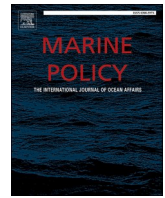


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## Toward transparent governance of transboundary fisheries: The case of Pacific tuna transshipment

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## ABSTRACT

Transparency is one of the most influential themes in global environmental governance, however it has received limited treatment in transboundary fisheries. Transparency is essential to ensure officials are held accountable for the use of public resources and the achievement of environmental objectives, such as sustainable harvest. Here, we use a case study approach to assess transparency in transboundary fisheries governance, evaluating transshipment in the Western and Central Pacific Ocean, one of the world's most abundant and lucrative fisheries. Transshipment at sea occurs extensively in these fisheries, but often lacks strong monitoring and oversight, and has been associated with illegal or illicit activities. However, actors that rely heavily on transshipment at sea maintain that it can be a legitimate part of the fish commodity chain, under effective regulation. Here we assess whether at-sea transshipment in one of the most regulated and visible fisheries in the world is traceable, verifiable, and legal. Using AIS data and qualitative information from regional and sub-regional sources, we find that 68% of observed potential transshipments remain unsubstantiated even after triangulating with diverse data. We identify three primary areas for improving traceability and transparency of transshipment at sea in the WCPO, and suggest that transparency is ultimately hindered less by technical or administrative constraints, but by tensions between the actors and objectives within management institutions. Increased transparency, and a focus on the underlying dynamics that inhibit it, is necessary to ensure effective conservation and management of transboundary fish stocks, now and in the future.

### 1. Introduction

The notion of transparency has been one of the most influential themes in emerging global environmental governance in the last few decades [1,2]. Its growing importance as an analytical lens, normative standard, and policy tool are evident in right-to-know laws, open government data programs, and vocal calls for the increasing availability of public information emanating from public and private actors alike [3–6]. Transparency takes many shapes, but perhaps the most frequently cited definition is that transparency is “the degree to which information is available to outsiders that enables them to have informed voice in decisions and/or to assess the decisions made by insiders” [7]. Taking this definition, transparency has three constitutive parts: it is about the *availability and flow of information*, however it is also fundamentally

about *to whom* that information flows and *for what purposes*. As Mason states, “transparency in governance is always relational: it is invoked to support other, more primary, social purposes and values” [8]. While a diversity of purposes and values may be supported by increased transparency [3,9], the most evident and most closely related to functions of governance is that of accountability. In environmental governance, accountability is conceived of as the obligation for public officials to disclose the use of public resources, and their answerability to the public to meet certain stated objectives, usually pertaining to environmental processes and outcomes [4,10]. Presumably, transparency facilitates accountability by providing sufficient information to enable greater scrutiny of “political and economic power-wielders” by outsiders and the less empowered [8]. This informational base is critically important, as it is the necessary foundation for all subsequent functions of

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transparency, such as equity, legitimacy, and accountability.

Substantial literature promotes the importance of transparency in the governance of diverse systems such as human rights, social media, security, monetary policy, and corporate governance [9,11–13]. Within environmental governance, transparency has become widely accepted as an essential component in the governance of many industries such as forestry, agriculture, and mining [11,14]. However, the concept has received limited treatment in the realm of transboundary fisheries [9]. Transboundary fisheries are complex resource systems involving diverse actors spanning multiple jurisdictions and requiring intensive resources to manage; thus, they are particularly important systems in which to consider the role of transparency. The primary institutions with a mandate to manage transboundary fisheries are Regional Fisheries Management Organizations (RFMOs), whose stated objectives are to “ensure effective conservation and management” of fish stocks [15]. However, RFMOs have historically come under criticism for their opacity [9,16]. In fact, the 2012 Sustainable Fisheries Resolution of the United Nations General Assembly stated that it “urges regional fisheries management organizations and arrangements to improve transparency and to ensure that their decision-making processes are fair and transparent” [17]. Here, we use a case study approach to assess transparency in transboundary fisheries governance by evaluating the degree to which the public—broadly construed as those outside the membership or governing structure of the RFMO—has sufficient information to hold RFMOs accountable.

