties in 2004 did not resolve the underlying differences of opinion in the objectives and attitudes among countries in relation to the use of CITES and the role of scientific information in policy and decision-making, noting that controversy was ongoing. Questions have since been raised by CITES Parties (e.g. Sri Lanka, Japan and others), FAO and IUCN (CITES, 2016b) on elements of the CITES listing process and on whether sufficient time is allocated for adequate assessment and consideration of advice (CITES, 2017).

Noting divergent views on the different analyses and interpretations, and recognizing the decisions of CITES Parties (CITES, 2017), we review and discuss assessments and advice that informed Parties considering proposals to list two pan-global shark species in Appendix II at the 17th CITES Conference of Parties. We selected these two proposals because they continue to be the subject of debate in terms of how we assess the status of marine species (see also Cochrane, 2015) and because they are commercially exploited by fisheries. Moreover, the removal of such apex predators is argued to have had a deleterious (Ruppert, Fortin, & Meekan, 2016; Ruppert, Travers, Smith, Fortin, & Meekan, 2013; Sandin et al., 2008) or equivocal (Kitchell, Essington, Boggs, Schindler, & Walters, 2002; Roff et al., 2016) consequence on trophic cascades.

We did not review the listing amendment processes where advice is provided to Parties in order to ascertain the validity of CITES listing decisions, because these decisions are the sovereign right of Parties. Rather, we assessed the process to identify ways of improving future discussions regarding the determination of which fish species meet the CITES criteria, with the objective of supporting remedial management for better long-term conservation and sustainable use of marine species, where that support is needed.

2 | METHODS

2.1 | Review process

We used expert elicitation to synthesize opinions on the CITES listing proposal and advisory process. We aimed to assess the main elements of this process and the information used to help Parties

TABLE 1 CITES listing amendment-process decision history (adapted from Cooke, 2011; Guggisberg, 2016), including advice from various processes and the decision of CITES Parties

CITES Conference of Parties Species Proposals	FAO expert panel	IUCN-TRAFFIC	CITES secretariat	CITES parties
Conference of Parties 13 (2004)				
Carcharodon carcharias, Lamnidae	Meets App. II	–	Adopt	App. II
Cheilinus undulatus, Labridae	Meets App. II	–	Adopt	App. II
Lithophaga lithophaga, Mytilidae	Does not meet	–	Reject	App. II
spp. of Helioporidae, Tubiporidae, Milleporidae, Stylasteridae and within the Order Scleractinia	No decision	–	Adopt	Annotation included
Conference of Parties 14 (2007)				
Lamna nasus, Lamnidae	Does not meet	–	Adopt	Reject
Squalus acanthias, Squalidae	Does not meet	–	Adopt	Reject
Pristidae	Meets App. I, II	–	Adopt	App. I App. II
Anguilla anguilla, Anguillidae	Meets App. II	–	Adopt	App. II
Pterapogon kauderni, Apogonidae	Does not meet	–	Adopt	Not listed
Panulirus argus, *P. laevicauda*, Palinuridae	Does not meet	–	Reject	Not listed
Corallium, Coralliidae	Does not meet	–	Adopt	Reject
Conference of Parties 15 (2009)				
Sphyrna lewini, Sphyrnidae	Meets App. II	Meets App. II	Adopt	Reject
Carcharhinus longimanus, Carcharhinidae	Meets App. II	Meets App. II (I?)	Adopt	Reject
Lamna nasus	Meets App. II	Meets App. II	Adopt	Reject
Squalus acanthias	Does not meet	Meets App. II	Adopt	Reject
Thunnus thynnus, Scombridae	Meets App. II, (I)	Meets App. I	Adopt	Reject
Coralliidae	Does not meet	Conceivable, but no decision	Adopt	Reject
Conference of Parties 16 (2012)				
Carcharhinus longimanus	Meets App. II	Meets App. II	Adopt	App. II
Sphyrna lewini	Meets App. II	Meets App. II (I?)	Adopt	App. II
Lamna nasus	Meets App. II	Meets App. II	Adopt	App. II
Pristis microdon, Pristidae	Meets App. I	Meets App. I	Adopt	App. I
Manta spp., Mobulidae	No decision	May meet App. II	Adopt	App. II
Paratrygon aiereba, Potamotrygonidae	No decision	No decision	Reject	Reject
Potamotrygon motoro, *P. schroederi*, Potamotrygonidae	No decision	No decision	Reject	Reject
Conference of Parties 17 (2016)				
Carcharhinus falciformis	Does not meet	Meets App. II	Adopt	App. II
Alopias superciliosus	Does not meet	No decision	Reject	App. II
Mobula tarapacana, *Mobula japanica*, Mobulidae	Meets App. II	May meet App. II	Adopt	Reject
Potamotrygon motoro	Does not meet	No decision	Reject	Not listed
Pterapogon kauderni	Meets App. II	Meets App. II	Adopt	Not listed
Holacanthus clarionensis, Pomacanthidae	Does not meet	Does not meet	Reject	App. II
Nautilidae	Meets Appen. II	Meets Appen. II	Adopt	App. II

determine whether CITES criteria have been met for a proposed species. These were as follows: (a) extent of expertise contributing to advice formulation; (b) inherent productivity of the species in question; (c) species trends (historical extent of decline, recent rate of decline, declines in combination); (d) other factors influencing decline; and (e) the communication of information.

Despite the main elements of the CITES listing criteria being clearly articulated in CITES texts (e.g. CITES, 2016a), some disagreement between fisheries and environmental sectors still exists on the definition of thresholds in the Convention text (Cochrane, 2015; Guggisberg, 2016). For this reason, we have not reported the expert participants' final determination as to whether a species met CITES

criteria, but more on their perception of the quality of the information used by assessors, assessments completed and the presentation of analyses and results.

Noting that commercially exploited and traded sharks were our focus, FAO sent invitations to a range of people with expertise in the sustainable use and conservation of these species, asking them to participate in the study. Those that accepted represented a wide range of expertise, from national government fishery and environment departments in both the Northern and Southern Hemispheres, regional fishery and environment organizations, universities and non-governmental organizations (NGOs; Table 2). We did not extend invitations to the original authors of the four advice documents under review to avoid potential biases and conflicts of interest.

We used a structured-survey framework, in which a questionnaire required study participants to score questions integral to supporting CITES Parties' decision-making (Supplementary Section 1). Using the IDEA protocol, the structured expert elicitation required study participants to provide draft scores and comments, and then have the opportunity to revise and update their inputs after seeing the results of the other anonymous study participants in a subsequent round of scoring before making their final submission. This protocol is well explained by Hemming, Burgman, Hanea, McBride, and Wintle (2018a), Hemming, Walshe, Hanea, Fidler, and Burgman (2018b) and others (Rowe & Wright, 2011); however, in summary, the two-round scoring process for structured expert elicitation has been argued to help overcome operational challenges and improve the quality (accuracy and calibration) of expert judgements (Hemming, Burgman, et al., 2018a; Hemming, Walshe, et al., 2018b). In addition, preliminary analyses (an ordinal logistic regression) showed no marked differences in the scoring patterns between the first and final responses of experts.

