Ballast Water Management:

Protecting Marine Environments in Small Island Developing States in the Pacific

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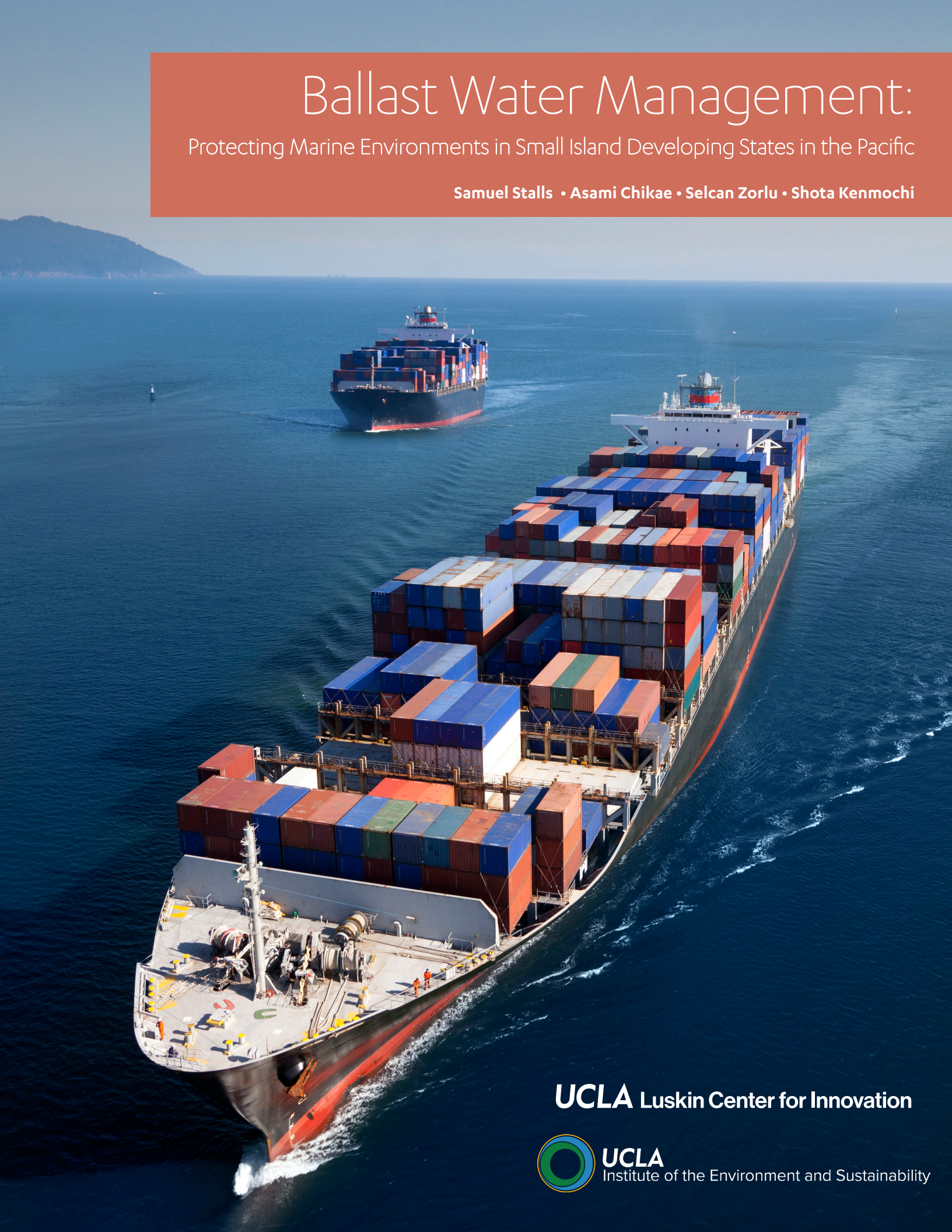

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DISCLAIMER

This report was prepared in partial fulfillment of the requirements for the Master's in Public Policy degree in the Department of Public Policy at the University of California, Los Angeles (UCLA). It was prepared at the direction of the Department and of the Luskin Center for Innovation as a policy client. The views expressed herein are those of the authors and not necessarily those of the Department, the UCLA Luskin School of Public Affairs, UCLA as a whole, or the client.

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ACRONYMS

BWM	Ballast Water Management
BWMC	International Convention for the Control and Management of Ship's Ballast Water and Sediments
BWMP	Ballast Water Management Plan
BWTS	Ballast Water Treatment System
DWT	Deadweight tonnage
DSS	Decision support system
EEZ	Exclusive Economic Zone
IAS	Invasive Alien Species
IMO	International Maritime Organization
MOU	Memorandum of Understanding
NAMEPA	North American Marine Environmental Protection Association
NIR	New Inspection Regime
OECD	Organization for Economic Cooperation and Development
PSC	Port State Control
SIDS	Small Island Developing States
SPC	Secretariat of the Pacific Community
SPREP	Secretariat of the Pacific Regional Environmental Program
UNCTAD	United Nations Conference on Trade and Development
USCG	United States Coast Guard

TABLE OF CONTENTS

DISCLAIMER i
ACKNOWLEDGEMENTS ii
ACRONYMS iii
TABLE OF CONTENTS iv
LIST OF FIGURES vi
LIST OF TABLES vi
EXECUTIVE SUMMARY vii
1. INTRODUCTION 1
2. BACKGROUND INFORMATION 2
2.1 The Pacific and Small Island Developing States 2
2.2 Invasive Alien Species 5
2.3 Ballast Water 8
2.4 International Response 10
3. METHODOLOGY 13
3.1 Clients 14
3.2 Criteria for Evaluating Policy Options 14
4. PROBLEM IDENTIFICATION 15
4.1 Lack of Enforcement Mechanisms 15
4.2 Deficiencies in Infrastructure Around Enforcement 16
5. CURRENT PRACTICES FROM AROUND THE WORLD AND POLICY OPTIONS 19
5.1 Risk Assessments 19
5.2 Mandatory Reporting 25
5.3 Onboard Testing 28
5.4 Laboratory Testing 29
5.5 Penalties for Noncompliance 29
6. POLICY RECOMMENDATIONS 30
6.1 Developing the Most Appropriate Enforcement Regime 31
6.1.1 Risk Assessment 31
6.1.2 Enforcement Tools 32
6.1.2.1 Mandatory Reporting 33
6.1.2.2 Onboard Testing 34
6.1.2.3 Laboratory Testing 34

6.2 Building Infrastructure Around Enforcement 35
6.2.1 Developing National Strategies 35
6.2.2 Developing Regional Cooperation 37
6.2.3 Raising Revenue for Enforcement 39
6.2.3.1 Other Ways to Complement Funding 40
6.2.5 Legislation of Penalties for Noncompliance 43
6.2.5.1 Types of Penalties 43
6.3 Discussion 45
7. CONCLUSION 47
BIBLIOGRAPHY 48
APPENDIX: International Shipping in the Pacific Region 58
List of Shipping Companies Serving to Pacific SIDS 58
List of Shipping Agencies Located in SIDS 58
Selected Shipping Routes in the Pacific Ocean 59

LIST OF FIGURES

Figure 1: Map of Pacific region with EEZs 3
Figure 2: Shipping services calling at ports in the Pacific SIDS 4
Figure 3: Global containerized trade (Million 20-foot equivalent units and percentage annual change) 4
Figure 4: Ballast water cycle and transfer of invasive species 9
Figure 5: Summary of Authorities and Responsibilities established by the BWM Convention .. 13
Figure 6: Generic Ballast Water Discharge Risk Assessment Developed in Europe 21
Figure 7: Example of a DSS 22
Figure 8: Ship Risk Profile 24
Figure 9: Timeline of Inspection 25
Figure 10: A Sample from the Required BWM Reporting Documents 27
Figure 11: 10Cells device from BBE Moldaenke 28
Figure 12: Results from Performance Verification Tests of 10Cells (left) and Fastballast (right) 29
Figure 13: Problems and corresponding solutions 30
Figure 14: Ships in the Asia-Pacific Region by Ship Risk Profile 32
Figure 15: Cost vs. expected detections of violations for different enforcement tools 32
Figure 16: An example of national strategy: Cook Islands' national strategy 36
Figure 17: Data about Green Bond 41
Figure 18: Case of Issuance of Green Bond in Fiji 42

LIST OF TABLES

Table 1: The BWM Convention Ratification of SIDS in the Pacific 11
Table 2: Evaluation Criteria 14
Table 3: Criteria-Alternative Matrix for Oversight Mechanisms 35
Table 4: Summary of Evaluation for Each Options 45

EXECUTIVE SUMMARY

Ballast water, which is carried in tanks to balance ships and might bring invasive species to other regions, is one of the biggest threats to local marine ecosystems around the world. It is a huge problem especially for the Pacific Small Island Developing States (SIDS) as they are also highly dependent on transport and trade in their economies.

Corresponding the ballast water issues, the International Maritime Organization (IMO) adopted the International Convention for the Control and Management of Ship's Ballast Water and Sediments in 2004 to set international standards to prevent the carriage of invasive species, and there are currently seven SIDS that ratified the BWM Convention in the Pacific. However, they generally lack enforcement and oversight for ballast water management in terms of both legal framework and inspections of ships, which is related to obstacles in funding, technical/administrative capacity, and planning. This research aims to make a set of policy recommendations for SIDS to effectively ensure compliance of the shipping industry to protect their ecosystems from invasive species while maintaining economic advantage associated with shipping.

To accomplish this, we start with checking if the seven SIDS comply with IMO standards and ensure enforcement. We did this through literature review, basic data analysis and Skype/phone interviews with officials on site and experts in this area. Then we analyze the reasons for non-complianceand offer policy recommendations based on the unique characteristics of SIDS, best practices, related guidelines, case studies, and interviews.

We separate the in two areas: (1) the lack of enforcement, and (2) deficiencies in infrastructure around enforcement, typically due to typically limited funding, the lack of technical and administrative capacity, and the lack of planning. Based on our analysis, we conclude the following:

- To address the lack of enforcement, risk assessment, reporting and onboard testing are the ones that should be implemented considering environmental effectiveness, financial, administrative, and political feasibility.
- To develop infrastructures around enforcement, we recommend that port states consider developing legislation, national strategies, regional cooperation, and raise revenue for enforcement.

1. INTRODUCTION

Invasive alien species (IAS) are a significant threat to marine environments around the world. They destroy species composition by changing the environment they invade and so disrupt the food chain. IAS often arrive on islands through discharges of ballast water by commercial ships. Ballast water is water carried by ships in special tanks to improve balance and stability, taken in along coastal waters when cargo is unloaded, and discharged when cargo is loaded in another location. The problem with ballast water is intake usually contains living organisms that spread once discharged into a new environment. Billions of tons of ballast water are transferred globally each year in ships' ballast tanks, carrying thousands of species daily.

The threat of IAS is high for Small Island Developing States (SIDS) around the world, and particularly SIDS in the Pacific Ocean. The fact that they depend on maritime transport and the ocean for a living and share shipping routes and regional infrastructure increases the likelihood of IAS introduction to their waters. It is extremely difficult and costly to reverse the environmental harms if IAS are established within the region. These environmental harms will likely have economic effects as well.

The International Maritime Organization (IMO) has been addressing the issue of IAS and ballast water through the International Convention for the Control and Management of Ships Ballast Water and Sediments ("BWM Convention"). Adopted in 2004 and signed by enough countries to be in force starting in 2017, it set a standard to protect ocean environments. However, for various reasons, including the lack of financial and technical resources, effective measures have not been taken in the Pacific SIDS.

Policy Question

This project aims to provide a set of policy recommendations to SIDS in the Pacific to ensure the ballast water of ships using their ports are managed properly and incorporate information about best practices to the current situation in standards, compliance and enforcement. Signers of international treaties concerning ballast water have obligations as "flag states" and as "port states." Those terms will be defined later, and this project is concerned with Pacific SIDS in their capacity as port states. Specifically, we are seeking to answer the question:

How can the SIDS in the Pacific who have ratified the Ballast Water Management Convention, in their capacity as port states[1] effectively ensure compliance of the shipping industry to protect their ecosystems from invasive species while maintaining the economic advantages associated with shipping?

Clients

Our principal client is the University of California, Los Angeles (UCLA) Luskin Center for Innovation (LCI). LCI's research covers a wide range of policy issues confronting our community, nation and world, and their initiatives are linked by the themes including sustainability.

[1] The 2004 BWM Convention assigns responsibilities to port states, states in control of ports where ships operate. This is in contrast with state's responsibilities as "flag states," or the flag under which ships fly.

Our target client are the seven Pacific SIDS who have ratified the BWM Convention, including: Republic of Fiji, Kingdom of Tonga, Republic of the Marshall Islands (RMI), Republic of Kiribati, Republic of Palau, Tuvalu, and the Cook Islands. These nations have demonstrated some willingness to regulate ballast water but most have not yet reached the standards set by the BWM Convention. Our recommendations are tailored to the unique conditions determined by each country's geographic and economic realities.

2. BACKGROUND INFORMATION

2.1 The Pacific and Small Island Developing States

The Pacific Ocean is the world's largest ecosystems and covers around half of the surface of the earth.[2] It contains 7,500 islands, taking up around 2% of the ocean's surface.[3] Despite their relatively small landmasses, maritime laws grant Pacific Island countries and territories control of the ocean up to 200 miles from their shores, areas designated as Exclusive Economic Zones (EEZ). Combined, these countries total around 38 million square kilometers of the Pacific Ocean, (Figure 1).[4] Pacific island countries are categorized as Small Island Developing States (SIDS), which were recognized as a specific group of developing countries facing a unique set of vulnerabilities at the United Nations Conference on Environment and Development in 1992.[5] Although the United Nations did not establish any criteria to determine an official list of SIDS, fourteen of them are listed in the Pacific for analytical purposes.[6,7]

SIDS vary in terms of development, but they all have small land masses, tiny populations, and their marine environments directly impact every aspect of the lives of their citizens.[8,9] These environments house numerous aquatic species and activities that support economies and provide livelihoods for millions of people.[10] Therefore, any damage to the marine ecosystem constitutes a major concern not only for Pacific Islanders but also other nations and environmental organizations.[11]

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[2] Secretariat of the Pacific Regional Environmental Program (SPREP), "State of Conservation in Oceania, Regional Report," Regional Report, 2013, 29. https://www.sprep.org/attachments/Publications/BEM/state-conservation-oceania-report.pdf.

[3] Shine, C., J.K. Reaser, and A.T. Gutierrez (eds.), *Prevention and Management of Invasive Alien Species: Proceedings of a Workshop on Forging Cooperation throughout the Austral-Pacific* (Cape Town, South Africa: Global Invasive Species Programme, 2003), 3. http://www.issg.org/pdf/publications/GISP/Resources/AP-2.pdf.

[4] Shine, Reaser, and Gutierrez, *op. cit.*, 66.

[5] UN-OHRLLS, "About the Small Island Developing States," http://unohrlls.org/about-sids/ (03/02/2019).

[6] UNCTAD, "UNCTAD's Unofficial List of SIDS," https://unctad.org/en/pages/aldc/Small%20Island%20Developing%20States/UNCTAD%C2%B4s-unofficial-list-of-SIDS.aspx (03/02/2019).

[7] United Nations, "Small Island Developing States," *Sustainable Development Goals Knowledge Platform*, https://sustainabledevelopment.un.org/topics/sids/list (03/02/2019).

[8] Shine, Reaser, and Gutierrez, *op. cit.*, 4.

[9] UNCTAD, *Review of Maritime Transport 2014* (New York and Geneva: United Nations, 2014), 106-107, https://unctad.org/en/PublicationChapters/rmt2014ch6_en.pdf (03/02/2019).

[10] SPREP, "State of Conservation in Oceania, Regional Report," *op. cit., 29.*

[11] Shine, Reaser, and Gutierrez, *op. cit.*, 5.

Figure 1: Map of Pacific region with EEZs
(Source: SPREP-JICA, https://www.sprep.org/attachments/Publications/WMPC/cleaner-pacific-strategy-2025.pdf)

From an international maritime transport perspective, SIDS share common features: geographic remoteness, limited trade volumes, trade imbalances with heavy reliance on imports and concentration of exports in a few products. These unique characteristics limit their economies by preventing them from exploiting economies of scale.[12],[13] In addition to this, the remoteness of their locations limit the interconnectedness of these SIDS with the rest of the world since they are not within general east-west shipping routes. Rather they are served, directly or indirectly, through the global feeder/relay ports of countries such as Singapore and China, from or through Australia and New Zealand or occasionally via services from the west coast of North America (Figure 2).[14] There are slightly more than ten international shipping lines serving Pacific SIDS, with at least one shipping company in each SIDS acting as the agency of such shipping lines.

[12] UNCTAD, "Small Islands Developing States: Challenges in Transport and Trade Logistics," Note by the UNCTAD Secretariat, 3. https://unctad.org/meetings/en/SessionalDocuments/cimem7d8_en.pdf.
[13] UNCTAD, *Review of Maritime Transport 2014* (New York and Geneva: United Nations, 2014), 109, https://unctad.org/en/PublicationChapters/rmt2014ch6_en.pdf (03/02/2019).
[14] UNCTAD, *Review of Maritime Transport 2014*, *op. cit.,* 110-113.