Some of the most abundant and lucrative transboundary fisheries in the world are tuna fisheries [18]. Further, the largest tuna fishery in the world is in the Western and Central Pacific Ocean, accounting for more than half of global tuna catches and more than \$22 billion at final point of sale [19,20]. The Western and Central Pacific Fisheries Commission (WCPFC) is the RFMO charged with managing these fisheries, and is often considered to exercise the best policy practices of any tuna RFMO [21,22]. Here we evaluate transparency in the WCPFC as it relates to tuna transshipment, which the WCPFC Convention defines as “the unloading of all or any of the fish on board a fishing vessel to another fishing vessel either at sea or in port” [23](Article 1 h). At-sea transshipment occurs extensively in the Western and Central Pacific tuna fisheries; as of July 2019, WCPFC received reports for 7561 high seas transshipment events since June 2010 when their management measure on transshipment was first implemented. The numbers of reported high seas events have also increased annually with 1092 events reported in 2017 [41]. This activity occurs especially in the tropical region for species of albacore, bigeye, and yellowfin—enabling fishing vessels to remain at sea on the fishing grounds for longer periods of time, thereby reducing operating costs and maximizing fishing opportunities [24]. In-port transshipment is primarily conducted by carrier vessels at designated anchorages in States’ territorial waters, but also occurs at sea in the Exclusive Economic Zones (EEZs) of some coastal States [25]. When these events occur in the Western and Central Pacific, they are subject to the rules and regulations of the port or coastal State in which it occurs [26]. However, at-sea transshipment is oftentimes conducted on the high seas far from shore, with limited monitoring and oversight [24, 25]. As such, transshipment at sea has frequently been associated with illegal or illicit activities, such as fish and money laundering, trade of illicit commodities (e.g. drug or wildlife trafficking), labor violations, and illegal, unregulated, and unreported (IUU) fishing [27–29]. Where illegal activity is *not* associated, transshipment at sea still oftentimes obscures the origins and destinations of fish commodities, inhibiting efforts to improve sustainability, traceability, and transparency in fishing practices [24,30]. However, while this practice is often problematic, governments and fishing enterprises that rely heavily on transshipment at sea maintain that where transshipment is regulated, it can operate as a legitimate part of the fish commodity chain [31]. The importance of transshipment in the WCPFC is underlined by the recent establishment of a working group, and allocation of substantial resources, toward the review transshipment policies [32].

With this study, we seek to evaluate transparency in transboundary fisheries governance using the case study of transshipment in the Western and Central Pacific Ocean. We evaluate the degree to which the public has sufficient information to assess whether regulated at-sea transshipment is traceable, verifiable, and legal. To answer this question, we considered the most highly regulated and visible subsector within the tuna RFMO considered to exercise best practices [21,22]: the purse seine fishery in the primary tropical tuna waters in the WCPFC convention area. We considered this fishery to be the most highly regulated because of its requirements for 100% coverage by the WCPFC vessel monitoring system (VMS) [33], 100% observer coverage on all purse seine fishing vessels [34], 100% at-sea observer coverage for carrier vessels, prohibition on at-sea transshipment (with limited exemptions) [26], and high levels of automatic identification system (AIS) coverage relative to other fleets. Though limited in scope, our aim in using this “best practices” case is to suggest that findings are likely representative of transparency practices in transboundary fisheries more broadly. The purpose of this study is first to assess whether highly regulated at-sea transshipment in the Western and Central Pacific Ocean is in fact transparent and traceable to “outsiders” [7]. As mentioned above, this is a necessary first step to evaluating the ultimate purposes of transparency, including legitimacy and accountability. Second, we identify gaps in the current monitoring and regulation of transshipment at sea, and provide recommendations to address those gaps. Finally, we discuss the implications of this study and the importance of improving transparency and accountability for transboundary fisheries management.