The authors of this paper collated and summarized all comments in the questionnaires. To communicate important themes in the comments fields of the questionnaire, we aggregated messages that illustrated real-world examples that accompanied the quantitative scores. In the subsequent writing of the paper, we filtered these further to show the relative support for these comments. The weighting of participants' support for comments is described by qualifying statements on a 4-point scale that quantifies the consensus of that comment across questionnaire responses. The 4-point

TABLE 2 Study participants

Study participant	Affiliation	Affiliation focus	Publication focus
Colman O'Criodain	World Wildlife Fund (WWF)	Biodiversity conservation	Biodiversity conservation
Corey Bradshaw	Flinders University	Biodiversity conservation	Biodiversity conservation
Denham Parker	Department of Agriculture, Forestry and Fisheries (DAFF), South Africa	Sustainable use of fishery resources	Fisheries
Enric Cortés	National Oceanic and Atmospheric Administration (NOAA)	Sustainable use of fishery resources	Fisheries
Ian Campbell	Ex WWF, Project Aware	Biodiversity conservation	Biodiversity conservation
Irene Kingma	Dutch Elasmobranch Society, Shark Alliance, Save our Sharks SoS	Independent consultant—fisheries policy; conservation	Mixed
Javier Tovar Avila	Instituto Nacional de Pesca (INAPESCA)	Sustainable use of fishery resources	Fisheries
Matias Braccini	Western Australian Fisheries	Sustainable use of fishery resources	Fisheries
Matt Walsh	Springer Publications; Environment Directorate, European Commission	Independent consultant—marine biodiversity and human ecology; communications.	Biodiversity conservation
Michael Frisk	Stony Brook University	Academic—fish ecology; fisheries	Mixed
Ramón Bonfil	Océanos Vivientes A. C. Mexico	independent consultant—ecology and fisheries sharks	Mixed
Ray Hilborn	University of Washington	Sustainable use of fishery resources	Fisheries
Samuel Shephard	International Council for the Exploration of the Sea (ICES)	Sustainable use of fishery resources	Fisheries
Shingo Ota	Fisheries Agency of Japan	Sustainable use of fishery resources	Fisheries
Sophy McCully Phillips	Centre for Environment, Fisheries and Aquaculture Science (CEFAS)	Sustainable use of fishery resources	Fisheries
Stephen Brouwer	Secretariat of Pacific Community	Sustainable use of fishery resources	Fisheries
Wetjens Dimmlich	Pacific Islands Forum Fisheries Agency (FFA)	Sustainable use of fishery resources	Fisheries

Note: Other invited experts: co-Chairs of the IUCN Shark and Ray Specialist Group and a wide range of representatives for shark conservation NGOs (e.g. Shark Advocates International, Shark Trust).

scale for qualifying reported comments includes terms that: show clear consensus among participants (≥15 participants; over 88% of responses, with no variance in agreement), have majority ("most") support (≥9 participants; 53% of responses or above, but not quite consensus), support from some participants (5–8 participants; ≥29% of responses, but < most) or only a few participants (1–4 participants, <29% of responses). In some cases, the percentage of supporting responses helps with the readability of the text; however, we preferred reporting on a 4-point scale because it more accurately reflects the aggregated responses. We describe general consensus of participants as "the participants," while we refer to cases where only a few participants supported the concept by providing the actual number.

We drafted the paper by collating inputs from a subset of the authors before offering all study participants an opportunity to correct any perceived errors, and suggest edits or additions before finalizing the publication.

2.2 | Analysis

We applied ordinal logistic regression to test for differences in the score distributions across questions related to the CITES criteria for the FAO Expert Panel report, IUCN-TRAFFIC's analysis and CITES advice, relative to study participants' perception of the corresponding proposal (Scores: 1–5, Supplementary Section 1). In one case, where we compared the authorship of the FAO Expert Panel and IUCN-TRAFFIC reports (the only two where information was available), we selected the Expert Panel report as a standard for the comparison. We did statistical analyses using the *mass* package (Venables & Ripley, 2002) in the R programming environment (R Core Team, 2018).

3 | RESULTS

3.1 | Participating experts in the review process

A total of 17 policy, academic and practitioner experts from 13 countries participated in this study (Table 2). All participants had postgraduate degrees (PhD: 67%, MSc: 33%), with a mix of professional responsibilities in fields focusing on the assessment and management of fisheries stocks (fishery focus $n = 10$), biodiversity conservation or both (mixed focus $n = 7$; Table 2).

3.2 | Expertise employed in the formulation of advice reports

3.2.1 | Review of scientific training of knowledge providers

The identity of people contributing to or authoring the four assessment reports was only documented for the FAO Expert Panel and the IUCN-TRAFFIC analyses, so our analyses only pertained to these two processes. In terms of fishery management, the FAO Expert Panel analyses scored higher than that of IUCN-TRAFFIC ($p \leq .01$), whereas for the other areas of expertise outlined in the questionnaire (see Questions Concerning Processes, including questions 2a–2d of the questionnaire; Supplementary Section 1), there was no evidence of a difference between the two groups (analysis results in Supplementary Section 2).

3.2.2 | Suggested strengths and recommendations

Most participants recommended greater transparency in the identification of contributors or authors as an area for potential improvement. There was a notable exception, with one participant stating that it was:

> … important that proposal authors were not listed by name, to allow unbiased review [of the available information] [:] the world of shark specialists is quite small and there are many preconceived ideas about persons.

Some participants (47%) also noted that including background information on the range of relevant training/expertise/experience would be valuable to the reader to offer insights on perspectives represented across disciplines. This would also assist in contextualizing the potential political implications of submissions, particularly in relation to the cultural understanding of stakeholders, illegal, unreported and unregulated fishing, trade and also some areas of biology relating to the species; however, as socio-economic considerations play no role in the current CITES listing criteria, one participant stated that "… socio-economic considerations" should not be a focus. A few participants ($n = 2$) noted that as CITES is a trade convention, input from trade expertise is needed to understand the likelihood and implications of applying trade controls. Noting the limitations in the capacity available to run such assessments, one participant did not understand why there were three different assessments of each proposal, noting that two of them (IUCN-TRAFFIC and CITES) "… look rather limited," and recommended that all expertise be combined within a single assessment.

Some study participants gave indicative scores for the expertise of proposal and CITES authors, although these authors' identities were not publicly available, so presumably they were inferred or scored because of inside information available to these study participants. One study participant noted that "… for a large number of proponent countries, a certain level of expertise is assumed." Reasons given for the limited value of content in proposals included "… a lack of knowledge of this information by their authors," with some participants noting that proposals missed more recent fisheries references, and tended to omit important evidence while not clearly separating anecdotal information from scientific evidence.

Most participants deemed that the competence of the 19 experts (plus seven observers) on the FAO Expert Panel was a strength, with panel members active in fisheries science, management and trade, or as specialists of individual species/group of species (names, institutions and field of expertise of each

documented expert were available at the end of the Expert Panel report). Furthermore, country experts putting forward the listing proposals were invited to present their proposals verbally to the panel, and the transparency of this approach was lauded. A few (n = 2) participants recommended that there should be less compromise between the expertise of the FAO Expert Panel and ensuring that there was suitable geographical and gender representation, with one stating that "… FAO should put more effort into inviting the best possible experts for the specific species being considered in the proposals." Some requested more emphasis on selecting experts with a background in conservation biology/environment, Regional Fisheries Management Organizations, small-scale fisheries and food security, to gain a better understanding of governance, use and trade elements. Another suggestion from one participant was that the Expert Panel could include a general expert (possibly even from a terrestrial background) to help with interpretation of CITES criteria and the logic of listing. In this regard, two CITES Secretariat staff attended as observers, and both IUCN Shark Specialist Group co-Chairs were invited to join the Fifth Meeting of the FAO Expert Panel prior to the 17th CITES Conference of Parties.