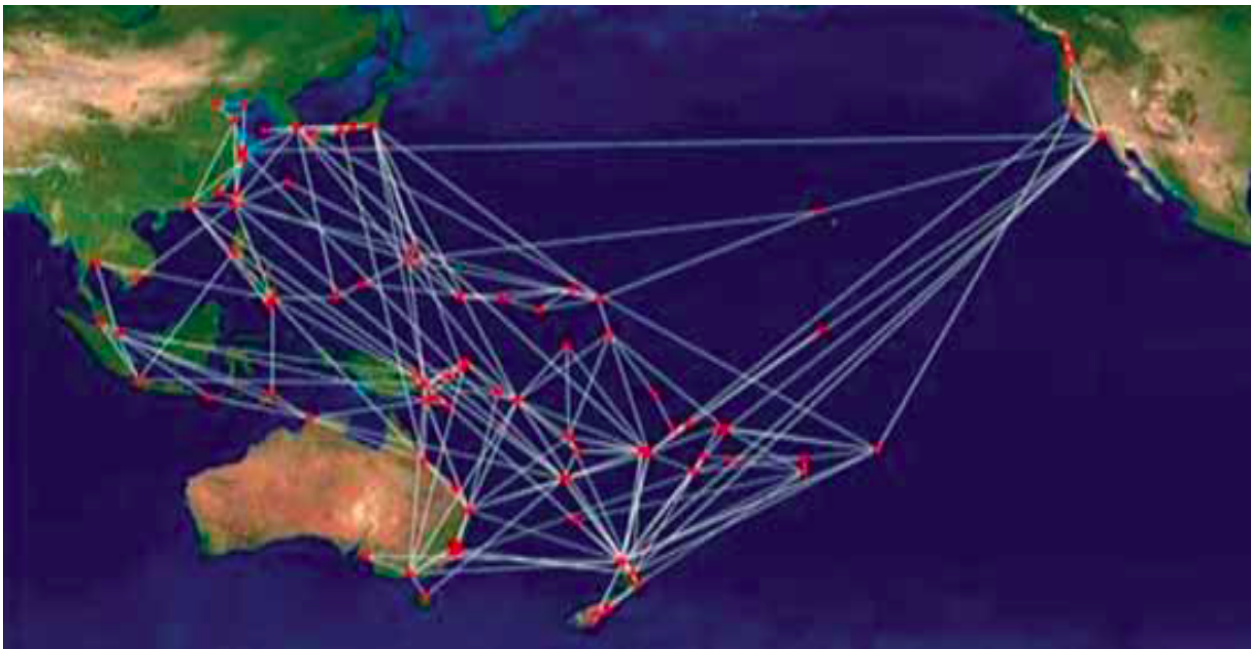

Figure 2: Shipping services calling at ports in the Pacific SIDS
(Source: UNCTAD, https://unctad.org/en/PublicationsLibrary/dtltlb2014d2_en.pdf)

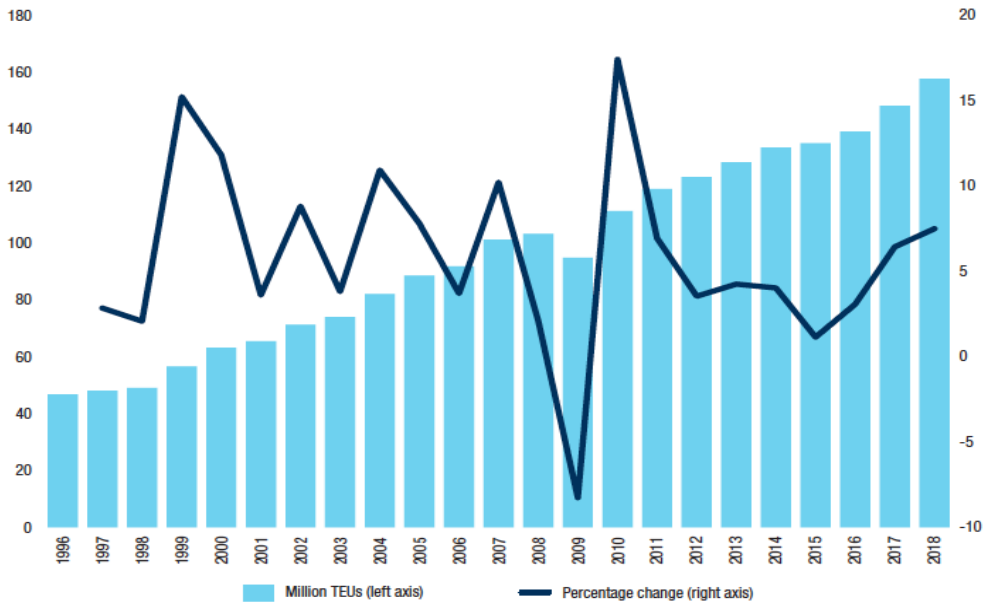

Figure 3: Global containerized trade (Million 20-foot equivalent units and percentage annual change)
(Source: UNCTAD, https://unctad.org/en/PublicationsLibrary/rmt2018_en.pdf)

With globalization and increased trade between SIDS and rest of the world, shipping activities have increased dramatically. This is especially the case for SIDS that depend on maritime

transport as their primary means of trade. Despite its importance in SIDS' economic development, maritime transport poses severe risks to SIDS unique marine ecosystems, of which ballast water discharge is one example.[15] Moreover, increased shipping activities between different parts of the world with the use of sea water as ballast makes it easier for species in one part of the world to be transferred to another. There are studies estimating that 10 billion tons of ballast water are transferred globally each year in ships' ballast tanks, carrying 7,000 species daily.[16] The spread of these species has implications for the environment and human well-being and the problem of transferring Invasive Alien Species (IAS), which have the potential to damage marine ecosystems and is one of the most important port-related challenges SIDS face.[17]

2.2 Invasive Alien Species

In general, IAS are defined as non-indigenous organisms that have been deliberately or unintentionally transported to a region where they historically do not inhabit. They may become established and severely damage the ecosystem.[18,19,20,21] They are one of the most significant drivers of environmental change worldwide as globalization is greatly increasing the rate, diversity, and number of species moving around the world.[22]

IAS is one of the five greatest threats to the world's marine biodiversity, with the other four being overexploitation of resources, pollution, habitat destruction and ocean acidification.[23] Although information about IAS on land can be researched and assessed easily, this is not the case for marine IAS. In fact, there are large gaps in available information about IAS in marine environments, so our knowledge is limited regarding the extent of the damage the shipping industry has done to marine ecosystem.[24] Thus, research and control of IAS continues to be an important concern in the marine industry.[25]

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[15] OECD, *Environmental Impacts of International Shipping: The Role of Ports*, (Paris: OECD Publishing, 2011), 26. https://doi.org/10.1787/9789264097339-en.

[16] IMO, *Guidelines for Development of a National Ballast Water Management Strategy*, GloBallast Monograph Series No.18 (London: IMO, 2010), 4. https://www.sprep.org/att/IRC/eCOPIES/Global/382.pdf.

[17] IMO, *Guidelines for Development of a National Ballast Water Management Strategy*, GloBallast Monograph Series No.18 (London: IMO, 2010), 1. https://www.sprep.org/att/IRC/eCOPIES/Global/382.pdf.

[18] California State Lands Commission, *Assessment of The Efficacy, Availability and Environmental Impacts of Ballast Water Treatment Systems for Use in California Waters* (Sacramento: California State Lands Commission, 2007), 1-2. https://www.slc.ca.gov/wp-content/uploads/2018/08/MISP-T_2007.pdf.

[19] IMO, *Economic Assessment for Ballast Water Management: A Guideline*, GloBallast Monograph Series No.19 (London: IMO, 2010), 1. https://portals.iucn.org/library/sites/library/files/documents/2010-075.pdf.

[20] SPREP, *Battling Invasive Species in the Pacific: Outcomes of the Regional GEF-PAS IAS Project* (Apoia, Samoa: SPREP, 2016), 9. https://www.sprep.org/attachments/Publications/BEM/battling-invasive-species-pacific.pdf.

[21] IMO, *Guidelines for Development of a National Ballast Water Management Strategy*, GloBallast Monograph Series No.18 *op. cit*., 2.

[22] Shine, Reaser, and Gutierrez, *op. cit.*, 10.

[23] IMO, *Economic Assessment of Ballast Water Management*, GloBallast Monograph Series No.24 (London: IMO, 2017), 1. http://www.imo.org/en/OurWork/Environment/MajorProjects/Documents/Mono24_English.pdf.

[24] SPREP, "State of Conservation in Oceania, Regional Report," *op. cit.*, 51

[25] American Bureau of Shipping, "Taking Lead in Addressing Ballast Water Management after MEPC 70," https://ww2.eagle.org/en/news/abs-news/Taking-Lead-Addressing-Ballast-Water-Management-MEPC70.html (03/02/2019)

Once established, the impacts of IAS tend to be irreversible and can have serious human health, infrastructure, economic and ecosystems impacts.[26,27,28,29] Because of this, prevention is very important rather than finding remedies after it becomes a problem. This urgency is stated in several papers detailing the technical challenges[30,31,32,33] and high associated costs,[34,35] all further emphasizing the importance of regulating ballast water management of ships to control transfer and establishment of IAS.

In 2003, after studying six ports in the United States, Australia, and New Zealand, one measure estimated a new species established itself every thirty-two to eighty-five weeks, and this rate is increasing.[36] There are many examples of IAS with which ships' ballast water are directly linked (Box 1). With standards only implemented in 2017, it is likely the problem has worsened, despite the attempts of several nations, especially the United States, to combat it.

BOX 1: Example of IAS - Zebra mussel

One of the most well-known examples of IAS is the zebra mussel. Native to Europe, they were brought to the American waters by ballast water on ships in the mid-1980s.[37,38] This organism harmed the ecosystem of much of the northeastern United States (U.S.) and Great Lakes region through the rapid consumption of plankton and with it, the disruption of the

[26] IMO, *Economic Assessment for Ballast Water Management: A Guideline*, GloBallast Monograph Series No.19 (London: IMO, 2010), 1. https://portals.iucn.org/library/sites/library/files/documents/2010-075.pdf.
[27] California State Lands Commission: Marine Facilities Division, *Assessment of The Efficacy, Availability and Environmental Impacts of Ballast Water Treatment Systems for Use in California Waters*, op. cit., 1-2.
[28] SPREP, "State of Conservation in Oceania, Regional Report," op. cit., 5.
[29] SPC, *Pacific Islands Regional Ocean Policy and Framework for Integrated Strategic Action* (New Caledonia: SPC,, 2005), 17. http://macbio-pacific.info/wp-content/uploads/2017/08/Pacific-Ocean-Policy.pdf.
[30] California State Lands Commission: Marine Facilities Division, *Assessment of The Efficacy, Availability and Environmental Impacts of Ballast Water Treatment Systems for Use in California Waters*, *op. cit., 2-3*
[31] Shine, C., J.K. Reaser, and A.T. Gutierrez. (eds.). 2003. Prevention and Management of Invasive Alien Species: Proceedings of a Workshop on Forging Cooperation throughout the Austral-Pacific. Global Invasive Species Programme, Cape Town, South Africa, 29.
[32] IMO, *Economic Assessment for Ballast Water Management: A Guideline*, GloBallast Monograph Series No.19, *op. cit.*, 1.
[33] IMO, *Economic Assessment of Ballast Water Management*, GloBallast Monograph Series No.24, *op. cit.*, 2
[34] IMO, *Economic Assessment of Ballast Water Management*, GloBallast Monograph Series No.24, op. cit., 2
[35] California State Lands Commission: Marine Facilities Division, *Assessment of The Efficacy, Availability and Environmental Impacts of Ballast Water Treatment Systems for Use in California Waters*, *op. cit.*, 2-3.
[36] Nicholas Bax, Angela Williamson, Max Aguero, Exequiel Gonzalez, and Warren Geeves, "Marine Invasive Alien Species: A Threat to Global Biodiversity," *Marine Policy* 27 (2003), 313.
[37] Bikram Singh, "Everything You Wanted to Know About Ballast Water Exchange and Management Plan," *Marine Insight*, https://www.marineinsight.com/maritime-law/everything-you-wanted-to-know-about-ballast-water-exchange-and-management-plan/ (03/02/2019)
[38] Malini Wimmer, "How Ballast Water is Affecting the Maritime Industry and Marine Environment Today," *NAMEPA,* https://namepa.net/2018/06/19/2018-6-19-how-ballast-water-is-affecting-the-maritime-industry-and-marine-environment-today/ (03/02/2019)

local food chain.[39] The cost in damages of zebra mussels in the US alone is estimated to have been between $750 million and $1 billion between 1989 and 2000.[40] Other examples of such invasive organisms include golden mussels, North American comb jellyfish, the cladoceran water flea, and the North Pacific seastar.[41]

The information and research on IAS have mainly occurred in developed countries. Developing countries, especially SIDS, do not have the necessary technical and financial capacity to conduct a comprehensive assessment of invasive species in their waters and then deal with it effectively. The majority of invasive species are not managed and though the impact is massive, it is poorly quantified, and in most cases not seriously addressed by policy makers in most of the SIDS.[42] Most of the current knowledge on marine IAS comes from research conducted at a limited number of locations and over short periods of time, whereas repetitive and detailed monitoring is required to produce results which are generally beyond the financial capability of SIDS.[43]

The impact of IAS has the potential to be particularly high on SIDS, and it is predicted that the impact will only grow.[44] IAS are a significant threat to the marine environment of Pacific SIDS and to the lives of inhabitants who depend on the ocean for a living, and it may be extremely difficult and costly to reverse the harms if IAS are established within the region.[45,46] SIDS' dependency on maritime transport, shared shipping routes and regional infrastructure increases the likelihood of IAS introduction.[47] It is estimated that the spread of diseases and IAS in any form costs the region millions of dollars in economic impacts annually and threaten biodiversity and livelihoods.[48]

The number of IAS is reported in broad categories in some research papers; however, marine environments are poorly studied and monitored, so those values are likely to be underestimates.[49,50] Specific studies on IAS in the Pacific SIDS have not been conducted although threatening species have been found in their waters. These include the barnacle *Chthalamus proteus*, several macro-algae species, harmful planktonic algae species and the black striped mussel *Mytolopsis sallei* from the Gulf of Mexico/Caribbean.[51] It is estimated that in the Republic of Palau, one of our target SIDS, most marine IAS come from a small group of marine invertebrates

[39] Cary Institute of Economic Studies, "Zebra Mussel Fact Sheet," https://www.caryinstitute.org/sites/default/files/public/downloads/curriculum-project/zebra_mussel_fact_sheet.pdf.
[40] Malini Wimmer, "How Ballast Water is Affecting the Maritime Industry and Marine Environment Today," *op cit*.
[41] Malini Wimmer, "How Ballast Water is Affecting the Maritime Industry and Marine Environment Today," *op cit*.
[42] SPREP, "State of Conservation in Oceania, Regional Report," *op. cit.*, 52.
[43] Republic of Palau, "National Biodiversity Strategy and Action Plan" (Ngerulmud, Palau: Republic of Palau, 2005), 35, available at https://www.cbd.int/doc/world/pw/pw-nbsap-01-en.pdf (03/02/2019).
[44] IMO, *Guidelines for Development of a National Ballast Water Management Strategy*, GloBallast Monograph Series No.18, *op. cit., 1.*
[45] SPC, "Pacific Islands Regional Ocean Policy and Framework for Integrated Strategic Action," *op. Cit., 17.*
[46]SPREP, *Battling Invasive Species in the Pacific: Outcomes of the Regional GEF-PAS IAS Project, op. cit.,*
[47] Shine, Reaser, and Gutierrez, *op. cit.*, 3.
[48] SPREP, *Battling Invasive Species in the Pacific: Outcomes of the Regional GEF-PAS IAS Project, op. Cit., 9.*
[49] SPREP, *Battling Invasive Species in the Pacific: Outcomes of the Regional GEF-PAS IAS Project, op. Cit., 23.*
[50] SPREP, "State of Conservation in Oceania, Regional Report," *op. cit.*, 52.
[51] SPREP, "Shipping-Related Introduced Marine Pests in the Pacific Islands: A Regional Strategy" (Apia, Samoa: SPREP 2006), i. https://www.sprep.org/att/IRC/eCOPIES/Pacific_Region/105.pdf

possibly introduced from ballast water.[52] The Kingdom of Tonga is also highly vulnerable to new IAS despite its considerable efforts to manage existing IAS.[53] This is contrasted with the Cook Islands, where the will to address IAS is found only when they affect economic interests.[54]

2.3 Ballast Water

Introduction of IAS can occur through many pathways, and ships' ballast water is one of the two main ways for the introduction of marine IAS.[55,56,57,58,59] In one study, shipping was found to be responsible for 80% of invertebrate and algae introductions to North America and ballast water was a possible vector for 69% of those introductions.[60]

The concept of ballast, using heavy substances to balance ships, has been employed since ancient times, when vessels sandbags, rocks, or iron blocks, which were loaded or unloaded following cargo operations.[61] Today ships generally fill specially placed tanks with water. If there is no ballast, it can lead to dangerous conditions, such as the propeller not being fully immersed in the water.[62] The ballast water is taken into the tank along coastal waters when cargo is unloaded and is adjusted along the way as cargo is loaded and unloaded, and then discharged at the end of the voyage when cargo is loaded.[63,64]

The problem with ballast water is that it usually contains organisms that are not native and harmful to the environment in which they are released, i.e. IAS.[65,66,67] A process of intaking and discharging of ballast water is shown in Figure 4 below. At the source port (1), the ship discharges cargo to shed weight. To compensate, the ship intakes ballast water, including all the living creatures in the water, both harmful and innocent. During the voyage (2) the ship travels to its destination with ballast water stored in its tanks. At the destination port (3) the ship loads cargo so its weight increases. Thus, to balance itself it needs to discharge the necessary amount of ballast

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[52] Republic of Palau, "National Biodiversity Strategy and Action Plan," *op. cit., 40.*

[53] Shine, Reaser, and Gutierrez, *op. cit.*, 47.

[54] Shine, Reaser, and Gutierrez, *op. cit.*, 64.

[55] IMO, *Economic Assessment of Ballast Water Management*, GloBallast Monograph Series No.24, *op. cit.*, 1.

[56] SPREP, "Shipping-Related Introduced Marine Pests in the Pacific Islands: A Regional Strategy," *op. cit., i.*

[57] IMO, *Economic Assessment for Ballast Water Management: A Guideline*, GloBallast Monograph Series No.19, *op. cit.*, 1

[58] IMO, *Guidelines for Development of a National Ballast Water Management Strategy*, GloBallast Monograph Series No.18, *op. cit., 4.*

[59] Malini Wimmer, "How Ballast Water is Affecting the Maritime Industry and Marine Environment Today," *op. cit.,*

[60] California State Lands Commission: Marine Facilities Division, *Assessment of The Efficacy, Availability and Environmental Impacts of Ballast Water Treatment Systems for Use in California Waters*, *op. Cit.*, 2.

[61] Anish Wankhede, "A Guide to Ballast Tanks on Ships," *Marine Insight,* https://www.marineinsight.com/naval-architecture/a-guide-to-ballast-tanks-on-ships/ (03/02/2019).

[62] *Ibid.*

[63] Malini Wimmer, "How Ballast Water is Affecting the Maritime Industry and Marine Environment Today," *op cit*.

[64] California State Lands Commission: Marine Facilities Division, *Assessment of The Efficacy, Availability and Environmental Impacts of Ballast Water Treatment Systems for Use in California Waters*, *op. cit.*, 2.

[65] Malini Wimmer, "How Ballast Water is Affecting the Maritime Industry and Marine Environment Today," *op cit*.

[66] IMO, *Guidelines for Development of a National Ballast Water Management Strategy*, GloBallast Monograph Series No.18, *op. cit.,* 5.

[67] Braathen, N., ed, *Environmental Impacts of International Shipping: The Role of Ports* (Paris: OECD Publishing), 2011, 93. https://doi.org/10.1787/9789264097339-en.

water from its tanks into the sea. At this point, all the surviving species that were taken in at the source port are also discharged into the sea. If the destination port has an appropriate environment for those species, they are likely to form a new habitat for themselves there, causing harm to that ecosystem. When a ship continues its voyage after loading cargo (4) it normally does not carry ballast water.