## 2. Methods

Multiple high quality data sources are available to the WCPFC Commission, as well as member States, to enable them to evaluate whether transshipment has been conducted in compliance with rules and regulations. Specifically, the WCPFC VMS tracks the locations and identities of all vessels registered within the WCPFC. The transshipment declarations, annual reports, and observer reports further detail aspects of transshipment, including vessels, gears, quantities of product transshipped, date, locations, and more [26]. However, data sharing rules within the RFMO prohibit the public sharing of these data, and they are only available to the Commission and member States under various restrictions [35]. WCPFC information that is public domain includes the Record of Fishing Vessels, which specifies any exemptions for purse seine transshipment in EEZs.

As such, this study was primarily conducted using public AIS data obtained from Global Fishing Watch [36,37]. Since WCPFC spatial and temporal data on the occurrence of specific transshipment events is not publicly available, this study focuses on AIS-observed encounters at sea between purse seine vessels and refrigerated cargo vessels (i.e., reefers) [38]. An AIS encounter, or potential transshipment, is defined as any occurrence in which a reefer and a purse seine vessel are fewer than 500 m from each other for more than 2 h, while located more than 10 km from any port [38]. Although transshipment is known to occur between two fishing vessels, encounters between all other vessel types are omitted to ensure a conservative estimate of purse seine transshipments. Further, in order to target the primary tropical tuna fishing grounds, and omit other target species within the WCPFC area of competence, the study area was defined as the WCPFC convention area between 30°N and 30°S latitude. A temporal range of 2014–2017 was chosen, as authors were not able to obtain verification of encounters for 2018–2019 from subregional organizations (e.g. PNA), and it was not possible to include years prior to 2014 due to AIS data limitations.

## 3. Results and discussion

Assessing encounters at sea between purse seiners and reefers, 77 potential transshipments were identified between 28 unique reefers, and

39 unique purse seine vessels (Fig. 1). The distribution of these encounters increased from year to year, likely due in large part to AIS data improvements within the Global Fishing Watch platform (e.g. 10 encounters in 2014, 14 in 2015, 25 in 2016, 28 in 2017) [39]. These 77 encounters occurred in eight different EEZs (n = 72) as well as on the high seas (n = 5) (Fig. 2) (Fig. 3). The most frequent flag states to encounter each other included Panama-flagged reefers with Papua New Guinea-flagged purse seiners (n = 13), Korea-flagged reefers with Korea-flagged purse seiners (n = 11), and Korea-flagged reefers with Kiribati-flagged purse seiners (n = 10) (Fig. 1). The primary reefer flag states involved in these encounters included Panama (n = 33), Korea (n = 23), and Vanuatu (n = 16), two of which (Panama and Vanuatu) are considered open registry, or “flags of convenience” States, with notably lax oversight [40]. Despite the limited number of encounters, distinct spatial trends emerge in the encounter behavior of flag-based fleets (Fig. 2). For example, encounters with Korean-flagged fishing vessels occur throughout the range of the Western and Central Pacific tropical tuna waters, whereas US and Taiwanese-flagged fishing vessel encounters are more concentrated in the Western part, and the high seas encounters are almost strictly attributed to fishing vessels flagged to Kiribati.

AIS data provides an opportunity to analyze encounter behavior of vessels at sea in an open-source, transparent way, unmediated by any specific governing body (e.g. state or RFMO-based data). However, the details and resolution of AIS are not equal to that of the VMS data collected and used within WCPFC. AIS data is currently constrained by technical and regulatory limitations that could lead to false assumptions, and requires further data or analysis to corroborate (Table 1). First, AIS is currently only internationally required by the International Maritime Organization (IMO) on vessels over 300 gross tons undertaking international voyages [41]. Many vessels licensed within the Western and Central Pacific are under this size requirement, and since international voyages are defined as those in which a vessel embarks from one port and lands in the port of another country [42], transshipment at sea is by nature a means of avoiding this designation, if primarily for the economic reasons of reducing costs. Additionally, fishing vessels are specifically exempt from these regulations within the IMO Safety of Life at Sea (SOLAS) Convention [43]. For these regulatory reasons, it is highly likely that a large number of encounters are not detected because one or both vessels do not broadcast AIS (Table 1, AIS limitation 1 and 2).