Some participants commended IUCN-TRAFFIC, despite documenting a smaller contingent of experts (five for silky shark and four for thresher shark) for giving a balanced representation to their relevant expertise—including experts in the field of fisheries science, shark biology and ecology, trade, biology and conservation. Recommendations for the IUCN-TRAFFIC included the need for more experts with a background in quantitative fisheries assessments (n = 3), as well as clarification on the role of the authors outlined in their report (n = 3); for example, it was unclear what the title "reviewers of summary information only" meant in the IUCN-TRAFFIC report. One participant highlighted the need for more expertise in fish biology/population dynamics or fisheries within the IUCN-TRAFFIC process, stating that "… the listing of commercial aquatic species is conceptually different to listing rare terrestrial species, and targeted expertise is merited." This was backed up another single participant's request for more diversity and a suggestion that the IUCN-TRAFFIC might increase and state its incorporation of advice from IUCN Expert Groups clearly.

In terms of CITES Secretariat, some participants questioned the "scientific rationale" of the CITES Secretariat's advice. In summary, study participants noted that the CITES advice was too concise, stating that it would be useful to provide a background on how the CITES Secretariat arrived at their conclusions as the rationale for decisions was not easy to interpret. One participant noted that longer formats had been presented by the CITES Secretariat on previous occasions.

3.3 | CITES criteria—inherent productivity

3.3.1 | Review of assessments of inherent productivity

The participants agreed with the determination of low productivity for the two shark species in all assessments where productivity was mentioned. In terms of referencing the best available scientific information on species productivity or making a valid interpretation of its meaning (both in their analyses and in their conclusions), the FAO Expert Panel report had higher scores than the silky shark (information: p = .01 and analysis and conclusions: p = .01) and thresher shark (information: p = .07 and analysis and conclusions: p = .05) proposals; the IUCN-TRAFFIC analyses and CITES advice were given similar scores to those for the proposals (Figure 1; Supplementary Section 6, Figure S1).

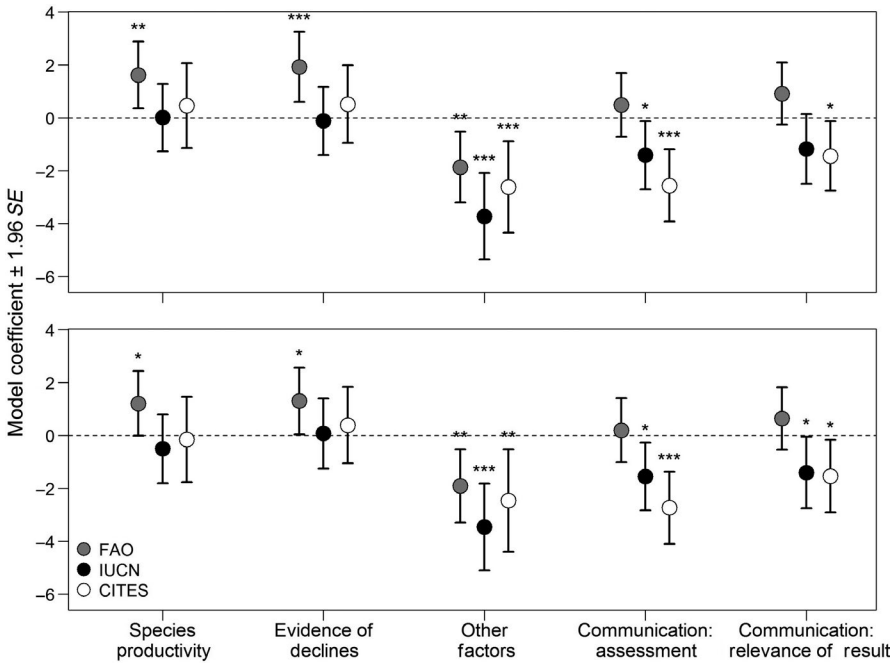

FIGURE 1 Summary (mean ± 1.96 SE) of ordinal logistic regressions for silky (top pane) and thresher (bottom pane) sharks. Coefficients for study participant scoring of their perceptions of the different assessments (relative to proposals, indicated as the baseline dotted line) on species productivity, population trends, other factors and communication in relation to the CITES criteria. Significance notation: * (.01 < p < .05); ** (.001 < p < .01); *** (p < .001). Note IUCN in legend is IUCN-TRAFFIC

3.3.2 | Suggested strengths and recommendations

Participants stated that the information on productivity was adequately evaluated across all assessments, except for CITES advice where it was stated but not discussed (see Supplementary Section 7 for more information on the strengths and recommendations for individual assessments). Most participants noted that the information delivered represented the full range of the species—this was especially notable in the proposals and FAO Expert Panel assessments. Most also recommended the need for a more explicit definition of the criteria used to classify the productivity status, along with a more objective framing of the classification for low, medium and high productivity. Lastly, a few participants (n = 3) recommended greater combining of effort across assessments, in one case suggesting that proposal authors might share reference material collated for their work on proposals to assist later assessments. This process (collation of background literature on productivity and other elements of the criteria) would save all groups' considerable time, which was recognized as limited.

3.4 | CITES criteria—species trends (historical extent of decline, recent rate of decline and declines in combination)

As both shark proposals were made under Annex 2a, paragraph A (CITES, 2016a), there was no confusion over whether species trends needed to be addressed. The assessment of species trends presents one of the biggest challenges to the assessment processes. For commercially exploited aquatic species, the "fisheries footnote" (CITES, 2016a: footnote 2 of Annex 5) indicates that the historical extent of decline and the recent rate of decline in trends should primarily be considered in combination (together)—this diverges from the CITES criteria text applicable to species other than commercially exploited aquatic species, where they are considered independently. The CITES criteria demand that the recent rate of decline should be considered over 10 years or three generations, whichever is the longer, whereas the fisheries footnote of the same advice document (CITES, 2016a) provides a guideline of 10 years (see also advice in FAO, 2002). This difference is marked in long-lived species like some sharks. There are also differences in what is considered a "marked recent rate of decline," which is defined in the standard CITES criteria as, "… a percentage decline in biomass of a stock of 50 percent or more (dependent on population size and biology of the species)," versus the valid criteria to use for commercially exploited aquatic species that states in the "fisheries footnote": "… one that drives a population down from the current population level to the historical extent of decline guideline (i.e. 5%–20% of baseline for exploited fish species), or is forecasted/projected to do so in the following 10 years." The footnote, which should be used by CITES Parties when considering commercially exploited aquatic species, also adds that a species could be considered for listing in Appendix II if it is near the extent of the decline guideline, where "near" means a precautionary range of 5%–10% more than that guideline.