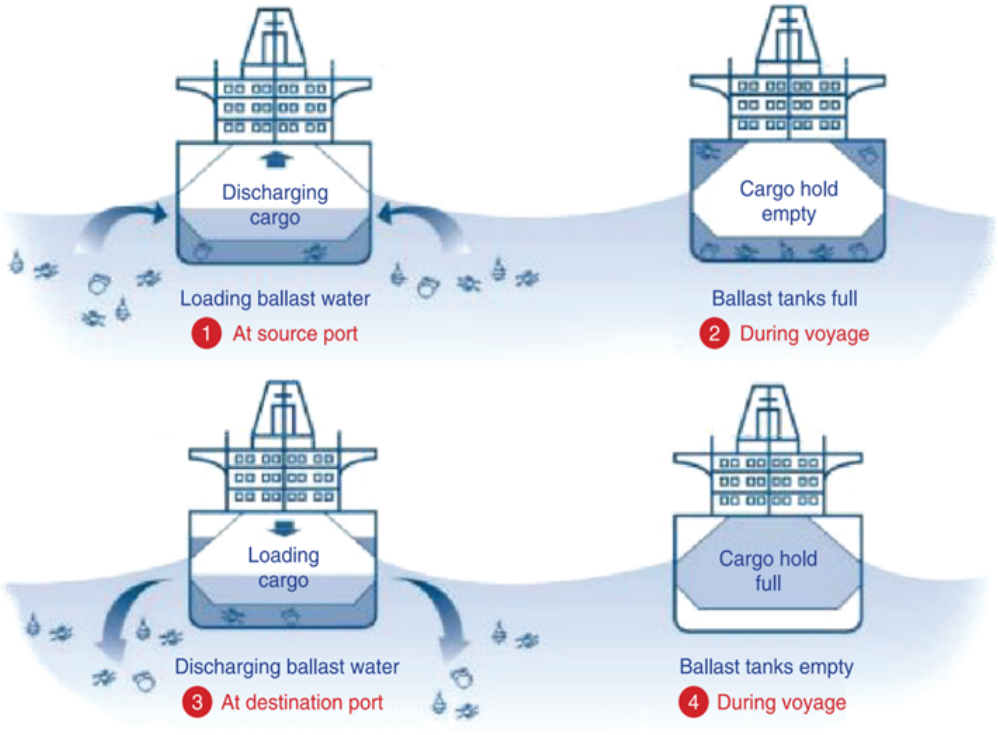

Figure 4: Ballast water cycle and transfer of invasive species
(Source: GloBallast Monograph Series No.18)

Ballast water makes it easier for species in one part of the world to be transferred to another part. There are studies estimating that 10 billion tons of ballast water are transferred globally each year in ships' ballast tanks, carrying 7,000 species daily.[68] In another study, it is estimated that at any time, 10,000 organisms are in transit via ships throughout the world.[69] The shipping industry transports not only marine species but also their different life stages such as eggs, larvae, spores or resting stages over great distances.[70,71]

With its significant role in causing the transfer of IAS and damaging marine ecosystems, regulating ballast water practices seems to be the first thing to do to prevent IAS problems. However, due to interconnectedness and the near monopoly power of the shipping industry, an

[68] IMO, *Guidelines for Development of a National Ballast Water Management Strategy*, GloBallast Monograph Series No.18, *op. cit., 4.*
[69] SPREP, "State of Conservation in Oceania, Regional Report," *op. Cit., 5.*
[70] SPREP, "State of Conservation in Oceania, Regional Report," *op. Cit., 31.*
[71] IMO, *Guidelines for Development of a National Ballast Water Management Strategy*, GloBallast Monograph Series No.18, *op. cit., 5*

individual country's effort would not be effective to adequately regulate ballast water. Prevention or control of IAS invasions is an international problem and should have international solutions, which in turn requires a coordinated information exchange network at all levels.[72] To take on this challenge, the IMO, which had been addressing the issue of IAS and ballast water for decades, adopted the BWM Convention which is the key tool for countries who want to stop introduction of IAS through ballast water discharge.[73]

2.4 International Response

Acknowledging the importance of proper ballast water management with respect to environment, in 2004 the IMO adopted the BWM Convention, though it went into force only in 2017.[74,75] Currently 80 countries have ratified it, representing 81% of world's gross shipping tonnage.[76] Among fourteen IMO-member SIDS located in the Pacific Ocean (including the Cook Islands), seven of those have ratified the BWM Convention as of January 2019 (Table 1).[77,78] Some of these SIDS, such as Tuvalu and the Republic of Kiribati, were early signatories, ratifying the BWM Convention within two years of its inception, whereas others, such as the Kingdom of Tonga and Republic of Fiji, only recently ratified it.

SIDS	Date of Ratification
Cook Islands	2010
Republic of Fiji	2016
Republic of Kiribati	2007
Republic of Marshall Islands	2009
Republic of Palau	2011
Kingdom of Tonga	2014

[72] Shine, Reaser, and Gutierrez, *op. cit.*, 36.

[73] IMO, *Economic Assessment for Ballast Water Management: A Guideline*, GloBallast Monograph Series No.19, *op. Cit., 1.*

[74]IMO, "International Convention for the Control and Management of Ships' Ballast Water and Sediments," http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Control-and-Management-of-Ships'-Ballast-Water-and-Sediments-(BWM).aspx (03/05/2019).

[75]Article 18 of the BWM Convention defines the date that went into force as "twelve months after the date on which not less than thirty States, the combined merchant fleets of which constitute not less than thirty-five percent of the gross tonnage of the world's merchant shipping" it was not ratified by more than 30 states the combined merchant fleet of which constitute more than 35% of the gross tonnage of the world's merchant shipping" ratified it. (BWMC, Article 18, paragraph 1). It could only reach that threshold in 2016 and went into force in 2017.

[76]IMO, "Status of Treaties," http://www.imo.org/en/About/Conventions/StatusOfConventions/Documents/StatusOfTreaties.pdf (03/05/2019)

[77] IMO, "Status of IMO Treaties" (London: IMO, 2019) http://www.imo.org/en/About/Conventions/StatusOfConventions/Documents/Status%20-%202019.pdf (03/05/2019)

[78] The Cook Islands is not a United Nations member state but has had their "full treaty-making capacity" recognized by United Nations Secretariat.

Tuvalu	2005

Table 1: The BWM Convention Ratification of SIDS in the Pacific

The BWM Convention puts both general obligations on all parties and specific obligations on flag states (states under which ships are registered), port states (states in control of ports) and the shipping industry. To begin with general obligations, all parties shall undertake all necessary measures to prevent, minimize and eventually eliminate transfer of such harmful organisms by ships in their tanks in the form of ballast water and sediments.[79] All states are required to develop national BWM policies.[80] Moreover, the importance of cooperation among parties is emphasized and regulated in several articles. For instance, Article 2 states that parties shall cooperate with other countries for effective implementation, compliance, and enforcement of the BWM Convention and to cooperate to address threats and risks to marine ecosystems and biodiversity effectively in ballast water related issues.[81,82] Cooperation is also required in detection of violation and enforcement of the BWM Convention and in the transfer of technology in respect of the ballast water management.[83,84] Apart from general cooperation, the BWM Convention also mentions cooperation among parties' bordering seas as they have common interest to protect the marine environment in that geographic area. Particularly, the BWM Convention entitles that such parties "shall endeavor, taking into account characteristic regional features, to enhance regional cooperation, including through the conclusion of regional agreements consistent with this Convention."[85]

The BWM Convention also puts a number of obligations on flag states. Flag states' obligations start with surveying ships to verify that the ballast water management plan (BWMP) and other associated equipment, process, etc. are fully compliant with the BWM Convention before issuing a certificate guaranteeing compliance.[86] The BWM Convention requires a valid certificate for all ships to which it applies and flag states are held responsible to issue such certificates to those under their flag after the successful completion of an initial survey.[87] In addition, flag states are required to conduct renewal, intermediate and annual surveys to ensure continuation of full compliance.[88] In addition, approving the ships' BWMP and BWM systems used to comply with the BWM Convention are among flag states' responsibilities to ensure the ships registered to its flag are properly and effectively managing ballast water.[89,90] Finally, Article 8 states that sanctions of violations shall be established under the law of the flag state of the ship

[79] International Maritime Organization, International Convention for the Control and Management of Ships' Ballast Water and Sediments, Article 2, paragraph 1. Henceforth cited as "BWMC," as it is often referred to.
[80] BWMC, Article 4, paragraph 2.
[81] *Ibid.*, Article 2, paragraph 4.
[82] *Ibid.*, Article 2, paragraph 9.
[83] *Ibid.*, Article 10, paragraph 1.
[84] *Ibid.*, Article 13, paragraph 2.
[85] *Ibid.*, Article 13, paragraph 3.
[86] *Ibid.*, Section E, Regulation E-1.
[87] *Ibid.*, Section E, Regulation E-2.
[88] *Ibid.*, Section E, Regulation E-1.
[89] *Ibid.*, Section B, Regulation B-1.
[90] *Ibid.*, Section D, Regulation D-3.

concerned, regardless of the location of the violation.[91] Therefore, having a national law which defines the regulations of BWM and consequences in case of violation is among the responsibilities of flag states. Indeed, all states have ships under their registry, therefore all states are flag states, thus having such national laws might also be considered as a requirement for all states.

Although there is no explicit definition of "port states" in the BWM Convention, it is clear that when it refers to activities in the ports themselves, it is the port states that are responsible for that action. For instance, Article 9 regulates the inspection of ships by stating that a ship may be subject to inspection by officers of a country in any port to determine whether the ship is in compliance with the BWM Convention by verifying existence of a certificate onboard, examining the ballast water record book and if deemed necessary, to sample ballast water.[92] It is clear that such an authority is given to the port states, as opposed to flag states. Likewise, Article 5 states that "each country shall ensure that, in its ports where cleaning or repair of ballast tanks occurs, facilities for the reception and safe disposal of sediments are provided which puts an obligation on port states".[93]

As the conduit for the introduction of IAS, the shipping industry also has obligations in the BWM Convention, some of which would incur considerable costs. As explained briefly in the paragraph above, any ship to which the BWM Convention applies are required to apply and be issued a certificate and prepare and maintain onboard a BWMP specific to each ship, both of which are approved by its flag state.[94,95] Moreover, each ship is required to have a ballast water record book in any format (such as electronic, on paper, integrated to into another record book/system etc.) where all intake, discharge or treatment are recorded with necessary details (such as location, salinity or temperature) and kept readily available for inspection at all times.[96] In terms of sediment management for ships, the BWM Convention obliges all ships to remove and dispose of sediments from ballast tanks in accordance with their BWMP.[97]

Moreover, ships are obliged to conduct one of two BWM options[98]: engage in ballast water exchange, done at least 200 nautical miles away from any coast (the D1 standard), or install and utilize a ballast water treatment system (BWTS) that limits the amount of viable organisms in discharged water below a specific level (the D2 standard).[99] Finally, to accomplish all the requirements, ships need to train crew members to implement the BWMP and ensure that all related activities are done properly and effectively.[100]

The D1 and D2 standards are considered vital for the regulation of ballast water. For the standards of the shipping industry, the BWM Convention regulates that the D1 standard shall be effective once the treaty entered into force but D2 standard shall be effective on a determined timeline which eventually requires all ships to have a BWTS on board to fulfill D2 standards; this

[91] *Ibid.*, Article 8, paragraph 1.
[92] *Ibid.*, Article 9, paragraph 1.
[93] *Ibid.*, Article 5, paragraph 1.
[94] *Ibid.*, Section E, Regulation E-2.
[95] *Ibid.*, Section B, Regulation B-1.
[96] *Ibid.*, Section B, Regulation B-2.
[97] *Ibid.*, Section B, Regulation B-5.
[98] By 2024, the only acceptable ballast water management option is going to be installing and using a ballast water treatment system onboard. the BWM Convention foresees a gradual transition, depending on the ships' put in service date.
[99] BWMC, Section D.
[100] *Ibid.*, Section B, Regulation B-6.

date has now been set as 2024.[101] This renders the D1 standard as an interim option to manage ballast water whereas the D2 standard will be more permanent and long lasting.

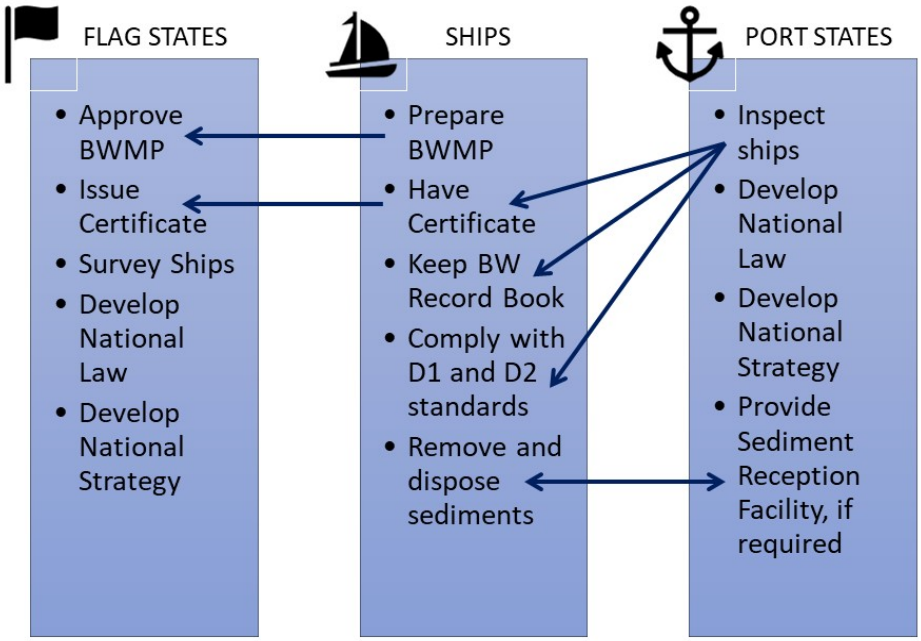

Figure 5: Summary of Authorities and Responsibilities established by the BWM Convention

3. METHODOLOGY

This project aims to provide a set of policy recommendations to Small Islands Developing States (SIDS) in the Pacific to ensure the ballast water of ships approaching their ports is managed properly in an environmentally-friendly way by incorporating information about standards, compliance, and enforcement best practices. Again, specifically we seek to answer to the following question:

How can the SIDS in the Pacific who have ratified the Ballast Water Management Convention, in their capacity as port states effectively ensure compliance of the shipping industry to protect their ecosystems from invasive species while maintaining the economic advantage associated with shipping?

To accomplish that, our study starts with checking if the seven SIDS in the Pacific that already ratified the BWM Convention comply with IMO standards and ensure enforcement. We did this through literature review, basic data analysis and skype/phone interviews with officials on site and experts in this area. Then we analyze the reasons for non-compliance, if any. We offer alternative policies based on our examination of best practices, related guidelines, case studies and interviews. Finally, we recommend a set of policies considering the unique characteristics of SIDS.

In the process of conducting research, we reached out to the following organizations/individuals: international organizations (e.g., IMO, World Bank, Conservation International, World Ocean Council), regional organizations (e.g., the Secretariat of the Regional Environmental Program, the Pacific Community, the Secretariat of Tokyo MOU), governments

[101] *Ibid.*, Section D.

and port authorities of target SIDS, international shipping companies, authors of reports/studies, and consulting companies.

3.1 Clients

Our principal client is the University of California, Los Angeles (UCLA) Luskin Center for Innovation (LCI). LCI's research covers a wide range of policy issues confronting our community, nation and world, and their initiatives are linked by the themes of sustainability.

Our target client is the seven SIDS who have ratified the BWM Convention: Fiji, Kingdom of Tonga, Republic of the Marshall Islands, Republic of Kiribati, Republic of Palau, Tuvalu, and the Cook Islands. These nations have demonstrated some willingness to regulate ballast water, but most have not reached the standards set by the BWM Convention. Our recommendations are tailored to the unique conditions determined by their geographic and economic realities.

3.2 Criteria for Evaluating Policy Options

To determine the most effective policies, each option was ranked as "low," "medium," or "high," in terms of meeting the following four criteria: environmental effectiveness, financial feasibility, administrative feasibility, and political feasibility (Table 2). Ranking was based on qualitative and quantitative data acquired from literature reviews, case studies, and interviews with a wide range of stakeholders.

Environmental Effectiveness	Financial Feasibility	Administrative Feasibility	Political Feasibility
Low	Low	Low	Low
Medium	Medium	Medium	Medium
High	High	High	High

Table 2: Evaluation Criteria

Environmental Effectiveness

The goal of each policy option is to protect the marine environments of the islands. An option with uncertain effects on protecting the local environment was ranked "low" for this criterion. Options with moderate effects were ranked as "medium" and substantial effects as "high." The estimate of each alternative's environmental effectiveness was based on previous research and perceived effectiveness by the government officials we interviewed, because raw measures of statistical effectiveness are few and far between. Despite the progress made since the 2004 BWM Convention, many important technological breakthroughs have yet to be achieved that would make managing ballast water easier.

Financial Feasibility

Many ports in these islands lack financing for upgrades, so cost-efficiency is vital. Financial feasibility relates to costs associated with the implementation of the respective policy, which include operational costs and personnel expenses, such training inspection officers. This

analysis incorporates costs that external entities bear. For instance, if an alternative is costly to vessels, the expense would have a negative impact on the alternative's political feasibility because ship owners and operators would be opposed to it. Instead of estimating exact dollar amounts, the likely costs were scored as "low," "medium," or "high" because of limitations associated with data. Possible sources of funding will be examined later to implement an option when it is possible.

Administrative Feasibility

An option's administrative feasibility depends on whether government officials who are in charge of the policy option have the technical and administrative capacity to properly implement the policy. Alternatives that government officers would be unable to implement were ranked as "low." Alternatives requiring additional resources, expertise, or authority were ranked as "medium." Alternatives within government officers' capacity were ranked as "high."

Political Feasibility

Each policy option's political feasibility depends on whether a government needs external support from political groups, such as higher-level government agencies, other countries, and ship owners. This is because a regulatory body of a small island nation often has weak authority, constrained by external political pressure in many cases. Any alternative requiring official or unofficial permission from external political groups and triggering strong oppositions was ranked as "low." An alternative that requires permission from external actors but has a chance of being granted was ranked as "medium." An alternative that would not require permission and have a good chance of being granted was ranked as "high."

4. PROBLEM IDENTIFICATION

4.1 Lack of Enforcement Mechanisms

Informational interviews, especially with the Secretariat of the Pacific Regional Environmental Program (SPREP), informed us that, among the seven target SIDS, only the Republic of Fiji conducts inspections for ballast water. Furthermore, while Fiji requires all ships to submit ballast water exchange information, they do not sample of ballast water.

In addition, there are more than ten international shipping lines serving Pacific SIDS, with more than thirty shipping agencies in the seven targeted SIDS. We reached out to them for informational interviews regarding their ballast water practices. The information from these interviews told us that ships are conducting ballast water exchange in the middle of the ocean, complying with the D1 standard mentioned above. However, this information cannot be generalized since the response rate was low, at around 2%. In the next chapter, we discuss underlying problems of insufficient enforcement.

There are many possible factors that might influence compliance rates of ships, such as moral convictions, community pressure, and economic factors. However, past studies indicate that compliance rates depend primarily on economic factors. The benefit of noncompliance is likely associated with primarily cost savings of no installation of BWTS itself or no operation/maintenance of BWTS. Since it will be relatively easy to find vessels that do not have BWTS, the benefit might be primarily cost savings of not using or not maintaining the system. The cost of noncompliance is associated with how regulations are enforced, weighing the potential

costs of not complying and getting caught. More specifically, the expected cost of noncompliance can be expressed by, according to one scholarly article "(1) the probability of a ballast water discharge violation being detected, (2) the probability of a detected violation resulting in a citation, (3) the probability of a citation being successfully prosecuted, and (4) the size of expected penalty."[102]

One estimate places the cost of installing a treatment system ranging from $600,000 to $1.2 million and yearly operating cost ranging from $15,000 to $125,000.[103] This makes the cost of compliance quite high, and any consequence of noncompliance must cost the ship or shipping company much more in terms of economic disruption.