Second, the practice of transshipping between fishing vessels—which are usually smaller in size than refrigerated cargo vessels, and thus under the IMO size requirement—is widely acknowledged in the Pacific [44], increasing the potential for undetected transshipment between vessels not requiring AIS (Table 1, AIS limitation 1). A third limitation potentially resulting in the underestimation of transshipment at sea is the fact that AIS is not tamper-proof, and individual vessels may alter their identities and locations, or turn off their AIS transponders (Table 1, AIS limitation 3). This represents a potential violation of existing international or even national AIS regulations, and may prevent detection specifically of illegal behaviors.

The three limitations above represent possible false negatives, leading to an *underestimation* of transshipment at sea. The solutions to most of these limitations are regulatory in nature, and relate to overall AIS adoption and oversight (Table 1). However, as a remotely sensed data source, AIS also has the potential to create false positive errors, over-identifying diverse encounters at sea as transshipment of fish. These potential false positives may lead to the *overestimation* of transshipment at sea, and need to be triangulated with other qualitative and non-remotely sensed data to understand specific on-vessel activities.

To reduce the potential for overestimation, we sought to triangulate results with regional and national observer data (Fig. 3). On the regional level, ideal data sources included WCPFC VMS data, annual reports, and observer reports, however, as previously mentioned, these are not considered public domain by the WCPFC. According to the 2007 WCPFC Data Rules, WCPFC VMS data is not available to third parties, and would require approval from all members, cooperating non-members and participating territories (collectively, CCMs) to obtain the data [35]. Considering the high resolution required to triangulate findings (e.g. vessel flag states, dates, times, etc.) and low likelihood of unanimous approval (e.g. to the authors’ knowledge, this data has never been granted to non-members) [45], WCPFC VMS data was considered infeasible for the purpose of this study and for overall third-party assessment of traceability, verifiability, and legality. WCPFC Annual reports were also explored to verify these encounters, however the Annual Report on Transshipping published by the Secretariat only covers high seas transshipments as reported by longliners and carriers, with a resolution of flag state rather than vessel. Furthermore, CCM Annual Report Part 1 demonstrated inconsistent to non-existent data on carrier vessels, with only occasional reports for transshipment in port [30]. Without at-sea transshipment information including purse seine vessels, annual report information was also deemed ineffective for triangulating AIS results. The last regional source of data with the potential to elucidate the nature of these encounters at sea was WCPFC observer data. However, while the Conservation and Management Measure (CMM) on Regulation of Transshipment requires that observers be on all carriers to observe high seas transshipments, there is no requirement for carrier vessel observer reports to be submitted to the Secretariat (e.g. 1 observer report was submitted for 956 transshipments in 2016 and none for the 1092 transshipments reported in 2017). Considering the above limitations in the availability or resolution of qualitative WCPFC transshipment information, no regional data was appropriate to clarify the nature of the observed encounters at sea between purse seine vessels and reefers.

In addition to regional data sources, we further identified two sources of sub-regional information that might assist in elucidating the identified encounters. Of the 77 observed encounters, 34 occurred within waters of states that are Parties to the Nauru Agreement (PNA) (Fig. 3). As PNA states have 100% observer coverage, it was possible to apply that qualitative information to the 34 eligible encounters [46]. Review by the PNA verified 25 encounters as observed non-transshipment, primarily consisting of provisioning, salt, spare parts, and exchange of crew members. Of the remaining nine encounters, seven lacked access to hard copy reports, and two were “unable to find transshipment” (Fig. 3). Both of these unverified encounters occurred between the same fishing and reefer vessels in 2017 in the