3.4.1 | Review of assessments of species trends

In terms of referencing and interpreting the best available information for historical, recent and combination declines (Figure 1; Supplementary Section 6, Figure S2), the FAO Expert Panel report had higher scores than the proposals (Supplementary Section 4—regression model results). By contrast, the IUCN-TRAFFIC report and CITES advice were given similar scores to the proposals. This pattern was consistent for both shark species.

3.4.2 | Suggested strengths and recommendations

In general, the four assessment reports referenced a diverse range of available information on species trends from a wide range of ocean basins. Importantly, the generation time of *A. superciliosus* and *C. falciformis* is 17–25 and 12–19 years, respectively, depending on the method used to calculate generation time and population considered. Compared to other fishes, these generation times are long, potentially making a three-generation timeline of up to 50 years or more. The consensus across participants was that there is confusion in the interpretation of trends in historic and recent declines, and they requested that reports of declines clearly articulate how the information presented reflects CITES criteria. To paraphrase one participant: "… a standardised interpretation of 'historical population declines' [and] 'baseline levels' seems to be required…, as current definitions, and therefore interpretations by the different [assessments], seem ambiguous." In the case of hindcasting, this would assist in narrowing divergence in approaches on how to calculate the starting point of historic declines.

The confusion in the interpretation of historical extent and recent rate of decline for long-lived species would benefit from clearly articulated guidelines on how to approach the assessment, with most participants recommending further development of guidance on appropriate timescales and population baselines. Furthermore, most study participants noted the need for better advice on the hindcasting and forecasting of declines, with clearer references to how changes in effort, fishing regimes or reporting processes (and resulting data sets) can be considered. In the case of hindcasting, this was especially apparent in the divergence of advice on starting points in historic declines.

There was also a majority call for a more definitive evaluation of the quality of information used (76%), with additional guidance on how to define a better information quality index (e.g. establishing protocols for ranking data time series, as several Regional Fisheries Management Organizations do). In previous FAO Expert Panel reports, time series have also been given a quality ranking. Finally, there were a range of comments by most participants on how, when and to what extent the precautionary approach was or should be applied. Some study participants recognized precaution was required across the full range of social and biological issues, while most presented arguments to emphasize precautionary approaches for sharks alone. A single participant's response suggested that the burden of proof for not meeting the CITES criteria should rest with

the reviews (with a null hypothesis being that the species meets the criteria until proven otherwise), rather than the proponent being responsible for demonstrating that criteria are met (i.e. absence of evidence = evidence of absence; see Parsons, 2016; Parsons, MacPherson, & Villagomez, 2017). During the writing of the paper, most participants did not agree, but this sentiment is included to highlight the full range of participants' views.

Most participants considered that an important strength of the proposals was the range of source information in the arguments presented, with a few (n = 4) noting references to different ocean basins. One participant welcomed the clear tabulation of population trends for silky and thresher sharks. Regarding recommendations for improvements in the selection and interpretation of information, most participants highlighted problems with labelling, mislabelling, use of discredited or superseded assessments and, in 53% of participants' responses, the omission of relevant data. Some argued that proposals should indicate the types of information (e.g. catch, catch rates, size, stock assessments outputs, fishery-independent vs. fishery-dependent sources) used to draw conclusions regarding population trends, with one noting that estimates from formal stock assessments are considered a gold standard.

Most participants wanted proposals to identify clearly and discount outdated, species-grouped or non-peer-reviewed data. Most requested that if proponents were presenting information with high uncertainty and potential error, proponents should clearly mention the limitations of the information and the extent to which it was used to support arguments in regard to the criteria. For example, using mixed-species catch information or data at the family level to infer population trends for a single species requires a clear description of: (a) why information from one species can be extrapolated to another, or at least evidence for the association, and (b) the related uncertainty and limits of inference from such data (e.g. inferring population abundance shifts from catch trends; see Pauly, Hilborn, & Branch, 2013). In addition, changes in catchability and gear selectivity across amalgamated time series need to be highlighted, because amalgamating data from different times and/or catch methods limits the capacity for inferences. A few participants (n = 2) requested that proposals should identify how known biological and environmental factors could result in systematic bias or large variation in abundance estimates, including detectability, and document where such surveys were used to derive abundance time series. These types of clarifications were deemed essential to avoid misleading readers by overstating the representativeness of information.

Some examples of mislabelling, omissions and use of discredited information are given below: mislabelling occurred in the reporting of Beerkircher, Brown, and Lee (2002), who did not show a 70% decline for bigeye thresher in the northwest Atlantic, while Rice and Harley (2013) reported silky shark declines of 33% and not 67%, as misstated in the proposal. Another example was noted for Aires-da-Silva, Lennert-Cody, Maunder, and Roman-Verdesoto (2014) who explicitly stated that their assessment of silky sharks in the eastern Pacific was not yet complete, but proposal authors used this to justify a claim of "significant declines." In other cases, most participants noted omissions of positive information on the status of shark stocks. For example, Baum and Blanchard's (2010) study stated that thresher shark stocks might have been stable since 2000, but the proposal excluded this information from its table of population trends (see Conferences of Parties proposal 43: Table 2). Elsewhere Young et al. (2015) suggested that thresher sharks do not meet the CITES criteria, but the proposal authors omitted this conclusion. Some participants also identified omissions for studies emphasizing the high interannual variability in recent indices of abundance of silky shark, which supported the lack of a definitive trend (Carlson, Hale, Morgan, & Burgess, 2012; Rice, Tremlay-Boyer, Scott, Hare, & Tidd, 2015). Finally, most participants noted that proposal authors used discredited assessments (i.e. studies criticized for their methodology, subsequent conclusions inferred and subsampling of data sets) to present a case for the two shark species meeting the CITES listing criteria (e.g. Baum et al., 2003).

Most participants considered that the strengths of the FAO Expert Panel were the comprehensiveness of their assessments, up-to-date referencing and critical investigation of available information on population trends. A few (n = 2) also complimented the use of standard figures to describe declines. A particular plot conceived by Sarah Fowler (Save our Seas Foundation) and originally coded by Nicholas Dulvy (Simon Fraser University) was highlighted as a potential standard for communicating the range of decline information in future proposals and reviews for wide-ranging species (Figure 2; also see original in FAO, 2016: Figure S1, p. 17 and p. 32). Some participants' suggestions for improvements to the FAO Expert Panel's assessment included a more detailed explanation of why some of the information presented in the proposal was rejected. The sentiment is captured well in the following statement:

> For datasets not used, it would be helpful to suggest clearly reasons for why the data could present spurious results — not just that a statement that it did not reflect shifts in abundance[.]

This issue of not clearly explaining the accepted process in fisheries stock assessments—in other words, discounting low-value or high-uncertainty data—contributed to the accusation by one participant that the FAO Expert Panel report showed greater support for fishery viewpoints than conservation. Some participants recognized that additional assessments of fishery data done by the FAO Expert Panel offered fundamental differences among assessments. One participant suggested that there should be clearer guidelines on the role of FAO in completing additional analyses to support or refute a proposal, while two other participants suggested that this work made a strong positive contribution to the FAO Expert Panel report, notably by analysing and drawing conclusions from conflicting documents such as Baum and Myers (2004) versus Burgess et al. (2005).