The violation often occurs when ship owners conclude that the benefit of noncompliance is larger than cost of noncompliance. Due to the current lack of enforcement, the benefit of noncompliance is *clearly* greater than benefit of compliance.

The IMO regulation and/or the port state's local regulations require ships exchange ballast water in open ocean at least 200 nautical miles from the nearest land. This operation requires no additional equipment or operator training, so it is relatively easy for ship owners to implement. However, this operation does not perfectly prevent the introduction of invasive species. In many cases, sediments and residual water are left in the bottom of ballast tanks, or sometimes organisms stick to the sides of the tank. In addition, it can be unsafe for ships to exchange water far away from coasts in bad weather.[104] Thus, ships are required to have a BWTS on board to make sure to discharge clean water around ports. The problem is, the BWTS is often expensive. Thus, with no oversight, the incentives are for shipping companies to not comply with the BWM Convention.

4.2 Deficiencies in Infrastructure Around Enforcement

SIDS are not able to enforce regulations because the infrastructure around enforcement is severely lacking. Funding, a huge obstacle for upgrades in ports in Pacific SIDS, is deficient. Legislation is not clear, so responsibilities and consequences have not been laid out. Planning and national strategies are underdeveloped. The technical and administrative capacity for enforcement is lacking. Other environmentally conscious nations with plenty of resources, such as Germany and Australia, are able to take proactive measures, whereas SIDS face more significant hurdles.

Funding is often one of the biggest hindrances for developing countries seeking to establish better policies. Funding is closely related to enforcement because, without it, port states cannot establish facilities and human resources for Port State Control to conduct inspection and sampling of ships coming into ports (Box 2).

[102] King, Dennis M. and Mario N. Tamburri, "Verifying Compliance with Ballast Water Discharge Regulations," *Ocean Development & International Law* 41, no. 2 (2010): 160.
[103] *Ibid.,* 160-161.
[104] MIT Sea Grant, "Marine Bioinvasions Fact Sheet: Ballast Water Treatment Option," 1. https://massbay.mit.edu/exoticspecies/ballast/fact.html (03/05/2019).

BOX 2: Rough Estimates of Costs for Conducting Inspections

US $105k as Initial Costs

- Inspection tool for onboard testing $6,000 × 2: $12,000
- Facility: typical cost in Fiji $93,000

US $100k per year as Operation Costs

- Personnel:
  - 2 inspectors × average annual income in Fiji $33,000[105] = $66,000
  - 1 administrator × average annual income in Fiji $33,000 = $33,000
- Maintenance and utilities: $1,000

Notes:

- Costs for follow-up inspections and detention cases are excluded, assuming that those are compensated by imposing charges actual costs to ship owners if needed.
- Typical costs in Fiji, which is the most developed country among the target SIDS, are used to be conservative.
- The cost for facility is calculated as the following: 700 square feet × average price per square feet to buy apartment in city center FJ$283.67[106] × exchange rate to US$ 0.47
- This estimate is purely for conducting inspections, and costs for other supplemental measures including risk assessment and regional cooperation are excluded.

In many cases, these governments have tight budgets and they rely on external financial sources, such as foreign aid from developed countries and international organizations. In addition, even if SIDS successfully secure enough funding for BWM, they cannot implement effective policy options without technical and administrative capacity. Since there are multiple factors and ministries involved in BWM, it is necessary for governments to make a comprehensive national strategy in order to strengthen enforcement. However, three out of the seven target SIDS (Fiji, Palau, Kiribati) do not have a national strategy, as of January 2019. Also, there is limited regional cooperation and data sharing among these SIDS, which might result in lost business for ports stringently enforcing measures to fully comply with the BWM Convention, as ships might divert their business to ports with more lax enforcement.

In addition to ratifying the BWM Convention, countries also need to develop their own national legislation about BWM where they define the country-specific issues such as rules, roles, procedures and penalties. This is also a mandate of the BWM Convention.[107] Having an act directly regulating ballast water practices might be the most explicit way of taking the issue seriously; however, it is not common to see such legislation in the seven SIDS. We examined whether the country has national legislation to internalize the regulations of the BWM Convention, and whether there is a specific penalty defined in case of non-compliance, as a proxy of direct information about how much the governments care about the ballast water problem.

[105] Salary Explorer, "Average Salary in Fiji 2019," http://www.salaryexplorer.com/salary-survey.php?loc=72&loctype=1 (03/10/2019).
[106] Numbeo, "Cost of Living in Fiji," https://www.numbeo.com/cost-of-living/country_result.jsp?country=Fiji (03/11/2019).
[107] BWMC, Article 8, paragraph 1.

The Kingdom of Tonga passed the Marine Pollution Prevention Act of 2002, revised in 2016, which contains an explicit regulation about discharging ballast water containing invasive species. The Act defines a penalty of discharge of such ballast water in form of a fine of up to $150,000.[108] It also mentions that any vessel conducting ballast water discharge shall comply with all requirements of the BWM Convention issued by the IMO and requires submission of a ballast water reporting form prior to the discharge of ballast water.

The Republic of Fiji regulates BWM with its Marine (Ballast Water Management) Regulations issued in 2014. The regulation defines a penalty of a fine of up to $10,000 or imprisonment for a term not exceeding three years, or both in cases of discharging harmful ballast water.[109] It also includes direct references to the BWM Convention and emphasizes the obligations under it.

In its National Ballast Water Management Strategy, the Cook Islands declares that the Maritime Transport Act of 2008 authorized the making of rules regarding ballast water in order to make the BWM Convention part of the Cook Islands national laws.[110] The Cook Islands passed this law in 2014, before the BWM Convention went into force. The rule regulates ballast water practices and states that anyone who fails to comply with the rules shall be considered committed an offence against the Maritime Transport Act, and thus is subject to penalties defined in the Act.[111] Thus, the rule points to the Act for penalties and such penalties are defined in the part regarding marine protection. Specifically, depending on the situation, imprisonment of six to twelve months, fines of $100,000 to $500,000, or both are defined as penalties for offences against the rules.[112]

Some of the SIDS issued certain regulatory documents such as marine decrees, notices or guidelines. For instance, the Marshall Islands issued a Marine Guideline by its Maritime Administrator in March 2018 to provide guidance regarding how to comply with the BWM Convention.[113] Although this document provides brief information about the requirements of the BWM Convention, it does not specifically address any national regulations such as penalties in case of non-compliance.

There are not specific national regulations yet in other countries. For instance, Tuvalu has regulations concerning ballast water discharge in its Quarantine (Maritime and Aerial) Regulations[114] but there is no mention of the BWM Convention or IAS. Moreover, its Marine

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[108] Kingdom of Tonga, "Marine Pollution Prevention Act of 2002, 2016 Revision," Part II, Article 6, paragraph 2. Legislation, https://ago.gov.to/cms/images/LEGISLATION/PRINCIPAL/2002/2002-0008/MarinePollutionPreventionAct_2.pdf?zoom_highlight=ballast#search=%22ballast%22 (02/27/2019).

[109] Republic of the Fiji Islands, "Marine (Ballast Water Management) Regulations 2014," Part I, Article 5, paragraph 5. Legislation, http://extwprlegs1.fao.org/docs/pdf/fij152576.pdf (02/27/2019).

[110] Cook Islands, "Cook Islands National Ballast Water Management Strategy 2016-2020," 11 https://www.sprep.org/attachments/VirLib/CookIslands/national-ballast-water-strategy.pdf (02/27/2019).

[111] Cook Islands, "Maritime (International Convention for the Control Management of Ships' Ballast Water and Sediments) Rules, 2014 No.1" Article 7 (Avarua, Cook Islands: Government of the Cook Islands, 2014), https://www.maritimecookislands.com/wp-content/uploads/2015/11/maritime-ballast-water-rules-2014.pdf (02/27/2019).

[112] Cook Islands, "Maritime Transport Act 2008," Part 12. Legislation, https://www.maritimecookislands.com/wp-content/uploads/2015/11/MaritimeTransportAct2008.pdf (27/02/2019).

[113] Republic of the Marshall Islands Maritime Administrator, "RMI Marine Notice 2-014-1, Ballast Water Management," RMI Marine Notice, https://www.classnk.or.jp/hp/pdf/activities/statutory/ism/flag/marshall/ism_marshall_mg-2-14-1_mar-2018.pdf (02/27/2019).

[114] Laws of Tuvalu, "Quarantine (Maritime and Aerial) Regulations, 2018 revised edition," Article 21. Legislation,

Pollution Act mentions ballast water with pollutants and prohibits discharge of such water[115] but it is not specifically dedicated to regulating BWM. Likewise, the Republic of Kiribati has some mentions of ballast water discharge limitations in its Biosecurity Act of 2011 where discharge of ballast water in the waters of Kiribati is prohibited with a fixed fine of $2,000 but there is no specific national legislation about regulations of the BWM Convention.[116] Though the Republic of Palau has a mention of ballast water in its Biosecurity Act of 2014 prohibiting discharge of ballast water in its waters, it is among the SIDS that does not yet have specific legislation for BWM.[117]

Our research of national legislation suggests that many of the SIDS have not yet established their national regulations about BWMt, except for distinct articles in related acts such as marine pollution or biosecurity. This might result in ambiguity in authority and responsibilities, which in turn decreases the likelihood of effective enforcement of the BWM Convention. Moreover, there seems to be a misalignment among the regulations and/or penalties among the Pacific SIDS. This creates a further challenge for effective enforcement since shipping lines stop at several SIDS in a route, each of which have different practices, creating unnecessary inconveniences.

5. CURRENT PRACTICES FROM AROUND THE WORLD AND POLICY OPTIONS

In terms of enforcement, port states around the world require regular and consistent reporting from ships and should conduct both/either onboard and/or laboratory inspections. In terms of inspections, port states should assess which ships are more likely to discharge ballast water and the ships with the greatest risk of bringing invasive species. To do this, ports have developed risk assessments.

5.1 Risk Assessments

To ensure effective BWM, some port authorities have also inspected ships' ballast water themselves. This requires onboard sampling, while testing can take place either onboard or in a shore-based laboratory. A vital component of inspection is risk assessment, which is used for deciding the likelihood of a ship discharging ballast water and whether this discharge has strong potential for introducing invasive species.

Risk Assessment: Europe

http://www.paclii.org/cgi-bin/sinodisp/tv/legis/TV-consol_act_2008/qaqaar507/qaqaar507.html?stem=&synonyms=&query=ballast (02/27/2019).

[115] Laws of Tuvalu, "Marine Pollution Act, 2008," Article 10. Legislation, http://www.paclii.org/cgi-bin/sinodisp/tv/legis/consol_act_2008/mpa200/mpa200.html?stem=&synonyms=&query=ballast (02/27/2019).

[116] Republic of Kiribati, "Biosecurity Act 2011," Section 21. Legislation, http://www.paclii.org/cgi-bin/sinodisp/ki/legis/num_act/ba2011156/ba2011156.html?stem=&synonyms=&query=ballast (02/27/2019).

[117] Republic of Palau, "Biosecurity Act 2014," Section 17. Legislation, http://www.paclii.org/cgi-bin/sinodisp/pw/legis/num_act/ba2014rn9582015241/ba2014rn9582015241.html?stem=&synonyms=&query=ballast (02/27/2019).

Several Central European scholars have developed a more "generic" model of risk assessment based on the amount and types of cargo loaded and unloaded. This built on other models from the US, Australia, and Europe, listed below.[118] The "generic" model (Figure 6), is based on the following assumptions, quoted verbatim:[119]

- "A vessel that loads cargo in general discharges ballast water, but:
- A vessel that loads very light cargo will not discharge ballast water; and
- A vessel that loads less than 10% of cargo in relation to vessel's deadweight tonnage (DWT) will not discharge ballast water.
- A vessel that conducts loading and unloading of cargo in a port will discharge ballast if the loaded quantity of cargo is bigger than the unloaded quantity, and that this difference is bigger than 10% of the vessel's DWT.
- The quantity of ballast water discharge will on average amount to 20% of the cargo loaded, if this represents more than 10% and less than 50% of the vessel's DWT.
- The quantity of ballast water discharge will on average amount to 25% of the cargo loaded, if this represents more than 50% and less than 80% of the vessel's DWT.
- The quantity of ballast water discharge will in average amount to 33% of the cargo loaded, if this represents more than 80% of the vessel's DWT."

However, this model will need to be adapted for the conditions on ships in the Pacific, taking into account the specifics of the cargo and shipping practices of the area. However, testing of the model in Figure 4 demonstrates it to be an effective method, overestimating the amount of ballast water discharged in the Port of Koper, Slovenia by 17%, whereas other models overestimated by up to 100%.[120]

[118] Suban, Valter, Marko Perkovic, Edyta Biolwas, and Daria Maroz, "Models for Determination of Ballast Water Discharges in Port of Gdynia.," 14th International Conference on Transport Science - ICTS 2011. Portoroz, Slovenia, 4-5.
[119] David, Matej, Marko Perkovic, Valter Suban, and Stephan Gollasch, "A Generic Ballast Water Discharge Assessment Model as a Decision Supporting Tool in Ballast Water Management.," *Decision Support Systems* 53, no. 1 (2012): 177-178.
[120] Ibid, 183.

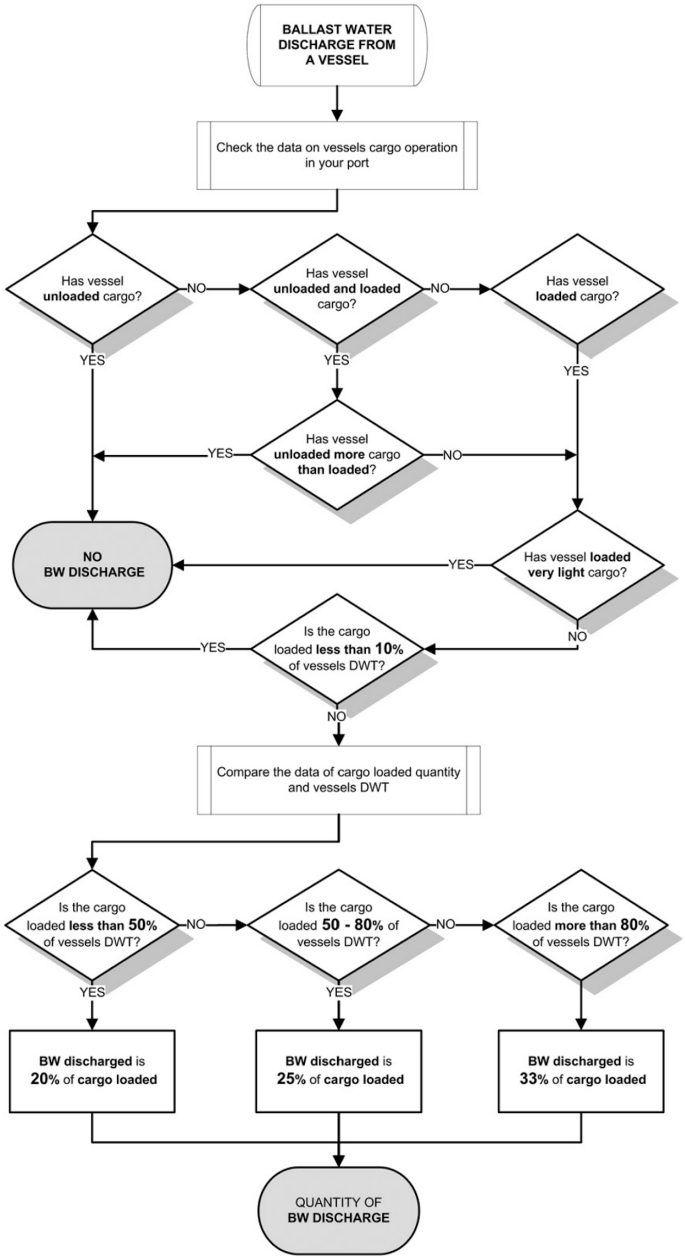


Figure 6: Generic Ballast Water Discharge Risk Assessment Developed in Europe[121]

There have been several other models developed by these same authors, including models for granting risk exemptions.[122] These risk exemptions are based upon salinity and target species. Salinity is a measure of environmental similarity between the organisms original and new habitat in which it is introduced. When looking target species, the more likely a target species is to spread rapidly, the less likely a risk exemption is to be granted.[123]

[121] *Ibid.*, 179.
[122] David, Matej and Stephan Gollasch, eds., *Global Maritime Transport and Ballast Water Management.* Dordrecht, Netherlands: Springer, 2015, 160.
[123] Ibid., 159-162.

Following up risk assessments, a decision support system (DSS) and speeds up decision making processes. A DSS has the advantage of standardizing compliance processes, not only taking them out of the hands of port state officials, but also making the decision-making process timelier.[124] This also allows port state officials to speed up their decision-making following risk assessments.

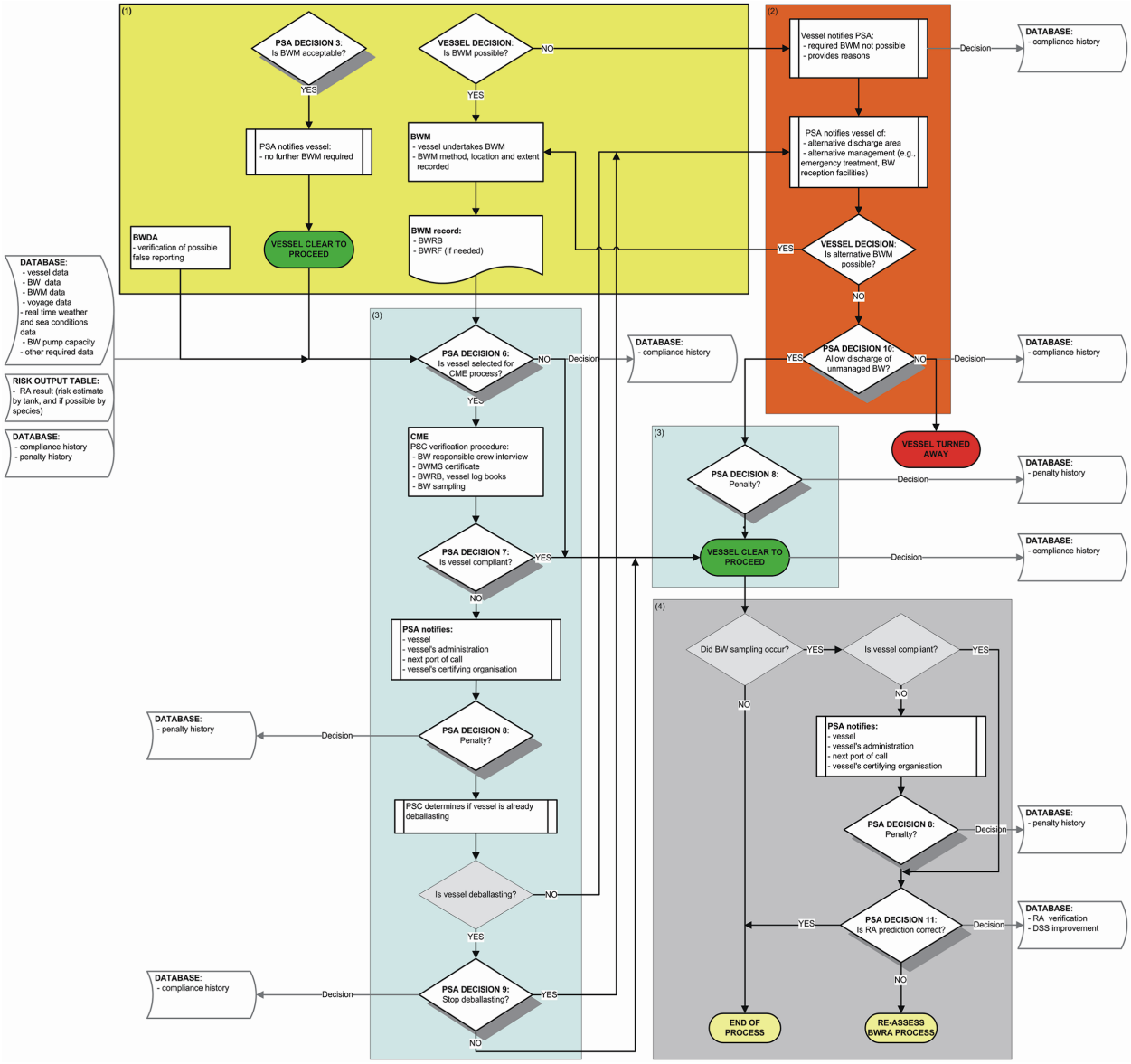


Figure 7: Example of a DSS
(Source: Global Maritime Transport and Ballast Water Management)

Risk Assessment: Tokyo Memorandum of Understanding (MOU)

A standardized assessment system, the New Inspection Regime (NIR), was adopted in the Asia-Pacific region in 2014 through the Memorandum of Understanding on Port State Control in

[124] Ibid., 226-228.

the Asia-Pacific Region (Tokyo MOU), which is one of the most active regional Port State Control organizations in the world with twenty member countries, including the Republic of Fiji and the Republic of the Marshall Islands.[125] Its member countries, most of which have limited human resources for inspection, are able to effectively inspect ships that are more likely to violate requirements by using the regional risk assessment system.