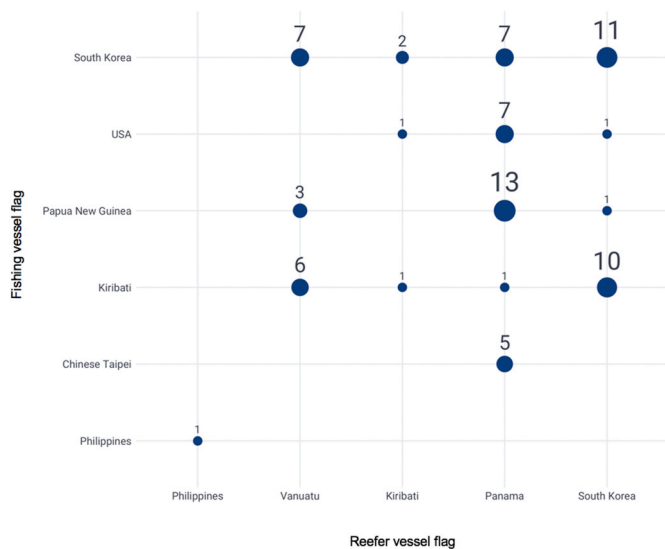


Fig. 1. Matrix of observed AIS encounters between purse seine fishing vessels and reefers, by vessel flag state, 2014–2017. The size of the symbol and corresponding number indicate the observed encounters between fishing vessel and reefer vessel flags during the study period.

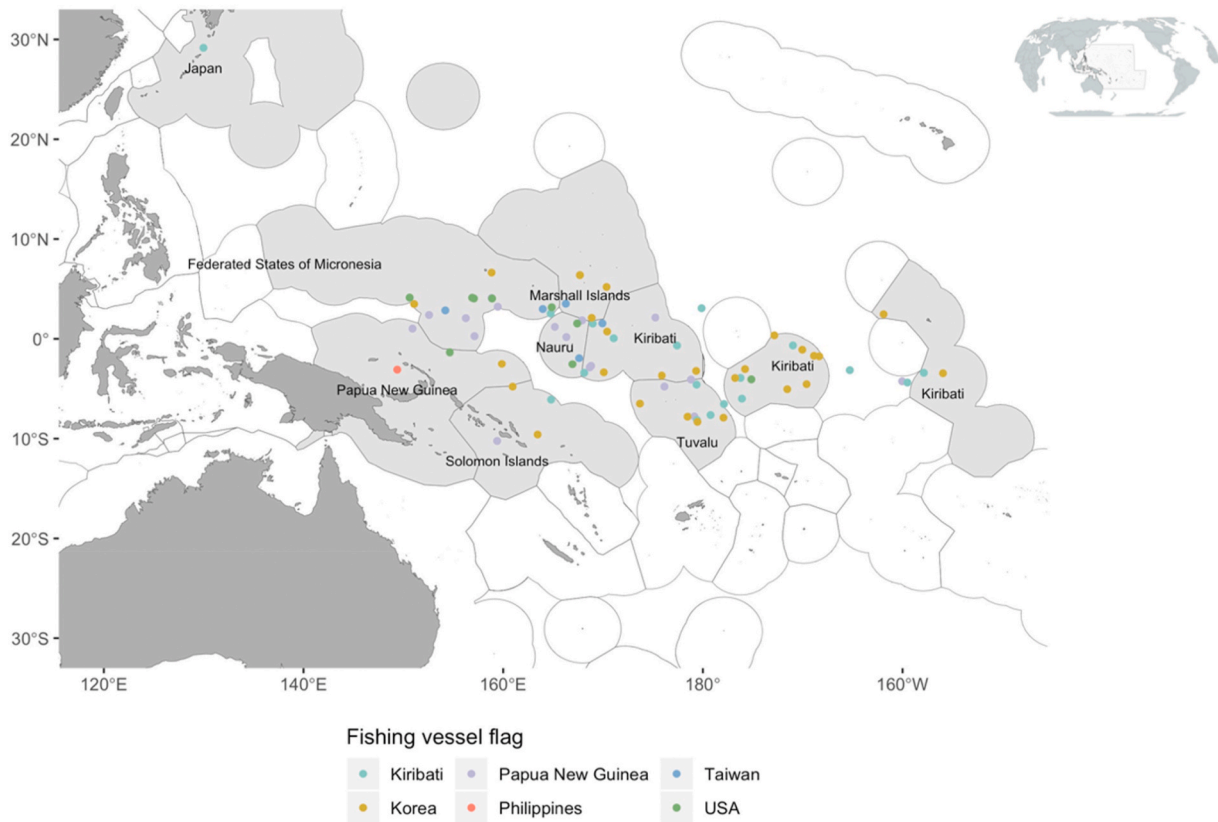


Fig. 2. Map of observed encounters between refrigerated cargo vessels and purse seiners.