A few participants (n = 4) commended IUCN-TRAFFIC's summary, which they considered a clear and concise evaluation of the

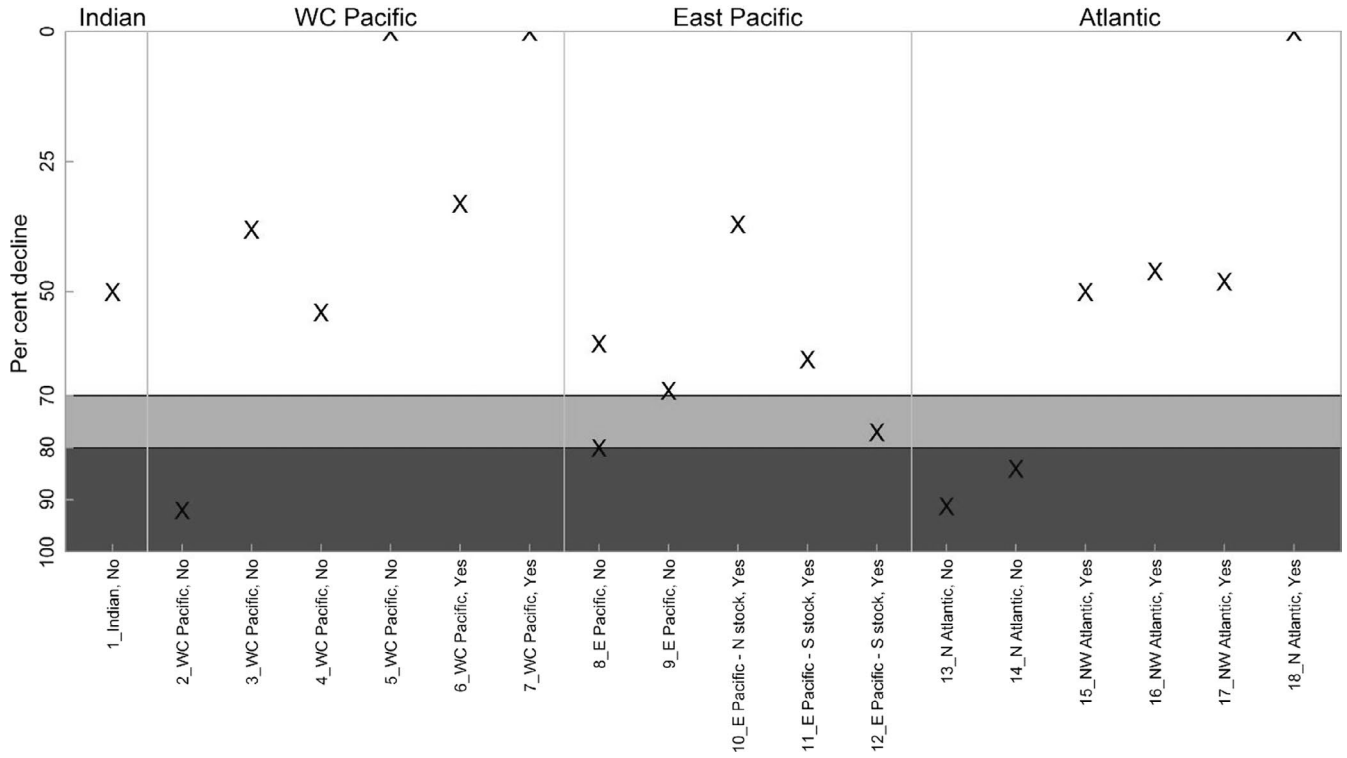

FIGURE 2 An example of a population decline plot from the Expert Panel report (FAO, 2016) that shows population relative to baseline for silky shark. The *x*-axis shows each individual data source. The light and dark grey horizontal shaded areas represent a decline from baseline of between 70% and 80% and >80%, respectively (see full CITES criteria description in footnote to Annex 5 of CITES, 2016a). On the *x*-axis, each data set is given a "Yes" or "No" qualifier to show whether it was used in the final Expert Panel assessment or not, and a further description is provided in a separate table of the report that notes the area and period of data coverage, the fishery indicator used, the extent of decline and literature reference for each numbered data source. This table also shows which data sets offer the best available information for use in the final assessment of population declines

limitations of data presented in proposals. Suggested improvements by most participants included the need to support decline statements with references, and the distinction between historic extent and recent rates of decline when discussing population trends. They recommended a more detailed assessment of historic and recent trends, and the combination of the two. For example, for the eastern Pacific silky shark, IUCN-TRAFFIC drew conclusions of declines based on data from 1994 to 2013 that did not include baselines because fishing exploitation had started in the 1950s. A small number of participants requested that report authors specify whether the catch per unit of effort series was nominal or standardized, as that would help to weigh up the different pieces of evidence presented. Most participants noted that more condensed reporting and broad statements made about declines overlooked some of the complexity in the discussion—both spatially and through time.

The CITES advice presented a description of decline information, including newly published information and noting the uncertainty associated with determining population declines. Because of the succinctness of the CITES advice, and little-to-no referencing of statements against the specific decline criteria, study participants suggested that a more detailed assessment is needed on how the Secretariat's advice is formulated.

3.5 | "Other factors" that influence extinction risk

3.5.1 | Review of other factors influencing extinction risk

The FAO Expert Panel report, IUCN-TRAFFIC assessment and CITES advice had lower scores than the proposals (Figure 1; Supplementary Section 6, Figure S3). However, some study participants noted that the term "other factors" is too vague to ask proponents or other assessment processes to define, recommending that the criteria and related advice should make unequivocally clear what can be considered in this category and how it should be scored.

3.5.2 | Suggested strengths and recommendations

Most study participants recognized the generally comprehensive overview provided by the proponents of the other factors that increase extinction risk (e.g. climate change, unreported catches globally, unknown mortality of live discards, aggregating behaviour, management-compliance issues), with a few (n = 3) pointing out that there was no mention of potentially positive or mitigating factors such as the binding measures

adopted by fishery managers (e.g. Regional Fisheries Management Organizations). For the FAO Expert Panel, IUCN-TRAFFIC and CITES advice, these assessments and recommendations were succinct or—in the case of CITES advice—absent, and most participants recommended providing additional information. Specifically, some participants suggested that by-catch issues and species behaviour should be considered. Additional examples were given, such as the behaviour of thresher sharks in stunning their prey in nets and subsequently becoming entangled themselves, which potentially increases their mortality risk.

3.6 | Communication

3.6.1 | Review of communication of information

The IUCN-TRAFFIC and CITES advice had lower scores than the proposals on the effective communication of the assessments made, and the relevance of the assessment for conservation. FAO scores were similar to those from proposals (Figure 1; Supplementary Section 6, Figure S4; Supplementary Section 5 for regression model results).

3.6.2 | Suggested strengths and recommendations

Only a few participants (n = 4) stated that the communication of the assessment and its relevance for conservation effectiveness was adequate across all assessment reports. Some participants requested the modification of the proposal format to address each of the CITES criteria more clearly, with separate sections corresponding to each of the criterion's elements. This information not being provided by the proposal authors, along with subsequent review assessments on how data and information relate to the CITES criteria—including potential strengths and weaknesses of the supporting information—was seen as a shortcoming.