The targeting of ships is based on Ship Risk Profile.[126] The member countries classify incoming vessels into "High Risk Ship," "Standard Risk Ship" or "Low Risk Ship," using the inspection sheet (Figure 8) and conduct inspections with a certain frequency considering the classification (Figure 9). The criteria for evaluating ships include the type and age of the ship, evaluation of its flag state, company performance, and inspection and detention history over the preceding three years. The member countries refer to a published report and the Tokyo MOU website for the necessary information in the assessment, which is publicly available. Then, they conduct inspection as follows, prioritizing High-Risk Ships.

- High Risk Ships face a more frequent inspection interval of five months.
- Standard Risk Ships are subjected to an inspection interval of nine months.
- Low Risk Ships are subjected to an inspection interval of nineteen months.

In addition to the effective use of limited administrative resources, this risk assessment method would be an incentive for ships to comply with required standards to avoid frequent inspections that can negatively affect their businesses. The same type of New Inspection Regime was also adopted by the Paris MOU that consists of 27 maritime authorities and covers the waters of the European coastal states and the North Atlantic basin from North America to Europe.[127,128]

[125] The Tokyo MOU was established with the following objectives; to establish an effective port State control regime in the Asia-Pacific region through co-operation of its members and harmonization of their activities, to protect the marine environment, to eliminate sub-standard shipping in order to promote maritime safety, and to protect working and living conditions on ships.

[126] Tokyo MOU, "New Inspection Regime (NIR)," http://www.tokyo-mou.org/inspections_detentions/NIR.php.

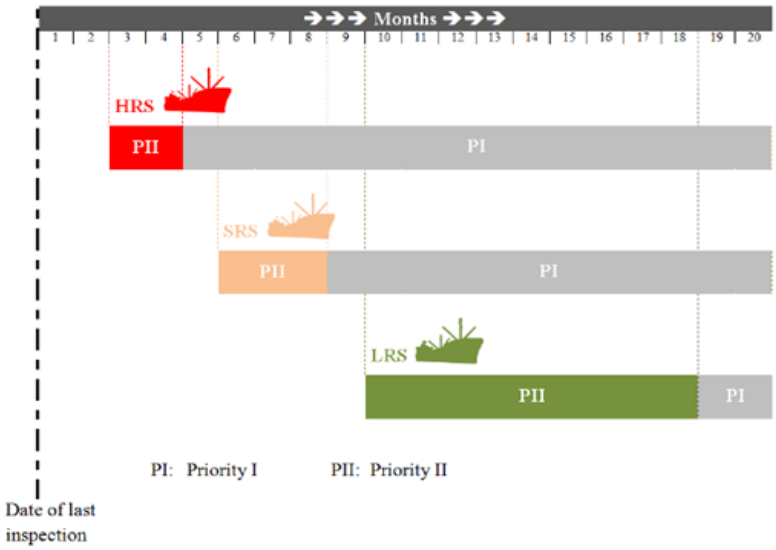
[127] Paris MOU, "Organization," https://www.parismou.org/about-us/organisation.

[128] European Maritime Safety Agency, "New Inspection Regime (NIR) & Ship Risk Profile (SRP) Calculator," http://www.emsa.europa.eu/psc-main/new-inspection-regime.html.

Parameters		Profile			
		High Risk Ship (HRS) (When sum of weighting points >=4)		Standard Risk Ship (SRS)	Low Risk Ship (LRS)
		Criteria	Weighting points	Criteria	Criteria
Type of Ship		Chemical tanker, Gas Carrier, Oil tanker, Bulk carrier, Passenger ship, Container ship	2	Neither LRS nor HRS	-
Age of Ship		All types > 12y	1		-
Flag	BGW-list[1)]	Black	1		White
	IMO Audit[2)]	-	-		Yes
Recognized Organization	RO of Tokyo MOU[3)]	-	-		Yes
	Performance[4)]	Low Very Low	1		High
Company performance[5)]		Low Very Low No inspection within previous 36 months	2		High
Deficiencies	Number of deficiencies recorded in each inspection within previous 36 months	How many inspections were there which recorded over 5 deficiencies?	No. of inspections which recorded over 5 deficiencies		All inspections have 5 or less deficiencies (at least one inspection within previous 36 months)
Detentions	Number of Detention within previous 36 months	3 or more detentions	1		No detention

Figure 8: Ship Risk Profile

(Source: Tokyo MOU," INFORMATION SHEET OF THE NEW INSPECTION REGIME (NIR)" http://www.tokyo-mou.org/doc/NIR-information%20sheet-r.pdf. 1-2)



Priority I: ships must be inspected because the time window has closed.
Priority II: ships may be inspected because they are within the time window of inspection.

Figure 9: Timeline of Inspection
(Source: Tokyo MOU, "SHIP RISK PROFILE INSPECTION WINDOW" http://www.tokyo-mou.org/doc/NIR-information%20sheet-r.pdf. 3)

5.2 Mandatory Reporting

This method of enforcement requires all incoming ships to report information on the vessel, current voyage and ballast water logs or records. Vessel information generally includes basic information such as vessel name and country of registry, as well as information about ballast water such as number of ballast tanks, volume of ballast water currently in tanks, and if available onboard ballast water treatment system (BWTS).

Reporting requirements can be specified in international (e.g. IMO), national (e.g. U.S.) or subnational (e.g. the state of California) regulations. In the BWM Convention, ships are required to maintain a ballast water management plan (BWMP) and record book onboard at all times so that whenever the ship arrives in port, the officials can investigate them in their regular ship inspection operation. The BWMP is a document that describes in detail "the actions to be taken to implement the ballast water management requirements and supplemental ballast water management practices."[129] It is specific to each ship and must be approved by the flag state. A ballast water record book is used to record all ballast water related activities such as intake, treatment, or discharge with detail information about when and where that action took place.[130] A record book gives the port officials valuable information regarding risk of IAS: whether ballast water has been exchanged in open seas or whether the ballast water currently occupying the ballast tanks was taken in locations known to have invasive species harmful in the port's ecosystem. Though the BWM Convention provides a framework and mandates all parties to take necessary steps to ensure compliance, each country determines its own enforcement, so exactly which

[129] BWMC, Section B, Regulation B-1.
[130] *Ibid.*, Section B, Regulation B-2.

information is required and procedures to prepare and send the reports might differ from port to port.

The United States also employs reporting as the baseline of enforcement in which ships are required to submit a report including the information about vessel, voyage, total ballast water (with detailed information regarding the origin of water, date, location, volume, and temperature). They are also compelled to declare which ballast tanks are to be discharged into US waters or to a reception facility as well as the ship's ballast water management plan.[131] In addition to U.S. Coast Guard (USCG) regulations, the state of California has its own ballast water regulations and standards. In terms of reporting, California requires ships arriving at its ports submit, for each port once annually, a document called the Ballast Water Management Report which includes ballast water history and Marine Invasive Species Program Annual Vessel Reporting Form.[132]

[131] Code of Federal Regulations, "CFR-2012 Title33 Vol-2 § 151.2060 Reporting requirements" (Washington, DC: US Government Publishing Office), https://www.govinfo.gov/content/pkg/CFR-2012-title33-vol2/pdf/CFR-2012-title33-vol2-sec151-2060.pdf (03.06.2019).

[132]California State Lands Commision, Letter, File Ref: W9777.234, https://www.slc.ca.gov/wp-content/uploads/2019/01/MISP_letter_07Jan19.pdf (03.06.2019).

Ballast Water Management Report

Vessel Information

Vessel name

ID number — IMO number

Country of Registry — Select country

Owner/operator

Type — Select vessel type — Gross Tonnage

Ballast water volume units — Select units

Total ballast water capacity — Number of tanks on ship

Onboard BW Management System

Voyage Information

Arrival port (port and state) — Select state

Arrival date

Last port (port and country) — Select country

Next port (port and country) — Select country

Total ballast water on board — Number of tanks in ballast

Number of tanks discharged

Alternative BW management conducted, per instructions from COTP ☐

Ballast Water History

Tank name/number — Tank capacity

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons — Select reason

Tank name/number — Tank capacity

Event	Date	Location(s) (for Management event include Start pt. / End pt.)	Volume
Discharge to US waters			
Select event			
Select event			
Select event			
Select event			

If BW management was *not* conducted for this tank, select one of the following reasons — Select reason

Figure 10: A Sample from the Required BWM Reporting Documents for Ships Entering Ports in California

(Source: California State Lands Commission, https://www.slc.ca.gov/wp-content/uploads/2018/08/BallastWaterForm.pdf)

Though the BWM Convention does not specify when to submit those reports, both the USCG and California require all reports to be submitted at least 24 hours prior to arrival at each port call (if the voyage is more than 24 hours).[133,134] Likewise, there is no specific information about how to send the reports in the BWM Convention, that decision is rather left to the countries. On the other hand, despite having different addressees and online systems, both the USCG and California provides options to submit the required reports as the submissions could be via online system, email or fax.[135,136]

5.3 Onboard Testing

When conducting inspections, onboard testing using sensor equipment is the quickest method, though somewhat less rigorous than laboratory testing of ballast water. There are several sensors on the market, and they are not prohibitively costly and even non-experts can be trained in only a few hours. Test results come back in a few minutes, meaning that they are not particularly burdensome on the ship operators themselves. These sensors are useful for telling when a ship is *clearly* not in compliance; above certain levels, more testing is often useful.

Two tools perform well on verification tests. One tool is the FastBallast compliance monitor from Chelsea Technologies Group Ltd. Measuring only 240 x 198 x 109 mm and weighing five kilograms, it is quite portable. To sample, a twenty milliliter sample of ballast water is taken and poured into the device. A pass or fail result comes back within ten minutes. The device uses a fluorescence method to test the presence of organisms in the water. It costs only a few thousand dollars per device.

Another example is the 10Cells machine from the German company BBE Moldaenke. This product uses a delayed fluorescence technique so it will not read dead algae, which according to the website, makes it more effective than the competition. It requires a ten milliliter sample and takes ten readings in one minute, using the mean of this sample for an estimation. According to our interview with an engineer at the company, it costs approximately €5,000 and is used by Hong Kong and Singapore. It also requires approximately half an hour of training for proper use.

Figure 11: 10Cells device from BBE Moldaenke

[133] Code of Federal Regulations, "CFR-2012 Title33 Vol-2 § 151.2060 Reporting requirements," *op. cit.,*
[134] California State Lands Commission, Letter, File Ref: W9777.234, *op. cit.*
[135] Code of Federal Regulations, "CFR-2012 Title33 Vol-2 § 151.2060 Reporting requirements," *op. cit.,*
[136] California State Lands Commission, Letter, File Ref: W9777.234, *op. cit.*

Testing of these tools reveals a general similarity in sensitivity between them. The Alliance for Coastal Technologies, a Maryland-based group, tested different sensors for use in marine environments. Below are charts of the two machines. Both BBE Moldaenke's machine and Chelsea Instruments score well though it appears 10Cells is the more sensitive machine.

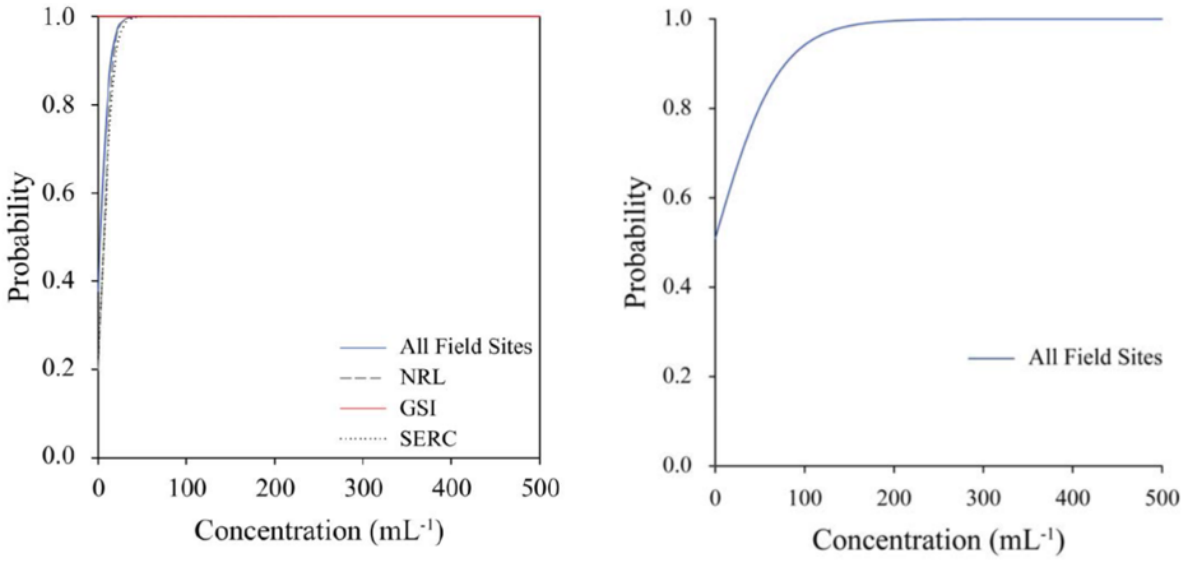


Figure 12: Results from Performance Verification Tests of 10Cells (left) and Fastballast (right)
(Source: Alliance for Coastal Technologies)

5.4 Laboratory Testing

There are a number of complex laboratory tools to measure the presence of organisms in ballast water aboard ships. They generally require port state authorities to board and take a large of sample of ballast water, bring it ashore, and run tests. These tests are more effective in assessing the presence of invasive species, however, they are costly and time consuming, with results coming back in hours or even days. Those conducting the tests must have extensive scientific training and the machines used for the tests are expensive.[137] Due to these constraints, only developed countries are planning on implementing this method to ensure compliance. In an interview with the Alliance for Coastal Technologies, we learned that Germany has decided to use laboratories particularly when readings are greater than one hundred organisms per milliliter.

5.5 Penalties for Noncompliance

Unfortunately, penalties are not well known or enforced around the world. Interviews tell us many BWM Convention ratifying countries, including Germany, are not yet levying penalties and are still in the middle of an exploratory phase. Besides the United States, which did not ratify the BWM Convention because of sovereignty issues, penalties are difficult to come across on official websites. Again, interviews tell us that fines are more difficult to enforce, as shipping

[137] Matej David and Stephan Gollasch, eds., *Global Maritime Transport and Ballast Water Management.* (Dordrecht, Netherlands: Springer, 2015), 171-221.

companies often challenge them in court. Rather, disruption of the economic activities of shippers through detention and additional inspection is more likely to encourage compliance, as this is more difficult to fight, and cause companies employing shipping lines to move their products an inconvenience. Consequently, those companies will place additional pressure on shipping lines.

6. POLICY RECOMMENDATIONS

In the previous chapters, we presented major problems SIDS face and options for enforcement tools. However, in order to effectively enforce regulations related to ballast water, port states need to build up the infrastructure around enforcement. In this chapter, we make a set of recommendations for the Pacific SIDS to effectively manage ballast water issues. Recommendations can be divided into two sets: (1) developing the most appropriate enforcement regime, and (2) identifying best strategies to successfully implement them. The first pertains to enforcement itself and interactions with shipping. The second would help establish the infrastructure around enforcement, to support it and make it more effective.