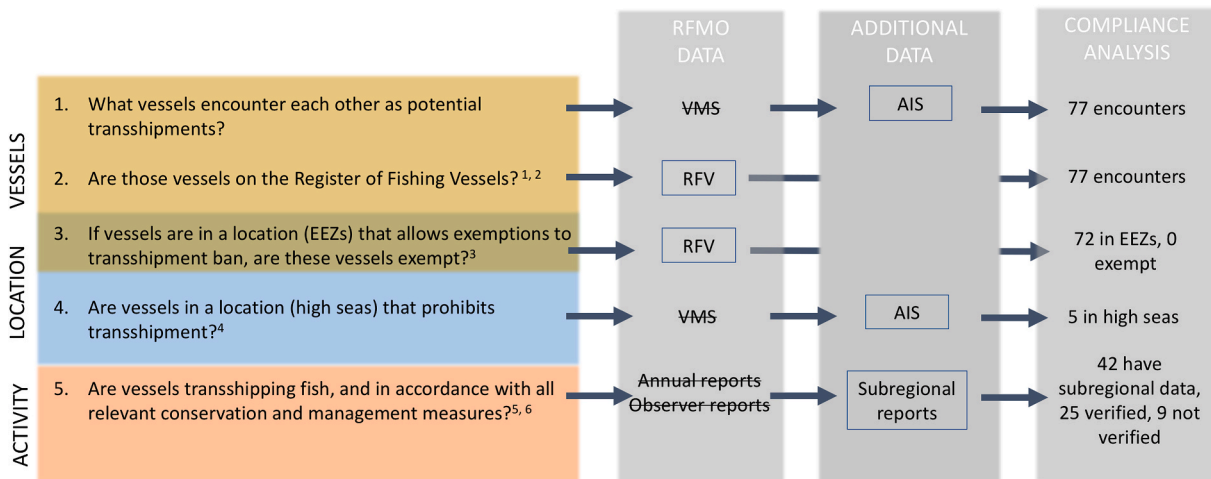


Fig. 3. Summary of 1) primary transshipment compliance questions, 2) RFMO and additional data that was unavailable (crossed out) and that which was used (boxed), and 3) the number of encounters evaluated with available data. Only the 25 encounters confirmed as non-transshipment of fish by subregional data are considered verified, while the remaining 52 are unverified, and thus potentially illegal transshipments of fish. Sources for transshipment compliance questions include: <sup>1</sup>Convention article 1(e); <sup>2</sup>Convention article 24(4); <sup>3</sup>Convention article 29(5); <sup>4</sup>CMM 2009-06 Conservation and Management measure on the regulation of transshipment Section 2; <sup>5</sup>Convention article 28(6)e; <sup>6</sup>CMM 2009-06 Conservation and Management measure on the regulation of transshipment Section 1(14).

waters of Japan and Tuvalu. Eight additional encounters fell within the purview of states within the Forum Fisheries Agency (FFA), for whom the Secretariat for the Pacific Community (SPC) collects data via the regional observer program. The study was unable to access this data so these eight encounters were unable to be verified.

#### 4. Conclusions and recommendations

Applying all available information from public (i.e., Global Fishing Watch), regional (i.e., WCPFC) and subregional (i.e., PNA) sources, 32% (n = 25) of the observed encounters between purse seiners and reefers are verifiable as non-transshipments of fish (Fig. 3). Thus, only this 32% of the observed encounters are considered verified, while the remaining 68% (n = 52) are unverified, and thus potentially illegal transshipments

**Table 1**

Summary of current limitations with AIS data, the analytical outcomes resulting from those limitations, and potential solutions.