For proposals, a few participants (n = 4) recommended using objective/impartial rather than emotive language, as well as including a dedicated section where the likely conservation effectiveness of a CITES listing could be discussed. At present, this is only a requirement outlined in the FAO instructions on their expert assessment (FAO, 2016). This could include factors influencing effectiveness (e.g. increase in enforcement issues, potential decline in subsequent fishery data quality, unwanted closure of fisheries, problems with the cross-border transport of biological samples for research purposes, logistical challenges in monitoring international trade, potential empowering of illegal trade) and means of mitigating misconceived public expectation that listing is the sole solution for management and conservation for these marine species. Some of these issues reflect those reported by Friedman, Gabriel, et al. (2018a) in an assessment of management progress following previous shark and ray CITES listings, which noted countries had difficulty in completing the provisions of CITES to allow legal trade.

For the FAO Expert Panel, a few participants (n = 3) recommended using simpler language because the technical complexity made the FAO report difficult to understand for non-experts. Most participants also recommended that the IUCN-TRAFFIC and CITES reports could be improved by providing explicit information for each element of the CITES criteria. Although not an instruction from CITES Parties, some participants requested the inclusion of analyses of the likely conservation effectiveness of a CITES listing which makes up part of the FAO Expert Panel's terms of reference (FAO, 2016). One participant highlighted some of the practicalities of accessing these reports, stating that the FAO Expert Panel report was not as easy to find on the CITES webpage as the CITES species proposals submitted by CITES Parties.

3.7 | Participant scores based on reviewers' nominal affiliations

We assessed the variance in responses between fisheries and mixed-focus study participants (Table 2), with the former scoring questions on the strengths of the various processes lower than the other study participants (Figure 3). This reflects more conservative scoring by study participants with a fisheries background, who were more critical of elements across the four different assessment/advice reports. This differential in scoring was most evident for parts of the process where statements were not supported by evidence (see example of authorship scoring above), or when fisheries study participants noted assessments that relied on outdated or discredited information.

4 | DISCUSSION

The struggle to negotiate common positions between communities involved in natural resource management and biodiversity conservation is perennial (Akçakaya et al., 2000; Biggs et al., 2017; Boakes, Fuller, McGowan, & Mace, 2016; Campbell, 2012; Carlson et al., 2017; CEE, 2018; Cochrane, 2008, 2015; Cvitanovic et al., 2015; Del Monte-Luna et al., 2007; Levin, 1992; Mace, O'Criodain, Rice, & Sant, 2014). In many cases, such policy discussion is informed by science (Adams & Sandbrook, 2013; Cooke et al., 2017; Pullin & Knight, 2012; Walsh et al., 2015), while others highlight deficiencies in enquiry, translation and uptake of science (Bauer, Nowell, Sillero-Zubiri, & Macdonald, 2018; Cook, Hockings, & Carter, 2010; Pullin, Knight, Stone, & Chapman, 2004; Roberts, Stewart, & Pullin, 2006).

The conversation on how best to approach the management and conservation of vulnerable sharks and rays is a globally recognized challenge (Clarke, 2013; Dulvy et al., 2017; Shiffman, 2016; Ward-Paige, Keith, Worm, & Lotze, 2012), and part of a wider discussion on the state of global fisheries (Pauly, Christensen, Dlasgaard, Froese, & Torres, 1998; Myers & Worm, 2003; Worm et al., 2006; vs. Hampton, Sibert, Kleiber, Maunder, & Harley, 2005; Hilborn, 2006; Murawski, Methot, & Tromble, 2007). While the scientific debate appears to be based on highly technical arguments to non-experts, contrasting positions seem essentially to be the result of different judgements applied by scientists from different disciplinary backgrounds regarding the appropriate data and methods to use to quantify the state of global fisheries (Mace & Hudson, 1999; Stokstad, 2009).

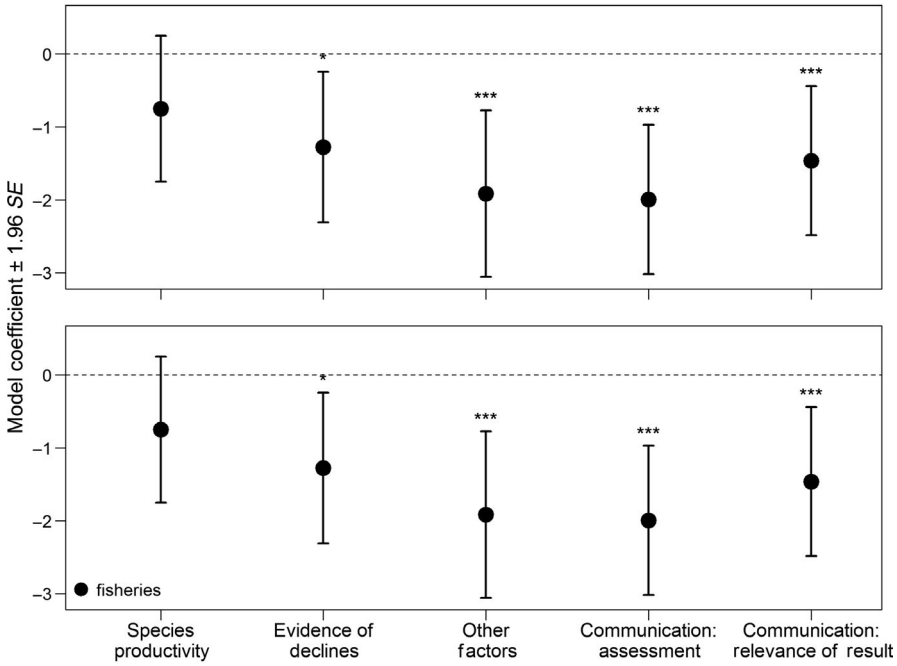

FIGURE 3 Summary (mean ± 1.96 SE) of ordinal logistic regressions for silky (top pane) and thresher (bottom pane) sharks. Coefficients for fisheries focused study participants (n = 10) relative to participants with a broader or environmental focus, indicated as the baseline dotted line (n = 7). Significance notation: * (.01 < p<.05); *** (p < .001)

Our study and that of Braccini (2016) both concluded that there are different perceptions of the status and management potential of sharks between experts with a fisheries background and those from other fields, which suggests an ongoing communication gap in the debate. This divide is observed across analogous situations where there are opposing interests between commercial and non-commercial foci (e.g. the forestry–forest ecology divide or the wildlife hunting–protection divide). We can also learn from how information review has improved in other fields, such as Cochrane's systematic reviews in medicine that adhere to formal, structured rules to minimize bias (Adams & Sandbrook, 2013; Higgins & Green, 2011; Roberts et al., 2006).

In a survey of a broad range of professional shark and ray researchers, Shiffman and Hammerschlag (2016) revealed disparity and polarizing positions across such a divide, and raised concerns that some environmental NGOs used incorrect information and focused on problems that were not considered central to achieving better management (see also Clarke, 2016; Friedrich, Jefferson, & Glegg, 2014; Naylor & Parsons, 2018). These studies noted the need for closer communication between the scientific and environmental communities to recognize and reconcile their differing values and objectives. Given the fundamentally different viewpoints across these communities based on their perceptions of the vulnerability of species, it is promising to observe counterexamples where the two sides are working well together to achieve conservation outcomes that support sustainable use of natural resources—one example is a discussion of the merits of trophy hunting in Africa (Di Minin, Leader-Williams, & Bradshaw, 2016) and there is even one example for the fishing of sharks (Simpfendorfer & Dulvy, 2017).