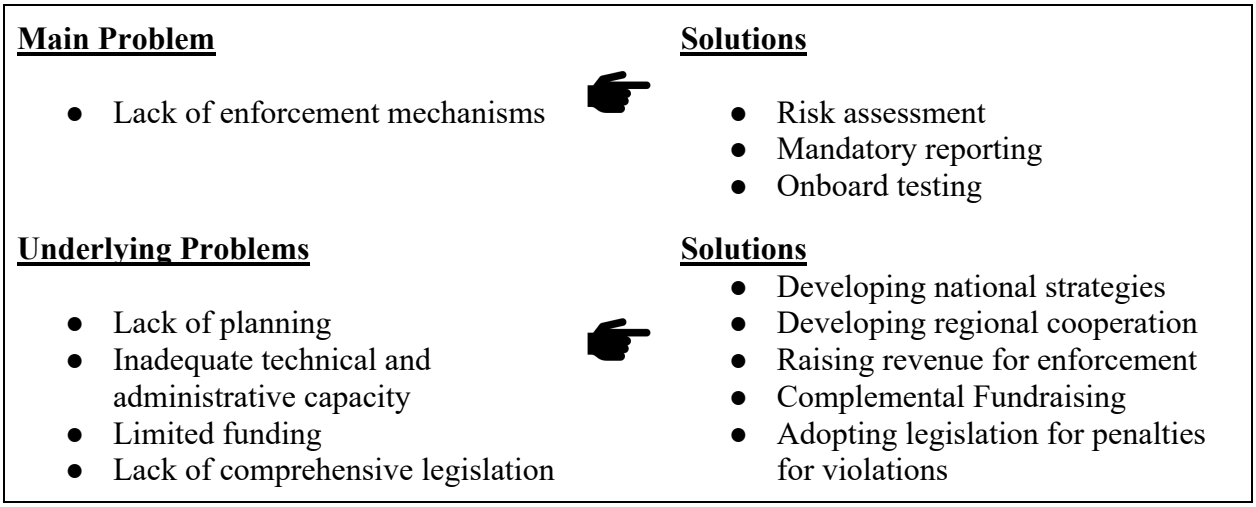


Figure 13: Problems and corresponding solutions

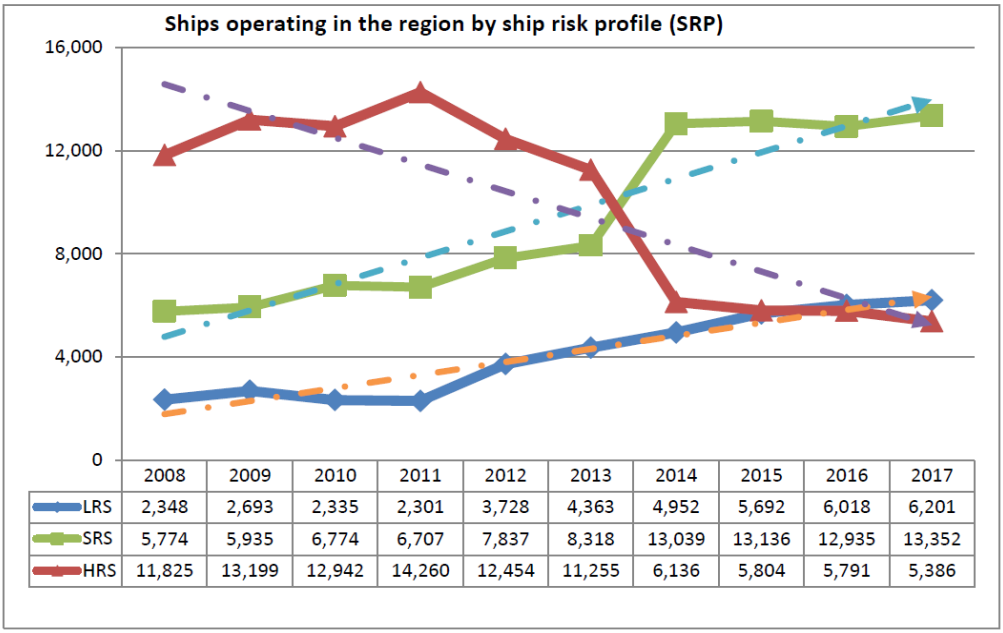
Naturally, Pacific SIDS are situated in a different environment than other countries, with differing needs and situations. SIDS are isolated islands with small economies. However, with maritime laws, their EEZs extend far into the ocean, giving them greater control of the water in comparison to land. In addition, SIDS do not have the same access to academic and technical resources developed countries do. Germany, for example, has greater access to academic and technical resources, takes the issue of ballast water very seriously. It also has ships coming in from both salt and freshwater ports, making short trips between these ports. SIDS in the Pacific mostly have ships hopping between islands, whose water is of similar salinity.

6.1 Developing the Most Appropriate Enforcement Regime

6.1.1 Risk Assessment

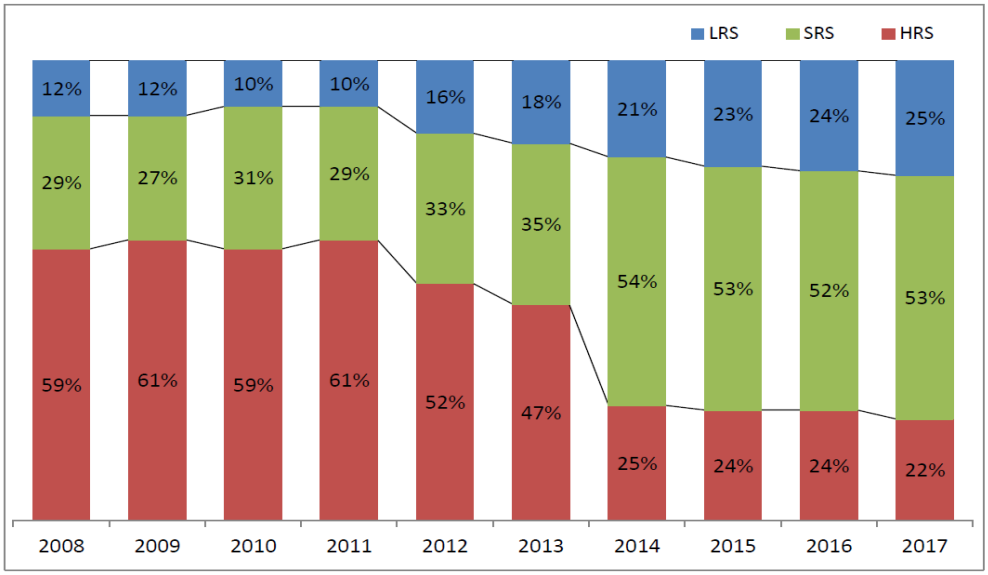
Considering the importance of regional harmonization, the New Inspection Regime that is used among Tokyo MOU member countries would be the most effective and optimized way for the seven SIDS to inspect at risk ships. In order to promote regional co-operation and harmonization of Port State Control activities, IMO recommended establishing regional Port State Control organizations and there are nine such organizations in the world. Standardized inspection methods prevent competition through skirting the rules and ships must prepare for similar inspections at different ports.

- Environmental effectiveness is "high" because it effectively addresses ballast water issues by identifying ships of higher probability of deficiencies in requirements and by incentivizing such ships to meet requirements. This is supported by the fact that the number of High-Risk Ships was drastically decreased while that of Standard Risk Ships drastically increased in the Asia-Pacific Region after the implementation of NIR in 2014 (Figure 14). The Tokyo MOU states that the big change was because of transition from previous system into the new system.[138]
- Financial feasibility is "high." The New Inspection Regime does not require any initial costs because they can freely use information provided by the Tokyo MOU. Using the publicly available data, SIDS are able to assess the risk of incoming ships.
- Administrative feasibility is "high" since the evaluation method is so simple that inspectors do not need heavy training to learn how to evaluate ships based on the inspection sheet.
- Political feasibility is "medium." It may require a permission from external groups, such as higher-level agencies that have stakes in private maritime businesses.



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
LRS	2,348	2,693	2,335	2,301	3,728	4,363	4,952	5,692	6,018	6,201
SRS	5,774	5,935	6,774	6,707	7,837	8,318	13,039	13,136	12,935	13,352
HRS	11,825	13,199	12,942	14,260	12,454	11,255	6,136	5,804	5,791	5,386

[138] Tokyo MOU, "25th Anniversary Memorial Brochure" (Tokyo: Tokyo MOU, 2018), http://www.tokyo-mou.org/doc/25%20years%20anniversary%20memorial%20brochure-web.pdf, 21.



Note: Big differences between 2013 and 2014 are because of transition from ship targeting system into NIR.

Figure 14: Ships in the Asia-Pacific Region by Ship Risk Profile

(Source: Tokyo MOU (2018) "25TH ANNIVERSARY OF TOKYO MOU." Tokyo MOU. December 11, 2018. P21. "http://www.tokyo-mou.org/doc/25%20years%20anniversary%20memorial%20brochure-web.pdf*)*

6.1.2 Enforcement Tools

To effectively enforce the regulations of the BWM Convention, SIDS have three tools, namely mandatory reporting, onboard testing and laboratory testing. Both the cost and efficiency increase as the SIDS go from mandatory reporting to onboard testing and to laboratory testing (Figure 15). Each of these tools is discussed in detail in the following section.

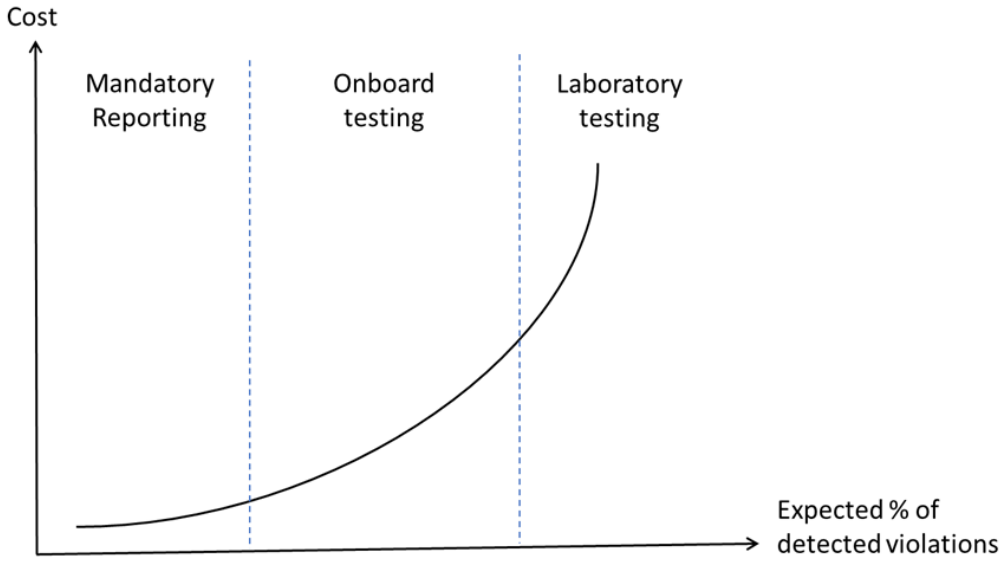


Figure 15: Cost vs. expected detections of violations for different enforcement tools

(Adopted from King and Tamburri, 2010)

6.1.2.1 Mandatory Reporting

Both as a requirement of the BWM Convention and as a good practice, it is important for SIDS to use reporting as the complementary tool to use as a baseline to get relevant information regardless of implemented enforcement tools. Reporting might be supplemented by some additional requirement to make it a stronger tool, such as requiring the reports 24 hours prior the arrival of the ship to the port in line with best practices implemented in the U.S. This practice enables port officials to be ready for inspection when the ship arrives. Moreover, providing a well-structured report template with predefined answers as well as options to the submitters are best practices since it lets the ship operators choose the most convenient way to fill out and submit the reports without having to deal with processes that may be complicated for them.

Preparing a report about their BWM practices, signing it, submitting to port authorities, and knowing that their reports will be inspected (and sanctions will be enforced in case of noncompliance) is expected to motivate ship owners to be more cautious in BWM practices. Still, it will depend on self-reporting and there is no way to ensure that reports reflect the truth by just looking at them. Also, even if the reports reflect the truth and all compliant behavior of BWM was conducted, it does not necessarily guarantee that ballast water to be discharged at the port is harmless to the local marine ecosystem. In any case, to ensure that discharged water does not contain harmful species, highly complex testing will be needed. Therefore, environmental effectiveness of this option is "low."

Requiring the submission of ballast water reports is the cheapest option among enforcement tools, namely onboard testing and laboratory testing. Basically, an email address or a fax number is enough to receive these reports which is available at the ports. In this case, additional costs would be negligible, if not zero. If an online web-based application is used for submission, the estimated cost is around $50,000.[139] It is also common in the software industry to keep 15-20% of the initial cost as a maintenance cost per year so $7,500-$10,000 is the average cost for maintenance.[140] Online systems have the additional benefit of being able to keep and display previous records so that when one is filling out a new report, much of the information is already there. In addition, since reporting only requires the submission of completed reports, it is easy to verify submissions. Since this process is not time intensive, currently employed port personnel Can be responsible for it, minimizing the need to hire more staff. The cost to the ships is also negligible because they are required to keep ballast water records under the BWM Convention. All that is needed in addition is to send the report in an email. Therefore, this option is highly affordable and so the financial feasibility is high.

The ease of submitting reports for ships and verifying submission leads to high degree of administrative feasibility. It will require little to no training to do such tasks.

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[139] Estimates are calculated by using https://estimatemyapp.com/ website, by defining a medium size platform, email and password sign-in, moderate level of user generated content (including file uploads), geolocation, payment processing (to pay fees or penalties), all admin features, enabled integration (in case the country has other online systems and wishes to integrate them) and security options including two factor authentication. The development of such a platform requires approximately 15 designer days and 109 developer days. This is an estimation of highly complex application which might be considered as the later versions of such online systems.

[140] Roy Chomko, "Maintaining an App is Critical to its Overall Success," *Fierce Wireless,* lhttps://www.fiercewireless.com/developer/maintaining-app-critical-to-its-overall-success (03/10/2019).

Since reporting is a requisite of the BWM Convention, there is no need to develop furhter regulation. A marine notice or letter published by the port authority will let all ships know about the requirement. This lack of need for high-level legislation eases the need for a high degree of political support. Moreover, mandatory reporting is unlikely to receive strong resistance from the shipping industry. Therefore, political feasibility is high for this option.

- Environmental effectiveness is "low" because self-reporting would likely stop only a small portion of violations. The likelihood of misreporting will be high, and it will be hard to detect misreporting.[141]
- Financial feasibility is "high." Reporting would cost both ships and port states very little. In one research paper, the cost of mandatory reporting is estimated to be nearly zero since verification will only include reviewing paperwork.[142]
- Administrative feasibility is "high" since submitting and reading reports requires very little training and could be easily manageable by current staff. Moreover, it can easily be incorporated into current inspection or reporting practices of the countries.[143]
- Political feasibility is "high." Mandatory reporting would not be difficult to implement and likely meet little resistance from shippers.

6.1.2.2 Onboard Testing

Onboard testing is an ideal option for verifying compliance. The testing machines themselves are not very expensive and it is easy to train members of port authorities or environmental protection agencies to operate them. A few inspectors would need to be hired. However, since the jobs would not require extensive training, salaries would not be prohibitive. These machines are also somewhat environmentally effective as they are able to identify when ballast water is not up to standard. It is also politically feasible with the low cost and the quickness of results. Ship operators can hardly object when tests results come back so quickly.

- Environmental effectiveness is "medium" because the sensors are effective at discovering ballast water clearly in violation. One estimate places likely effectiveness of onboard testing catching violations at between 50 to 90%.[144]
- Financial feasibility is "high" because the sensors are not costly.
- Administrative feasibility is "high" since training inspectors would not be difficult
- Political feasibility is "high." Considering the above situation, there is likely to be little political resistance to these measures.

6.1.2.3 Laboratory Testing

Laboratory testing is not feasible based on the current situation of SIDS in the Pacific, as SIDS lack both financial and administrative capacity. Financially, a laboratory would be far too expensive, requiring expensive equipment and hefty salaries for the highly trained scientists needed to run those labs. Administratively, SIDS lack the technical capacity to build a laboratory themselves and would have to hire outside experts. However, laboratory testing would be the most environmentally effective way of verifying compliance.

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[141] King and Tamburri (2010), 157.
[142] *Ibid.*, 157.
[143] *Ibid.*, 159
[144] *Ibid.*, 159.

- Environmental effectiveness is "high" because the sensors are very effective at discovering ballast water in violation. One estimate places the likelihood of finding violations at around 95%, depending on the amount of water sampled.[145]
- Financial feasibility is "low" because the aboratories contain costly equipment.
- Administrative feasibility is "low" since well-trained scientists would need to be brought to the island.
- Political feasibility is "low." Considering the above situation, there is likely to be political resistance to these measures from both politicians in port states and shippers.

	Environmental Effectiveness	Financial Feasibility	Administrative Feasibility	Political Feasibility	Total Score
Onboard testing	2	3	3	3	11
Laboratory testing	3	1	1	1	6

1: Low 2: Medium 3: High

Table 3: Criteria-Alternative Matrix for Oversight Mechanisms

Reporting and risk assessment do not substitutes for enforcement tools but should instead complement the chosen tool. On the other hand, onboard testing and laboratory testing are considered substitutes of each other and are evaluated in the Table 3 by the criteria defined. Criteria Alternative Matrix analysis suggests that onboard testing is the optimal option for SIDS.

6.2 Building Infrastructure Around Enforcement

In the first set of recommendations, we discussed and recommended the most appropriate enforcement regime, which directly address the problem: lack of enforcement of port states. The following second set of recommendations provides the Pacific SIDS options to address the underlying problems that are contributing to the lack of enforcement; namely, lack of planning, technical and administrative capacity, and funding.

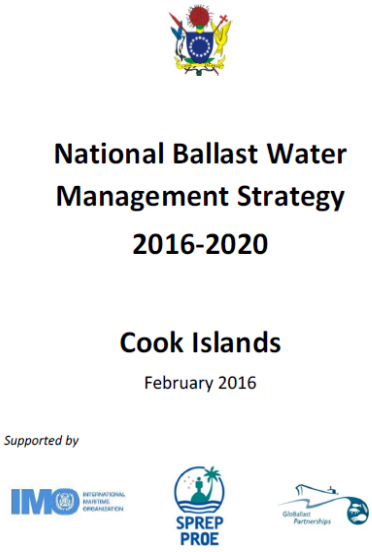
6.2.1 Developing National Strategies

To realize the first phase of recommendations, port states should start by developing national strategies, in which their current situation and priorities are discussed, and ways for securing needed resources and legislation are planned. The BWMC obligates ratifying countries to develop national policies, strategies or programs for ballast water management. Together with individual policies and programmes, creating comprehensive strategy is a key to successfully address ballast water issues, which overarch various government agencies and external stakeholders. A national strategy can enable SIDS to effectively implement policies and promote cooperation among stakeholders by clarifying a set of important decisions and actions, such as national goals, strategic priorities, action plans with a timeline, and stakeholders' responsibilities and their objectives.

However, according to SPREP, Fiji, Kiribati, and Palau have not developed a national strategy while the Cook Islands, Marshall Islands, Tonga, and Tuvalu have. Without significant

[145] *Ibid.*, 159.

spending, Fiji, Kiribati and Palau would be able to learn from precedent cases and develop a strategy, supported by international and regional organizations, such as IMO, SPREP, GloBallast Partnerships, which provided other SIDS with administrative and technical support for strategy making.


National Ballast Water Management Strategy 2016-2020

Cook Islands

February 2016

Supported by

IMO SPREP PROE

Contents

1. Executive Summary ... 3
2. Glossary ... 5
3. Introduction ... 6
3.1 Background to the issue of Invasive Alien Species ... 6
3.1.1 Internationally ... 6
3.1.2 Regionally ... 8
3.1.3 National (Cook Islands) ... 10
3.2 Ballast Water Management Convention ... 12
3.3 Shipping Activity ... 13
3.4 Existing Introductions ... 15
3.5 Scope ... 15
4. Purpose of the Strategy ... 15
5. Strategic Priorities ... 15
6. Leading Agency ... 16
7. National "Task Force" ... 17
8. Action Plan and Implementation Timetable ... 19
9. References ... 22

Figure 16: An example of national strategy: Cook Islands' national strategy
(Source: Cook Islands (2016) "National Ballast Water Management Strategy 2016-2020." February 2016. P1-2. https://www.sprep.org/attachments/VirLib/CookIslands/national-ballast-water-strategy.pdf)

Note: National strategies of Cook Islands, Marshall Islands, Tonga, and Tuvalu have the following common contents: purpose and scope of the strategy, strategic priorities, leading agency, national task force, action plan and implementation timetable

- Environmental effectiveness is "high" because it is a fundamental to tackle ballast water issues in a comprehensive and strategic way. With a well-developed national strategy, SIDS can clarify the most important courses of action in which scarce resources are allocated and can promote interagency collaboration that generates higher performance. Agencies often are able to find productive ways to work collaboratively and generate greater outcomes than can be achieved by working alone when the collaboration involves in common values and interests of the agencies[146]. In order to realize such effective collaboration, public managers need to be elaborate on identifying opportunities for value-adding collaboration and minimizing transaction costs and problems that can be caused from collaboration.
- Financial feasibility is "high." A certain amount of expenses associated with research, coordination, and publication are required. However, SIDS would be able to reduce these costs by utilizing existing data and publishing it only on their websites.
- Administrative feasibility is "medium." SIDS are be able to learn from precedent cases of other islands nations and get administrative and technical support from regional and international organizations.