Analytical error	AIS limitation	Analytical outcome	Potential solution
Possible false negative	1) Encounters where both vessels do not have AIS (and are not currently required to)	<i>Underestimation</i> of transshipment at sea	Expand AIS adoption requirements; use additional data sources
	2) Encounters where one vessel does not have AIS (and is not currently required to)	<i>Underestimation</i> of transshipment at sea	Expand AIS adoption requirements; use additional data sources; possible to analyze encounter-like behavior of single vessels
	3) Encounters where 1 or both vessels have tampered or off AIS	<i>Underestimation</i> of transshipment at sea	Increase oversight and enforcement of current AIS requirements
Possible false positive	4) Cannot separate transshipment of fish from other encounters	<i>Overestimation</i> of transshipment at sea	Triangulate with observer data and other narrative or anecdotal sources

of fish. As such, this study determined that for one of the most highly regulated and monitored transboundary fisheries in the world, it is not possible to verify transshipment—and thus traceability, legality, or impact on fish stocks—for the vast majority of observed encounters.

Several limitations currently constrain the ability to assess transshipment at sea, even in this highly-regulated scenario. First, the majority of regional WCPFC data is considered to be non-public domain data, severely limiting access by both members and third parties (Fig. 3). While substantial political will exists within WCPFC toward sharing operational data for research purposes, lack of clarity around data sharing procedures, and ambiguity in decision making requirements, *de facto* prevent their use in transshipment evaluation [32,35,47]. Second, the Secretariat likewise makes no regular assessment of this non-public domain data for the verification of transshipment activities. With no regular oversight and no formal data sharing arrangements with third parties or other RFMOs on transshipment-specific information (e.g. IATTC, NPFC) [30], this data is largely ineffective at ensuring traceability and legality. Third, while some transshipment regulations are in place, their current structure does not require sufficient reporting (e.g. observer reports) or resolution (e.g. annual reports) to enable adequate verification or accountability. Sub-regional regulations and policies are able to bridge some of that gap, but these institutions also lack regular oversight, and the vast majority of encounters (68%) remain unsubstantiated even after triangulating with diverse data sources.

In tracing encounters at sea, this study identifies three primary areas for improving the traceability and transparency of transshipment at sea within our case study. First, current reporting mechanisms are insufficient to achieve the goals they were constructed for. The current WCPFC transshipment measure (CMM 2009–06) should be strengthened, to require consistent transshipment reporting for all areas within the Convention Area, including all transshipments that occur in port and within EEZs. This should include requirements that transshipments be reported to the relevant flag State, coastal State, and port State, as well as the WCPFC secretariat, in a standardized format, using IMO numbers as each vessel's primary identifier. Reporting requirements should also include strict submission timeframes that ensure proper notification to all relevant authorities. In all cases this reporting should occur before the first point of landing for the catch is reached, regardless where the transshipment event occurred. These requirements will allow the Secretariat to receive a complete picture of transshipment activity, wherever that activity occurs within the WCPFC Convention area, and facilitate the cross-validation of reported information. In addition, all WCPFC-authorized carrier vessels intending to transship WCPFC-

managed species caught in the Convention area should provide electronic notification of their entry into WCPFC waters and intention to transship while in Convention area waters to the relevant flag State and the Secretariat. That notification should include confirmation of the vessel's compliance with near-real-time VMS reporting and observer carriage requirements to allow authorities to verify the information prior to any at-sea transshipment activity commencing. Second, inconsistencies in monitoring and reporting undermine the data validity. For example, the template provided by the Secretariat for transshipment reporting should be expanded to include data fields for number of off-loading and receiving vessels involved in transshipping, and locations where transshipping events occurred (e.g. high seas, EEZs, in port) [48]. This will allow cross-validation of vessel transshipment reporting and prevent inconsistency between offloading and receiving vessels. The Regional Observer Program (ROP) Standards and Guidelines should also be revised to mandate that carrier observers be specifically trained and certified to carry out their duties on a carrier vessel. In addition, it should mandate the submission of observer reports for all high seas transshipments occurring within the WCPFC Convention Area to enable the Secretariat to review, cross-verify and facilitate independent validation of reported transshipment information. Finally, and most substantially, current approaches to data sharing prevent any evaluation from outside actors or true transparent governance. To address this, the Commission could establish or expand formal transshipping data-sharing procedures with other RFMOs (e.g. NPFC, IATTC and SPRFMO), especially where authorized carrier vessels operate within overlapping convention area waters, conduct multiple transshipments, and transship species managed by different RFMOs during a single voyage [30]. The Commission could also update its data rules and procedures to modernize and clarify data sharing procedures with non-members and observers, to enhance transparency, enable effective supply chain audits, improve cross-verification and coordination, and strengthen the legitimacy and the social license of these fisheries.