CITES aquatic species proposals were the starting point for our review to gauge how species proposed for CITES listing should be assessed. When evidence is presented objectively, comprehensively and transparently against the CITES criteria, CITES Parties have the best opportunity to advance progressive management (Gough, Oliver, & Thomas, 2012; O'Leary et al., 2016). The mandate of the FAO Expert Panel, like the other assessments of proposals, concentrates on implementing the assessment in accordance with the CITES biological listing criteria. However, importantly the FAO Expert Panel is also mandated by its Member States to "… comment, as appropriate, on […] trade and management issues, as well as, to the extent possible, the likely effectiveness for conservation." These inputs are intended to ensure that trade and management considerations are also considered by those receiving the FAO advice, to support them in making listing decisions.

Evidence that a species meets CITES criteria identifies that management could potentially be assisted through the implementation of additional international trade regulations (Challender, Harrop, & MacMillan, 2015; Friedman, Gabriel, et al., 2018a; Kuo & Vincent, 2018; OECD, 2000; Schonfeld, 1985). Alternatively, if evidence is absent, based on erroneous information, or does not consider market realities, additional regulation can and has been shown to be less effective for overall conservation outcomes (Cochrane, 2015; Tolotti et al., 2015). In these cases, additional governance might not be required, or viewed as onerous, and come potentially at the expense of delivering normative fisheries management (Clarke, Manarangi-Trott, & Brouwer, 2014; Friedman, Gabriel, et al., 2018a; Mathews, 1996). In other situations, it can result in displaced and/or illegal trade and enforcement issues (McOmber, 2002; Nijman, 2015,

2017; Purcell, Polidoro, Hamel, Gamboa, & Mercier, 2014; Shiffman & Hueter, 2017), or paradoxically stimulate greater demand, for example, by leading to higher prices (Challender et al., 2015; Foster, Kuo, Wan, & Vincent, 2019; Naylor & Parsons, 2018).

Participants who reviewed the proposals in our study suggested that the chain of discussion from building proposals to arguing their merits has many strengths overall, but they also recommended as many improvements. Noting that different disciplines and communities of practice come with preconceived biases, how can the process for CITES listing simultaneously incorporate vigorous debate about the status of vulnerable species while ensuring that such discussions are not derailed by an expert's use of heuristics (i.e. decision shortcuts) and cognitive biases that can lead to polarized, sensationalized and/or politicized interactions (Guston, 2004; Heeren et al., 2016; Hilborn, 2006; Kloor, 2015; O'Bryhim & Parsons, 2015)?

Based on the results of this study, we have several suggestions for developing reliable and informative advice on proposals:

1. Approaches should be multidisciplinary and inclusive: assessment reports benefit from receiving broad participation from both commercial and environmental sectors. Using certified professionals from a range of expert communities will help to counter accusations of confirmation and selection bias (Cvitanovic et al., 2015; Hanich et al., 2018; Pullin & Knight, 2012). Similarly, transparency in the identity of publication authors offers readers an opportunity to assess the source of the guidance more effectively.
2. Evidence and arguments should focus on the CITES listing criteria (elements and thresholds). Data describing the long-term extent of decline, short-term rate of decline and their combination were contentious among the proposals and three assessments. There needs to be more agreement and cooperation on the rules for analysing and reporting these elements in relation to the CITES criteria. It is vital that the overall objectivity, transparency and comprehensiveness of the methodological framework are improved (O'Leary et al., 2016), especially because there are still differences in opinion regarding the interpretation of the criteria for "decline" and "reduce" for species proposed under both Annex 2a, paragraph A and paragraph B (CITES, 2016a), and potentially in the use of the fisheries footnote (see CITES, 2007a; FAO, 2002, 2007, 2011). Cochrane (2015) provided a clear description of how the listing criteria applied by CITES in 1997 were reviewed and then revised in Bangkok, Thailand, in 2004. Cochrane's paper included an in-depth discussion of issues related to different interpretations of the listing criteria, specifically Annex 2aB (CITES, 2007b), which remains a potential hurdle to achieving consensus among communities of practice (this difference in interpretation of the CITES criteria was not necessarily a complicating factor on this occasion because both shark species were proposed under Annex 2a paragraph A).
3. There needs to be a comprehensive and critical examination of the best-quality information. Synthesizing data while acknowledging bias and limitations transparently would be welcomed by end-users (Cooke, 2019; Dicks et al., 2017, 2014). This approach is fundamental to the process, but decisions by assessment authors about whether to include or exclude data will always include some subjectivity, thus affecting the determination of a species' status. Transparent weighting of the evidence with respect to the methodology employed, and its spatial and temporal relevance, should therefore be documented, noting the associated uncertainty in each case (Bolam et al., 2018; Stirling, 2010). This includes documenting where and how precautionary approaches were considered and adopted into the selection, analysis and reporting of information (Garcia, 1993). This should articulate how the principle of preventing "irreversible damage," as enshrined in the 1992 Rio Declaration (Principle 15), is relevant, or what other precautions are being considered. Descriptions on how information was considered not only offer an audit trail for parallel enquiry, but also allow retrospective scrutiny and traceability of the advice given (Haddaway, Land, & Macura, 2017).
4. There is currently no standardized, joint-reporting framework or harmonization in the terminology employed, with the result that arguments delivered by proposals and review assessments are not necessarily comparable. Formalizing the standardized and streamlined collation of information and assessments, and their subsequent communication, would alleviate much of the confusion and potential biases. This is common practice in other fields, notably medicine (Roberts et al., 2006) and climate change reporting (Herrando-Pérez, Bradshaw, Lewandowsky, & Vieites, 2019), but would require better cooperation among fishery and environmental agencies, and decisions by the governing body, in this case, CITES.
5. The FAO Expert Panel report, IUCN-TRAFFIC assessment and CITES advice are in themselves independent reviews of the proposals. However, if conflicting advice continues to emerge as to the question of a species meeting the CITES criteria, a further independent review should be encouraged to ensure that discredited, superseded or misleading information within assessments is removed prior to publication—or critical information that has been omitted can be added—and thus limit unchallenged bias. We acknowledge that this is a challenge considering the limited time available for assessments; however, such a "review of a review" could be completed quickly to highlight where arguments at the crux of differences between assessments might rely on weak foundations.
6. Under the current regime, the time constraints for reviews and adequate consideration can limit discussion, so longer periods of assessment, review, rebuttal and overview could enhance the opportunity for decision-makers to come to well-informed decisions. Such time is required not just for consideration of the species information against the CITES criteria but also the likely implication of CITES listing, so that legal and sustainable trade is not unduly disrupted, and CITES Parties are prepared to implement CITES provisions.