[146]Mark T. Imperial, "USING COLLABORATION AS A GOVERNANCE STRATEGY: Lessons from Six Watershed Management Programs," *Administration & Society* 37, No. 3 (2005): 281-320, https://journals.sagepub.com/doi/pdf/10.1177/0095399705276111.

- Political feasibility is "medium." There might be some opposition from private companies that try to minimize negative impacts on their business. However, developing a national strategy would not be politically infeasible considering that it is an international requirement and some SIDS have already created it.

6.2.2 Developing Regional Cooperation

In the western Pacific Ocean, the marine ecosystems of the SIDS are highly interconnected (See Figure 1). Moreover, SIDS are under particular risk of invasive species due to their particular dependence on shipping and maritime transport.[147] Considering these issues, it is clear that there should be a collective action to control, prevent and eliminate spread of harmful invasive species in this region.

Many of the recommended collective actions can be aggregated in "information sharing" which is the most prominent way of regional cooperation. the BWM Convention also dictates cooperation in information sharing about technical measures as well as best practices and national requirements. Specifically, the BWM Convention requires that each country promote availability of relevant information about issues such as technical and scientific measures undertaken, effectiveness of ballast water management deduced from implemented monitoring or assessment programs.[148] It also requires each country report to IMO the information about national requirements and procedures for implementation of the BWM Convention so that it is available for other member countries[149] which might also be considered as a dictate to cooperate in information sharing. Apart from obligations put by the BWM Convention, disadvantages of lack of technical knowledge can be compensated by sharing ballast water management related information with neighboring countries with similar limitations. More specifically, it would be effective for SIDS who are tackling ballast water issues to have a common database. The database might serve several purposes: to record and share important environmental information, national regulations and procedures, implemented and proved to be successful practices, ships' ballast water reports, information about violations and ships who committed those violations etc. This database could record native species living in each state's ecosystem, their vulnerability to invasive species and also their risk to other native species living in neighboring ecosystems, and also copies of ballast water management records of each ship can be uploaded onto this database. In addition, offenders and repeat offenders can be flagged so each state is aware of the risk associated with those ships. SPREP might be utilized to develop strategies for such a database and maintain it, with the members of SPREP sharing the cost of developing such a database. SPREP would also play an important role for providing a standardized format for ships' ballast water reports.

In addition to information sharing, regional cooperation should also include collective action in enforcement and penalties. Since these SIDS are highly interconnected in terms of both geographic proximity and maritime transport, any SIDS' effort to manage ballast water related problems individually would not be effective. They share the ocean and its problems so the solution should also be the one that is shared. Therefore, it is vital that SIDS collaborate in their regulations in terms of enforcement and penalties and use uniform measures. Particularly, regional cooperation should also include use of aligned formats and procedures in enforcement of the BWM Convention and collaboration on similar penalties for violations of the regulations. Without having such

[147] SPREP, "Shipping-related Introduced Marine Pests in the Pacific Islands: A regional strategy," *op. cit,.* i.
[148] BWMC, Article 6, paragraph 2.
[149] *Ibid.*, Article 14, paragraph 1.

uniformity, encouragement for compliance will be very limited for the ships as they might continue destroying the marine ecosystems by just bypassing the strictly enforcing SIDS. Moreover, it is one of the obligations put on the countries by the BWM Convention. For instance, Article 13 dictates that countries shall seek to cooperate with each other to develop harmonized procedures.[150] This regulation is in line with our recommendation to use uniform enforcement tools and formats. Furthermore, it is explicitly obligated to cooperate in the detection of violations and enforcement of the BWM Convention[151], in line with our recommendation to share information about violations and using similar penalties. Having a common format and enforcement tools will refrain ships from having to deal with several different procedures and make it easy for them to comply. For instance, if a uniform reporting format is used regionally, then ships will easily prepare reports for each port call without getting confused about which report was requested by which country. Also, when uniform or even similar penalties are used for violations, then ships will have no place to go in the region to avoid such sanctions. This also applies to using similar fee/charge structures, if any. When there is a regionally harmonized financial costs on ships due to ballast water regulations, then ships will not be able to avoid such costs by just avoiding that individual SIDS. All these cooperation areas will both increase the likelihood of compliance and decrease the risk of losing competitiveness of SIDS due to regulations to protect their environment.

- Environmental effectiveness is "high" because it effectively addresses our policy objective. Port states can use the information that shared in this database to prioritize high risk ships for inspections at ports. Also having harmonized procedures and penalties will encourage compliance of ships. According to the report by Tokyo MOU, the organization has been targeting under-performing ships since 2014, and currently, "the numbers of under-performing ships involved are only one fourth of those at the initial stage of implementation of the measures targeting under-performing ships."[152]
- Financial feasibility is "medium." A certain amount of initial cost for a system installation, and also operational costs including personnel expenses are required. However, the burden for each port state would be not high since costs are shared among participating SIDS. For example, Tokyo MOU spends around $60,000 per year for its software[153], but it would be less than $10,000 per SIDS if divided by seven SIDS.
- Administrative feasibility is "medium to high" since it requires coordination costs resulting from a close collaboration with the SPREP and other SIDS. The administrative feasibility will highly depend on the current administrative capacity of the SIDS and current level of cooperation. If they are already cooperating, it will be "high" because they will know each other, and they will already have set a norm to work together. Otherwise, it will be medium.
- Political feasibility is "medium". Technically, it does not require a permission from external groups, but does require a lot of cooperation which might be challenging to find an optimum solution, especially in penalties.

[150] BWMC, Article 13, paragraph 3.
[151] *Ibid.*, Article 10, paragraph 1.
[152] The Tokyo MOU Secretariat, "Annual Report on Port State Control in the Asia-Pacific Region 2017" (Tokyo: The Tokyo MOU Secretariat, 2017), http://www.tokyo-mou.org/doc/ANN17.pdf, 3
[153] The Tokyo MOU Secretariat, "Balance Sheet for FY2018," http://www.koueki-tms.or.jp/pdf/h29_bs.pdf, 1

6.2.3 Raising Revenue for Enforcement

Considering limited financial resources of SIDS, they should consider ways to raise additional revenue to cover some expenses for ballast water inspections.

One way is collecting charges from port users. It is common that port authorities charge for the use of their facilities and for services they provide at ports. There are various kinds of charges. Typical charges include Port dues, Pilotage, Towage, Berth, Cargo Handling, Security.[154] It is recommended that port states consider to raise revenue for enforcement by adjusting the amount of current charges (e.g. Port dues) or establish new levies like Australia, depending on each nation's situation. Collecting charges from port users would be effective and useful for port authorities because it would be easier to limit the use of collected money to port-related matters.

BOX 3: Local levies in Australia[155]

Australia Maritime Safety Authority "have a user pays approach to the provision of navigational aids, protection of the sea, and pollution clean-up activities" (Marine navigation levy, and Protection of the sea levy). They keep the levy system transparent by announcing that which levy will be used to recover the expenses of which services in their website.

In addition to regular inspections, there are some further expenses for ports when ships turn out they need follow-up inspections and/or detentions. For those cases, it is recommended that port states charge actual costs to ship owners. While regular inspections should be free (shippers do not get advanced notice of inspections), follow-up inspections and detention cases can be charged to the ships because they are a direct result of noncompliance. National legislation will be needed to start charging on vessels. As this practice is common worldwide, it is less likely there is opposition from shipping companies.

BOX 4: Charge for carrying out Port State Control inspections in other countries[156]

Italy: Authorities charge the owner only if the vessel has been detained. The amount to be paid will be €756,88 if the inspection which resulted in the detention of the vessel was a "more detailed" one and €1.248,46 if the inspection was an "expanded" one.
New Zealand: An hourly rate (NZ$166) is applied for second and subsequent inspections of foreign vessels in accordance with the Shipping Regulations 2000.
Australia: An hourly rate (A$ 272) is applied for follow-up inspections.

[154] United Nations Economics and Social Commission for Asia and Pacific (UN ESCAP), "COMPARISON OF PORT TARIFF STRUCTURES," https://www.unescap.org/sites/default/files/pub_2190_ch3.pdf, 2002, 16
[155]Australian Maritime Safety Authority, "Fines, Levies, and Payments." https://www.amsa.gov.au/about/fees-levies-and-payments#collapseArea350 (03/16/2019).
[156]Federation of National Associations of Ship Brokers and Agents, "Kenya Port-State Control Survey." https://www.fonasba.com/wp-content/uploads/2015/05/Kenya-Port-State-Control-survey.pdf (03/01/2019).

- Environmental effectiveness is "medium to high" because, while revenue-raising itself does not directly have effectiveness, it is almost necessary to strengthen enforcement, which is highly effective to protect their local environment.
- Financial feasibility is "high." There are some costs associated with revenue-raising, such as management costs, especially at the beginning. However, these costs would not be significant.
- Administrative feasibility is "high." Mechanisms exist for imposing charges to shipping liners.
- Political feasibility is "medium." Charging costs of pollution prevention on the polluter is internationally agreed principle, known as Polluter-Pays Principle, which was adopted by OECD in 1972 as an economic principle to allocate the costs of environmental pollution control[157]. Theoretically, the costs of pollution prevention policies should be reflected in the costs of goods and services that cause environmental pollution[158]. However, since shipping industry is very important for SIDS, they would have high lobbying power against such new charges.

6.2.3.1 Other Ways to Complement Funding

Most Pacific SIDS receive aid and grants from international organization and developed countries. These sources of funding are helpful but may not sometimes be available or not necessarily quite useful in terms of amounts, promptness, and flexibility. One way to complement funding for ballast water management would be corporate philanthropy. Due to the growing importance of corporate social responsibility, donation by companies has been increasing. In the U.S., donations by corporations grew by 8% to $20.77 billion in 2017[159] (Charity Navigator 2018)[160] There would be a chance for SIDS to gain donations from companies that care about environment and welfare in developing nations.

In addition to those traditional sources, there are ways to raise funds through the financial market, such as loan, bonds, and investments. Among other market-based funding channels, green bonds ought to be considered by SIDS's policy makers. Green bonds are bonds wherein the proceeds are invested exclusively in projects that provide positive environmental effects. For market participants who concerns about sustainability, such as large pension funds, green bond is a good way to commit to building sustainable society while pursuing investment opportunities. After the publication of the Green Bond Principles in 2014, the issuances of green bonds have been drastically increasing globally, especially in Asia (Figure 17). Green bonds benefit SIDS in several ways: expansion of financial base by building relationships with new investors, the possibility of raising funds on relatively favorable terms, and acquisition of public support by demonstrating

[157] According to the OECD, Polluter-Pays Principle implies that "in general it is for the polluter to meet the costs of pollution control and prevention measures, irrespective of whether these costs are incurred as the result of the imposition of some charge on pollution emission, or are debited through some other suitable economic mechanism, or are in response to some direct regulation leading to some enforced reduction in pollution." OECD, "The Polluter-Pays Principle OECD: Analyses and Recommendations" (Paris: OECD, 1992), 27.

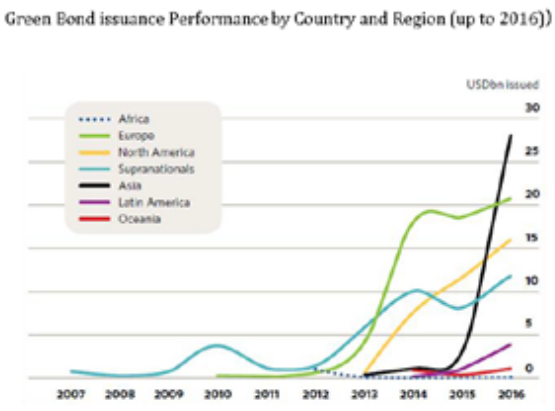
[158] OECD, "Economic Instruments in Environmental policy: Lessons from The OECD Experience and Their Relevance to Developing Economies" (Paris: Jean-Philippe Barde, OECD, Working Paper No. 92, 1994), 6.

[159] Corporate donation account for 5% of all donations. Donations to charity reached an all-time high in the US in 2017, with an estimated $410 billion investments towards philanthropic efforts.

[160] Charity Navigator, "Giving Statistics," https://www.charitynavigator.org/index.cfm?bay=content.view&cpid=42 (02/14/2019).

commitment to sustainability (MOE 2017).[161] Furthermore, SIDS would be able to have technical supports in structuring and issuing bonds from multilateral development banks, including the World Bank, European Investment Bank, and the Asian Development Bank that have expertise in green bonds.

Source: Created by the Ministry of the Environment based on the website of Climate Bonds Initiative and "2015 Green Bond Market Roundup" published by the Climate Bonds Initiative.



Source: An excerpt from Climate Bonds Initiative "Green Bonds Highlights 2016"

Figure 17: Data about Green Bond

(Source: "Green Bond Guidelines." Japan's Ministry of the Environment, March 2017. 16-18. http://www.env.go.jp/en/policy/economy/gb/en_greenbond_guideline2017.pdf*)*

Market-based approaches inevitably require SIDS to pay back to investors. Except some cases, such as cases where SIDS raise port user fees or tax, profits made directly from BWM projects tend to be very limited though it would have a significant positive impact on the entire domestic economy by protecting local ecosystem. Because of this mismatch between market expectations and attributes of benefits associated with BWM policies, it is unlikely that raising capital through the market is a main source of funding for most SIDS. However, there are cases of Pacific SIDS issuing green bonds in the past. Fiji has issued a sovereign green bond, raising $50 million to move to a climate-resilient and low carbon society. The bond proceeds will be used for projects, such as renewable energy, energy efficiency, climate change resilience, sustainable management of natural resources, low-emission transportation, water efficiency, wastewater management and pollution reduction[162]. The World Bank and the International Finance Corporation (IFC) provided the Fiji government with technical assistance to issue the green bond. What SIDS can learn from this case is that they might be able to issue green bonds by aggregating projects, some of which generate enough profits to pay back to investors, even if a ballast water project is not profitable itself. Another thing that enable SIDS to issue green bonds is a growing interest of institutional investors. For example, IFC's $2 billion Green Cornerstone Bond Fund,

[161] Japanese Ministry of the Environment, *Green Bond Guidelines* (Tokyo, Japan: Ministry of the Environment, March 2017).19

[162] Diletta Giuliani, "Sovereign Green Bonds Briefing," Climate Bonds Initiative, March 2018, https://www.climatebonds.net/files/reports/sovereign_briefing2017.pdf. 10

which is jointly created with Amundi and one of the largest green bond funds, will invest in green bonds that are issued by local banks in developing nations[163].

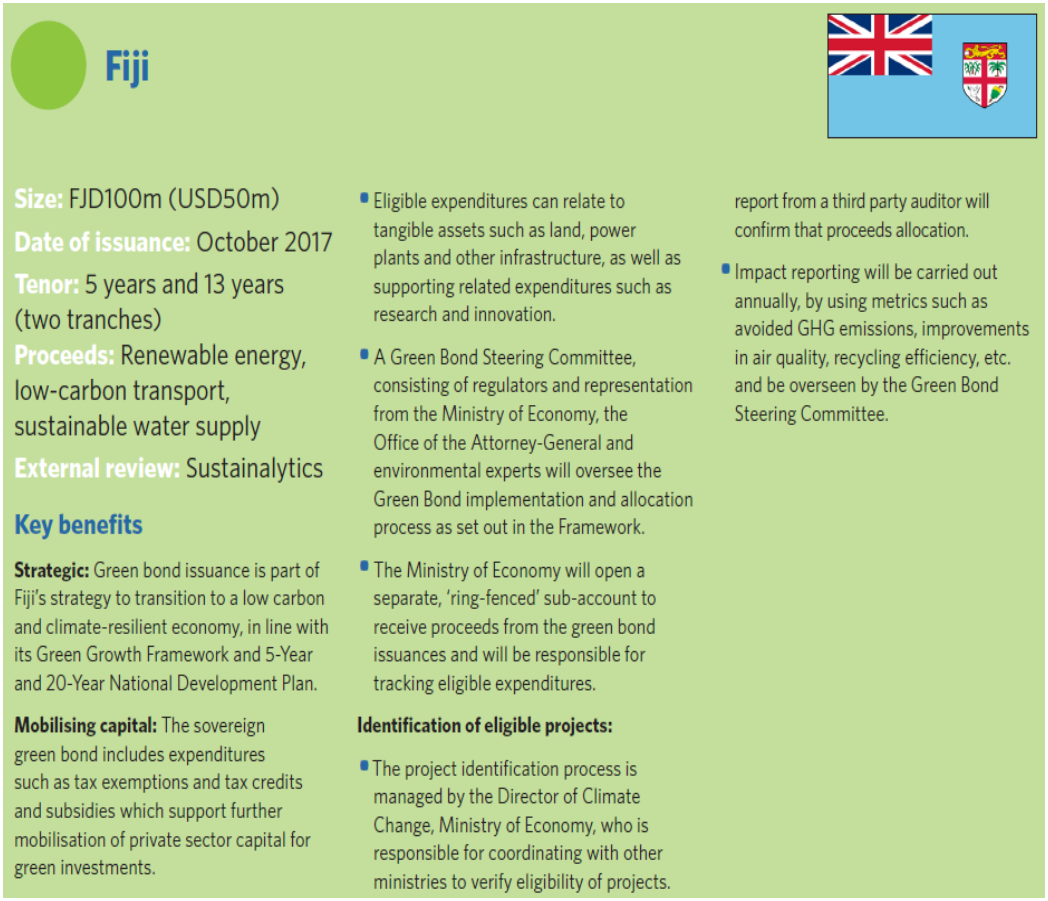


Figure 18: Case of Issuance of Green Bond in Fiji
(Source: Diletta Giuliani (2018) "Sovereign Green Bonds Briefing." Climate Bonds Initiative. March 2018. P 10 https://www.climatebonds.net/files/reports/sovereign_briefing2017.pdf*)*

- Environmental effectiveness is "medium" because additional funding would indirectly improve the local environment. With additional funding, SIDS can conduct more precise research, purchase tools for enforcement, and hire additional inspectors.
- Financial feasibility is "high." There are some costs associated with fundraising, such as grant writing, management costs, and interests for market-based capital. However, these costs would not be significant compared to the entire amount of the fund.
- Administrative feasibility is "medium to high." SIDS have experience in writing and managing grants from other countries or companies. In the case of market-based fundraising, it requires expertise in collecting investors, structuring, managing, and

[163] Christopher Kaminker, Christine Majowski, and Rory Sullivan, "Green Bonds - Ecosystem, Issuance Process and Case Studies" (Berlin: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. January 2018), https://webapp.sebgroup.com/mb/mblib.nsf/a-w/3c57af239091dddfc125822400522b99/$file/giz_seb_greenbondpublication_web.pdf. 45

reporting though there would be the possibility of getting technical supports from multilateral development banks.

- Political feasibility is "high." Even though it usually requires permissions from external groups, such as department of treasury and the congress, they would be welcome to new source of funding.