The primary purpose of this study was to evaluate transparency in transboundary fisheries governance by asking whether the public has sufficient information to hold RFMOs accountable to their mandate. We based the study in one of the most commercially and ecologically important fisheries, assessing a highly-regulated activity within the RFMO considered to have the strongest policies [21,22,49]. However, even within this arguably “best practice” scenario, we found that there is not sufficient information to hold governing bodies (e.g. states, RFMO) accountable to their mandate of ensuring “effective conservation and management” [15]. Similar states of transparency and insufficient reporting requirements are found within the transshipment management frameworks of the other four global tuna RFMOs, as evidenced through recent comparative analyses of reported transshipment activities. The studies collectively concluded, in part, that the availability of public information related to the occurrence and reporting of transshipment events in all of the tuna RFMOs was lacking, preventing the ability for any organization to independently verify transshipment data—or even to perform simple audit functions [50–54].

On the surface, this failure of transparency and accountability is due primarily to the non-public nature of valuable RFMO data and to substantial gaps in the conservation and management measures at play within RFMOs. However, these barriers are not attributable to a simple lack of technical or administrative capacity, and deeper dynamics underlie immediate explanations. Tensions between different institutions—such as the neoliberal market structures that dominate global fisheries and the States that are charged with managing them—may ultimately limit authentic or transformative transparency in transboundary fisheries [1,8]. For example, Petersson et al. found that fishing industry representatives were the most prevalent, consistent, and embedded non-state actors at RFMO meetings, often attending meetings as participants within member state delegations [55]. This industry involvement far outpaced that of civil society organizations, indicating substantially greater opportunities for industry representatives to

influence policy-making [55]. Where the interests of public information and accountable resource governance are in tension with the interests of commercial actors, transformative transparency is highly unlikely. Additionally, Gupta suggests that shortcomings in transparency are related to “power imbalances and broader conflicts over norms, practices and objectives” [1]. In addition to the tensions between market and state forces, transparency is also undermined by asymmetries in power relations between actors and their divergent goals. For example, with regard to other mandates of RFMOs (e.g. deterring illegal fishing, allocation of fishing rights), scholars have found that frequently the interests of more wealthy, powerful, developed nations have predominantly won out [56–58].

This study suggests that there is much room for improvement in transparency and accountability of transboundary fisheries management. In a highly-regulated “best case” scenario, sufficient information is not available for the public to evaluate the legality and legitimacy of dominant fishing practices. However, a key step moving forward will be highlighting the underlying dynamics that inhibit transparency, rather than stopping short at data limitations or flawed policies. Transparency is important not only as a principle in itself, but because it is key in holding authorities accountable to their goals of sustainable use. In the context of global fisheries, this mandate, and the role of the public in ensuring its achievement, are essential to ensure the effective conservation and management of fish stocks, both now and into the future.

#### CRedit authorship contribution statement

**Katherine Seto:** Conceptualization, Methodology, Software, Validation, Investigation, Resources, Writing - original draft, Visualization, Project administration, Supervision. **Nathan Miller:** Methodology, Software, Validation, Investigation, Resources, Writing - review & editing, Visualization, Validation, Data curation. **Mark Young:** Investigation, Resources, Writing - review & editing, Funding acquisition. **Quentin Hanich:** Conceptualization, Investigation, Resources, Writing - review & editing, Supervision, Funding acquisition.

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