5 | CONCLUSIONS

Rethinking and refining how we develop, analyse, review and share determinations in international processes is essential for the effective management and conservation of marine species. The United Nations Foresight report ranked "Reconnecting Science to Policy" as number 4 of 21 top challenges for sustainability in the 21st Century (UNEP, 2012). Some difference between different communities of practice, based on reviews of similar or identical information, is not uncommon (Biber, 2012) and can result in conflicting conclusions about the state of the world and the need for policy intervention. Such a divergence in views was observed among the proposals' proponents, the FAO Expert Panel report, the IUCN–TRAFFIC assessment and CITES advice, and also across our study's participants reflecting their backgrounds and main areas of expertise. While consideration of the full array of assumptions, inferences and interpretations is welcomed in the robust assessment of risk (Guston, 2004), there is also a danger of reinforcing entrenched viewpoints without reaching consensus.

Where the current process delivers polarized conclusions through sector-focused approaches (i.e. by separating arguments into a simplistic diametric), social coherence within like-minded groups ("groupthink") is strengthened, but at the expense of reaching decisions that enable practical actions that require cooperation across communities. There is therefore a need to improve the advisory processes, which means, in science as elsewhere, creating systems and practices that fully incorporate principles of inclusivity, transparency and accountability, and thus facilitating critical enquiry from a wide range of differing viewpoints (Adams & Sandbrook, 2013; Cook, Carter, Fuller, & Hockings, 2012). This approach can convert incomplete data into consensus determinations that are aligned with the CITES criteria. In addition to our main technical suggestions listed above, the study participants highlighted three consolidated recommendations in particular:

1. Promoting participatory approaches with independent oversight. Merging groups involved within the CITES Appendix amendment process across communities of practice could limit compartmentalization and help to counter confirmation bias (Addison, Flander, & Cook, 2017; Chamberlin, 1965; Haidt, 2012). More participatory processes would improve two-way communication (Cooke, 2019; Dick, Rous, Nguyen, & Cooke, 2016; Halle & Hill, 2009; Hulme, 2011) and ensure that a diverse range of problem solvers are part of the discussion (Bednarek et al., 2018; Cohen, James, & Olsen, 1972). Thomas and Pletscher (2000) described such a process with the analogy of several streams being forced to merge into a single, broad river channel, bringing diverse, intrasectoral to cross-sectoral approaches to building of consensus. Promisingly, some of this convergence is already taking place with fisheries internalizing globally recognized assessment frameworks into their policies, legislation and practices for governing sustainable use and conservation of marine species, while the biodiversity conservation-focused community has adopted sustainable use policies that emphasize an inclusive approach, formally recognizing the long-term value of "sustainable" and "beneficial" use of biodiversity that provides economic incentives for better custodianship of species or habitats. These current visions, where fisheries practise broader ecosystem approaches and biodiversity conservation embraces utilitarian values of nature, when sustainable, have increased practical opportunities for cross-sectoral collaboration (see Friedman, Garcia, & Rice, 2018b; Garcia et al., 2014; Juan-Jordá, Murua, Arrizabalaga, Dulvy, & Restrepo, 2017). Building relationships and processes further across sectors would benefit from starting well before questions on the CITES listing are reviewed, because it takes time to develop trust (Bigley & Pearce, 1996; McEvily, Perrone, & Zaheer, 2003). Independent oversight through peer review must be done by qualified, independent professionals with no conflicts of interest (Rice, 2011). In the case of doing reviews of reviews across advice originating within the CITES listing process, an independent assessment of advice would only be needed if there was conflicting advice originating from across expert sources of information.
2. Use the best-available information, clearly describing the assessment within a structured decision framework. Determining how information and data reflect CITES criteria requires clear and cross-sectoral understanding of the "rules" of the assessment process; it benefits from a transparent description of, and a clear rationale for, the factors considered when making a final decision (Van Putten, Cvitanovic, Fulton, Lacey, & Kelly, 2018; Woodcock, Pullin, & Kaiser, 2014). Recognizing that there is often a data deficit, better rules are needed for the quantification of small-scale, illegal unreported and undocumented exploitation, their magnitude and impact (Gregory, Arvai, & Gerber, 2013). Without greater transparency of decision-making (what was done, what was left out and why?), it is difficult to verify conclusions or distinguish facts from policy-laden assumptions, inferences or interpretations. To help authors and reviewers, we need the process to (a) have access to the full range of information, (b) identify uncertainty, (c) explain how uncertainty is resolved, and (d) clarify what, if any, value choices were included in the decision (see Addison et al., 2018, for descriptions of epistemic, linguistic and decision-making uncertainty). Sharing such information means that conclusions can be verified, thus helping to build public trust and lead to accepted, effective and enduring management (König & Jucks, 2019).
3. Deliver timely, consolidated advice to CITES Parties. Despite fishery and environment sectors having congruent or at least complementary mission statements, collaborative formulation and presentation of information across the CITES Appendix amendment process is still in its infancy. As a reader's attention span is a valuable commodity, one or two assessments provide a useful and practical input for busy government officials without a technical background, whereas four or more can result in information overload (Daniel Kachelriess, CITES Marine Species

Officer, personal communication; Cochrane & Doulman, 2005). To design communication that is relevant for reaching and influencing stakeholders (Jones, Keane, St John, Vickery, & Papworth, 2018), the presentation would benefit from greater cooperation among United Nations and related international agencies. The delivery of this information also needs sufficient time for discussion on the meaning of its technical and scientific content (similarly proposed by IUCN for reforming their role; Stuart et al., 2017), and there is a precedent for extending the CITES consultation periods: for example, 330 days of notification is required prior to voting of down-listing amendments for crocodilians (CITES, 2009).

Maintaining the biodiversity of natural systems is *prima facie* as much a primary concern of fisheries—in terms of food security, livelihoods and culture—as it is a cornerstone of environmental conservation. Agreeing on the risk to a species can be answered by science, whereas the answer to the question "What risk is acceptable?" can be considered more an ethical or policy decision that needs clear guidance from decision frameworks. There has been progress in the last two CITES Conference of Parties, where from the 15 proposals tabled for commercially exploited aquatic species, the use of the CITES criteria by the various assessment groups resulted in only a single difference (silky shark *C. falciformis*) in determinations between FAO, IUCN-TRAFFIC and the CITES Secretariat (Table 1). TRAFFIC's separate recommendations to accept the proposal for bigeye thresher shark *A. superciliosus* represented another departure from consensus (TRAFFIC, 2016). Despite these inconsistencies, the increasing agreement across outcomes through time, as shown in Table 1, is an indication that our conversations are converging, which suggests that CITES Parties are now receiving clearer advice that is less-conflicting.

What CITES Parties decide after receiving advice is a sovereign decision, and we recognize that implementing any listing and related fishery management is the real hurdle for achieving conservation for marine species. However, we hope that this study and its resulting suggestions offer guidance to countries, enhancing communication across sectors and United Nations agency processes, and delivering the decisional support needed by CITES Parties to overcome the first hurdle in the CITES listing process—that of assessing the need and merits for listing a species in the first place.

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DATA AVAILABILITY STATEMENT

Data used in the writing of this paper are held by FAO and are available from corresponding author. The data that support the findings of this study are available from the corresponding author(s) upon reasonable request.

ORCID

Kim Friedman https://orcid.org/0000-0002-4002-6585
Corey J. A. Bradshaw https://orcid.org/0000-0002-5328-7741
Rui Coelho https://orcid.org/0000-0003-3813-5157

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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