6.2.5 Legislation of Penalties for Noncompliance

Aside from enforcement tools, legislation can be the foundation of enforcement. Article 4 of the BWM Convention states that each country shall take effective measures to ensure that ships to which the BWM Convention applies comply with all requirements.[164] the BWM Convention only sets the standards and a framework for regulating the ballast water practices in each country but not specify the details. Particularly, the BWM Convention dictates that sanctions for any kind of violation of the requirements of the BWM Convention shall be established under the law of the states[165] with a special attention paid to flag states since they are the ones who shall ensure compliance of the ships under their flag. In line with this regulation, states should determine sanctions and take punitive measures appropriate for their particular circumstances and enforce them themselves.

Legislation in each country should clearly define what ships need to do, how and when with essential details. Also, the penalties for noncompliance should be explicitly defined in the related legislation. It is recommended that such penalties be included but not limited to fines, detention, invasive inspection upon return, and informing ports around the Pacific of those shipping companies with ships found to be in noncompliance.

- Environmental effectiveness is "medium to high". If prepared comprehensively and enforced strictly, such legislation is expected to be moderately effective to discourage discharge of untreated ballast water. Since having legislations does not necessarily mean that it is enforced, the environmental effectiveness would not be maximized.
- Financial feasibility is "high". Since adopting legislation will be done in routine law-making procedures in each country, there would not be extra financial costs to include specific regulations about consequences of noncompliance.
- Administrative feasibility is "high." Mechanisms exist for creating and passing legislation.
- Political feasibility is "medium". Since the shipping industry is very important for SIDS, they will have high lobbying power against such legislation which makes political feasibility very medium.

6.2.5.1 Types of Penalties

Fines

Interviewees had a low view of fines, claiming they will be disputed in international courts, where shipping companies will likely have advantages. More effective methods of punishments will disrupt the shipping business itself. Still, the presence of fines might create a nuisance to push some compliance.

- Environmental effectiveness is "medium." Its likely fines will have little effect.

[164] BWMC, Article 4.

[165] *Ibid.*, Article 8, paragraph 1.

- Financial feasibility is "high" as it costs very little to administer a fine.
- Administrative feasibility is "low" as states are unlikely to be able to administer fines.
- Political feasibility is "low" as interviews state fines would be rarely enforced, and shipping companies would push back strongly.

Detention

This type of penalty is likely more effective as it disrupts shipping activities. However, according to interviews, no SIDS engage in detention, despite the fact maritime law gives them this right.

- Environmental effectiveness is "medium" as its likely an effective deterrent for shipping.
- Financial feasibility is "high" as it likely costs little keep a ship in port.
- Administrative feasibility is "low" because so far, SIDS have not shown the willingness to keep ships in port and would face stiff opposition from shipping companies.
- Political feasibility is "low" as its likely shipping companies would protest, and SIDS seem to have little willingness to detain ships.

Publicity

If ships are found to be in violation, this information should be shared with other ports and just other SIDS.

- Environmental effectiveness is "medium" as ships knowing their violations would be known around the world would likely cause some change in behavior.
- Financial feasibility is "high" as this would cost very little.
- Administrative feasibility is "high" as sending information to other ports is easy.
- Political feasibility is "high" as shipping companies can do little about this

Further Inspection

This issue would probably run into the same problems as detentions. Shipping companies would fight it. Note, some countries who do this make the shipping companies themselves pay for further inspection, and this would be a recommended practice.

- Environmental effectiveness is "medium" as the threat would likely have some effect on the behavior of shippers.
- Financial feasibility is "low" as shipping companies themselves would pay for the
- Administrative feasibility is "medium" as inspectors need to be trained.
- Political feasibility is "low" as SIDS do not seem to have the political will to detain ships.

It should be noted that penalties should make the cost of compliance lower than the cost of non-compliance. This means the cost of fines or disruption to shipping should be higher than the cost of operating a BWTS. As stated previously, the estimation is around $70,000. Any fine should be multiplied by the likelihood of getting caught. With the type of inspection we are recommending, this number should be 0.6. $70,000 divided by 0.6 is approximately equal to $120,000, so fines and/or disruption to economic activities should cost the ship around that much per violation. As we had a low rate of response from shippers it is difficult to estimate exactly how much disruption to shipping costs per day, so estimates are difficult and possibly unwise based on our lack of information.

	Environmental Effectiveness	Financial Feasibility	Administrative Feasibility	Political Feasibility
Developing the Most Appropriate Enforcement Regime				
Risk Assessment	High	High	High	Medium
Reporting	Low	High	High	High
Testing				
Onboard testing	Medium	High	High	High
Lab testing	High	Low	Low	Low
Building Infrastructure Around Enforcement				
National Strategies	High	High	Medium	Medium
Regional Cooperation	High	Medium	Medium to High	Medium
Raising Revenue for enforcement	Medium to High	High	High	Medium
Complemental Fundraising	Medium	High	Medium to High	High
National Legislation	Medium	High	High	Medium
Penalties for Noncompliance				
Fines	Medium	High	Low	Low
Detention	Medium	High	Low	Low
Publicity	Medium	High	High	High
Further Inspections	Medium	High	Medium	Low

Table 4: Summary of Evaluation for Each Options

6.3 Discussion

Ideally, SIDS would be able to conduct high volume precise laboratory testing on ballast water to combat the threat of IAS. However, financial and technical constraints render this option infeasible so other options must considered. Our analysis suggests that onboard testing can be an effective alternative to check whether the risk ballast water on incoming ships. Since it is not feasible to inspect all ships, the ports should conduct a risk assessment to decide which ships need to be inspected; this optimizes the benefits and costs of inspection. In addition, prior to arriving at port, all ships should be required to submit a ballast water report to declare their ballast water

activities, ship schematics, and a voyage itinerary to give port officials proper information to assess the risk.

However, these tools alone would not be sufficient to effectively enforce ballast water regulations and sufficient infrastructure should be built around inspection. These complementary tools include developing national strategies, which would lay out a roadmap for ballast water management dealing with all related aspects such as possible resources, cooperation among stakeholder or timeline to accomplish certain goals. Such a roadmap will ensure having a comprehensive national perspective to deal with ballast water related problems and help to implement solutions. As another complementary tool, cooperating in regional level with other SIDS in aspects such as information sharing, enforcement tools and penalties is also very important. Without regional cooperation, the impact of enforcement tools would be limited due to SIDS' high interconnectedness. Acknowledging the financial constraints of SIDS, it is also important to find ways to increase revenues so that they can conduct the onboard testing and other tools. Lastly, to provide a legal baseline for all regulations and discourage the shipping industry from violating the regulations, there should be national legislation which explicitly defines the penalties for violation. Lack of such national legislation would undermine the motivation for ships to comply no matter which tool is used to inspect them.

All our recommendations are meant to help Pacific SIDS to protect their marine environment from ballast water related problems without a resulting in decline in ship calls due to strict enforcement standards. It is important to note that if implemented comprehensively, our recommendations are unlikely to deteriorate the competitiveness of the ports and SIDS due to several reasons. First of all, as explained previously, the responsibilities of ships to manage ballast water come from an international convention which is ratified by their flag states. It is the flag states who need to ensure all ships in their registry are in full compliance with the BWM Convention. In this sense, no matter how strict the enforcement tools in port states are, ships have to manage their ballast water properly in accordance with the regulations in the BWM Convention and our recommendations are based on mechanisms just to ensure this. Secondly, we highly recommend cooperating on a regional level with all aspects of BWM of the port states, including cooperation in enforcement tools, required documents and penalties for violations. Our recommendations should be considered as a set since each of them complements the others. Thus, if SIDS have a shared scheme of enforcement and penalties, the risk of losing competitiveness due to ballast water regulations will be very limited. Thirdly, there are more than 10 shipping companies[166] serving to Pacific SIDS which compete with each other to provide logistics service to their customers who are basically exporting and importing companies. Since competition among shipping companies as the private sector actors is naturally more than competition among states, it is likely that in case of a shipping company deciding not to call at a port due to ballast water regulations, it will be that shipping company who loses business, not the port itself. There is also some research analyzing the cost of ships' compliance to the BWM Convention and its impact on other stakeholders which concludes that since the shipping industry has the capacity to pass the cost of compliance to its customers,[167] the overall impact of enforcing ballast water regulations is likely to be insignificant.[168] Likewise, any additional charge or fee put by the ports to effectively enforce the BWM Convention will be embedded in the cost of services the shipping companies

[166] For a list of shipping companies serving the region, see the Appendix.

[167] The research also finds that the price increase in final products would only be around 0.005% which is probably not statistically significantly different from zero.

[168] IMO, *Economic Assessment of Ballast Water Management*, GloBallast Monograph Series No.24, *op. Cit.*, 5.

provide. Assuming that enforcement tools will not have unfair exemptions, such costs will be borne by all ships so it will not distort the relative competitiveness of ships with regard to a single port and will not affect ships' decision to call at the port. Moreover, as our research on shipping routes[169] indicates, the ships call on several ports in a single voyage since they operate in loops, instead of going only to one destination. This means that even if any ship decides not to call at a single port due to regulations, it will still need to cross that region and in that case cancelling calling to port will not be a rational decision for a profit-seeking entity. Also, we learned from our interviews with shipping companies that SIDS are used as final destination, not as a hub so that the ships do not necessarily have much bargaining power to resist enforcement. Lastly, one of the experts we interviewed informed us that SIDS know each other well and this motivates them to be better in every aspect, including environmental issues. He also stated that SIDS are in a kind of race with each other to do their best and governments especially care about being the pioneer in the region so that when any of the SIDS initiate something, the other will follow. Based on this information, it is likely that SIDS in the region will align themselves with using similar enforcement tools, rather than competing to attract polluting ships.

7. CONCLUSION

In conclusion, to address the lack of enforcement, risk assessment, reporting and onboard testing are the ones that should be implemented considering environmental effectiveness, financial, administrative, and political feasibility. To develop infrastructures around enforcement, we made several recommendations that include legislation, national strategies, regional cooperation, revenue-raising for enforcement, and complemental fundraising. We discuss each recommendation from the perspective of each evaluation criteria, since when they select policies from our list of recommendations, it is considerably important to take such distinctive factors into account.

Ultimately, we believe implementing these recommendations will safeguard marine environments for Pacific SIDS. Not implementing them at some level leaves these nations vulnerable to invasive species and potential environmental and economic catastrophe.

[169] For sample routes, see Appendix.

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APPENDIX: International Shipping in the Pacific Region

List of Shipping Companies Serving to Pacific SIDS

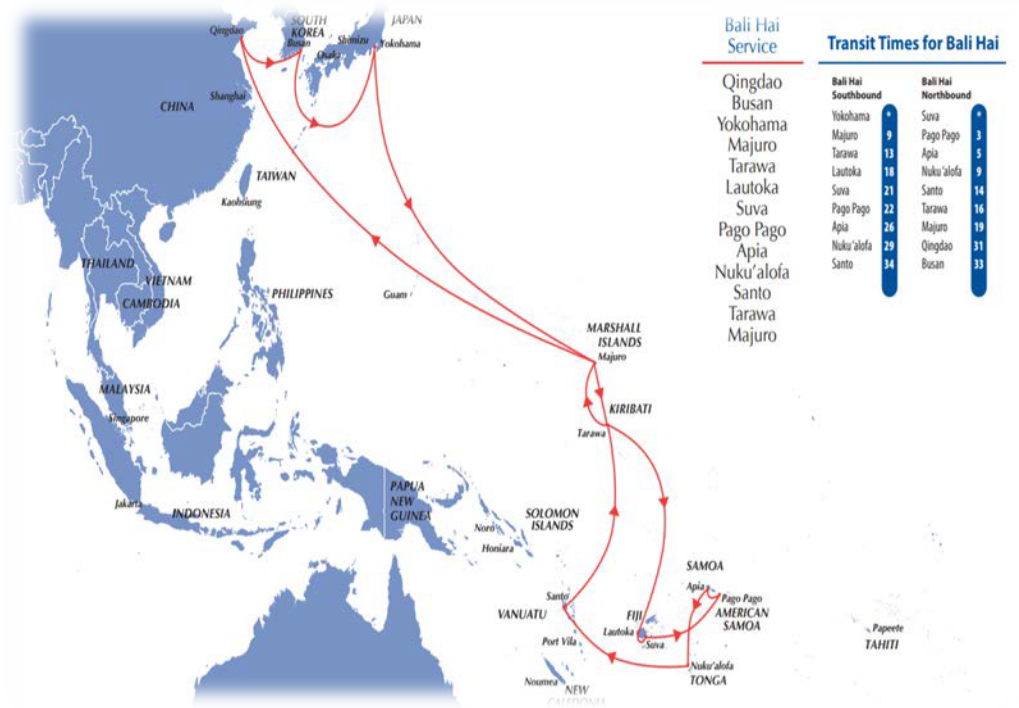
- Kyowa Shipping Co Ltd https://www.kyowa-line.co.jp
- Ocean Network Express (ONE) https://www.one-line.com/
- Matson Inc. https://www.matson.com/
- Pacific Direct Line (PDL) http://www.pdl123.co.nz/
- Sofrana Unilines (Sofrana) http://www.sofrana.co.nz
- Pacific Forum Line (PFL) https://www.pacificforumline.com/
- Neptune Pacific Line https://www.neptunepacific.com/
- Swire Shipping http://www.swireshipping.com/
- CMA CGM Panama Direct Line https://www.cma-cgm.com/products-services/line-services/flyer/RTWPAN
- Hamburg Sud https://www.hamburgsud-line.com/liner/en/liner_services/index.html
- Mariana Express Lines Pte. Ltd. (MELL) https://www.mellship.com/
- Polynesia Line http://www.polynesialine.com/polynesialine/home_page.html
- ANL https://www.anl.com.au/
- Pacific International Line https://www.pilship.com/en-pil-pacific-international-lines/1.html

List of Shipping Agencies Located in SIDS

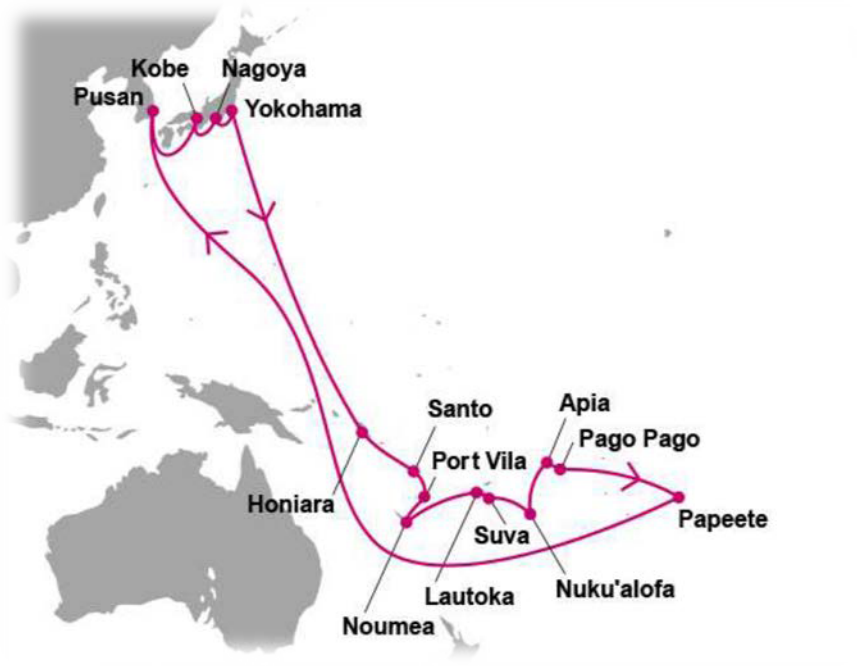
SIDS	Agencies
Marshall Islands	• Pacific Shipping • CenPac Shipping Agency
Tonga	• Kingdom Shipping Agencies • Dateline Transam Shipping • Polynesia Shipping Agency • CFR Tonga • Oceantranz Tonga
Cook Islands	• Hawaii Pacific Maritime • Transam Cook Islands • EXCIL Shipping • Taio Shipping • Cook Islands Towage Ltd • Matina Travel Ltd

	• Cook Islands General Transport Ltd
Fiji	• NPT Agency • Transam Fiji • Export Freight Services • Carpenters Shipping • All Freight Logistics • Shipping Services (Fiji) Pte • Williams & Gosling Ltd.
Tuvalu	• Transam Tuvalu
Kiribati	• Shipping Agencies of Kiribati • Transam Tarawa
Palau	• Belau transfer & terminal company • Eurasia pacific incorporated • Orion maritime services • Palau sea & air transportation agency • Palau shipping agency • Western pacific shipping

Selected Shipping Routes in the Pacific Ocean



Source: http://www.swireshipping.com/files/Service%20Frameworks/7_Bali_Hai_Flyer_1junD.pdf



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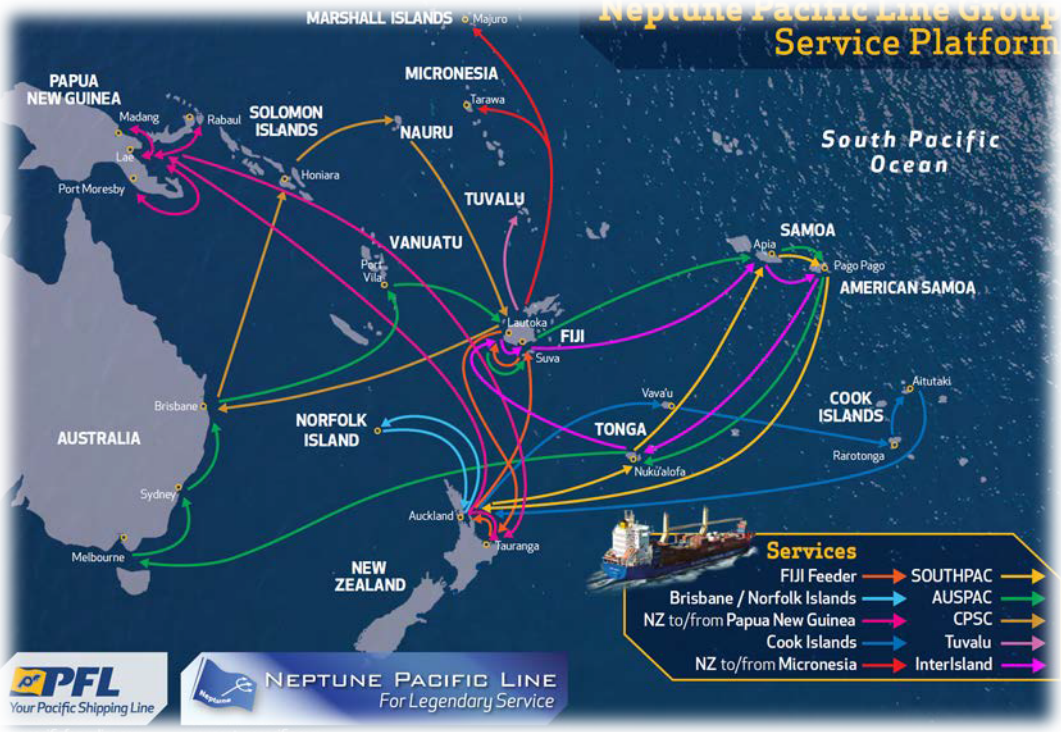

Source: https://www.pacificforumline.com/services/ (consolidated group service map)

Source: https://www.matson.com/matnav/services/south_pacific.html