



# Cost-effective ways to meet ballast water discharge standards --under current and future regulations

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*Under review: Management of Biological Invasions*

# Brief introduction

- Shipping activity accounts for 90% of the world trade
- Ballast water and species introduction
- Negative impacts of invasive species
  - Ecosystem
  - Health
  - economy
- Natural-human system: risk, technology, policy

# Review of current Ballast Water Management

- *International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (BWM Convention)*; Entered into force in 2017
- D-1 standard: ballast water exchange
- D-2 standard: maximum amounts of viable organisms and ballast water treatment system (**BWTS**)
- Amendment to Regulation B-3: new implementation schedule of BWTS mandatory installation; every vessel needs to have BWTS onboard by 2024.

# Expectation for future policies – stricter regulation

- BWM Convention is not final/permanent
- The current standards are results of negotiation and compromise (Linda S. Johnson)
- Further amendments may occur based on evidence-based review

*The MEPC adopted a resolution on “the experience-building phase” to carry out systematic and evidence-based review (Resolution MEPC. 290 (71))*

- Future stricter standards may be regional, instead of global, because certain issues are unique to a certain area
- Balance of protection and cost
- *The BWC explicitly acknowledges the right of individual states to establish more “stringent measures...consistent with international law” (Article 2.3)*

# Motivation

- Rank all the 3421 ports with identified risk (Mandana, 2018)
- We are thinking to treat the ports most vulnerable to the invasion risk first

risk

To assist the MEPC in its review of ballast water standards, Resolution 2 of the Conference Final Act calls for the application of “suitable” decision-making tools:

(1) an enhanced understanding of which trade routes and vessel types present the greatest risk

(2) information on which treatment technology will need be to employed on a particular vessels;

(3) the exploration of the least-cost solution for that vessel;

(4) an evaluation of the cost-effectiveness of meeting the present standards and/or alternative standards.

- Compare the costs of vessel- or barge-based BWTS for the world fleet

- Policy-making

policy

technology



# Expectation for future policies – stricter regulation

- Marine Invasive Species Act: California's stricter ballast water discharge standards

Organism Size Class	U.S. Federal (USCG, EPA)/IMO D-2	Interim California
Organisms greater than 50 $\mu\text{m}^{[1]}$ in minimum dimension	< 10 living/ <i>viable</i> organisms per cubic meter	No detectable living organisms
Organisms 10 – 50 $\mu\text{m}$ in minimum dimension	< 10 living/ <i>viable</i> organisms per ml <sup>[2]</sup>	< 0.01 living organisms per ml
Living organisms less than 10 $\mu\text{m}$ in minimum dimension		< 10 <sup>3</sup> bacteria/100 ml < 10 <sup>4</sup> viruses/100 ml
<i>Escherichia coli</i>	< 250 cfu <sup>[3]</sup> /100 ml	< 126 cfu/100 ml
Intestinal enterococci	< 100 cfu/100 ml	< 33 cfu/100 ml
Toxicogenic <i>Vibrio cholerae</i> (O1 & O139)	< 1 cfu/100 ml or < 1 cfu/gram wet weight zooplankton samples	< 1 cfu/100 ml or < 1 cfu/gram wet weight zoological samples

- Feasibility Study of Shore-Based Ballast Water Reception and Treatment Facilities in California (the Delta Stewardship Council)

# Ballast water treatment system (BWTS)

- Vessel-based: lower unit cost; every vessel needs one
- Port-based: higher unit cost; can be shared by many vessels
  - Barge-based: can be used on different locations
  - shore-based



- IMO-BWTS: type-approved under G8 guideline; or Alternative Management System by US Coast Guard
- Stricter-BWTS: designed for California's stricter regulation

# Data needed

- Costs of IMO-BWTS
  - King et al, 2009
- Costs of stricter-BWTS and barges
  - Delta Stewardship Council, Shore-based ballast water treatment in California, task 10: Cost analysis, 2018
- Shipping traffic and port profile
  - Lloyd's Database
- Ballast water discharge volume profile
  - National Ballast Information Clearinghouse Database (NBIC)

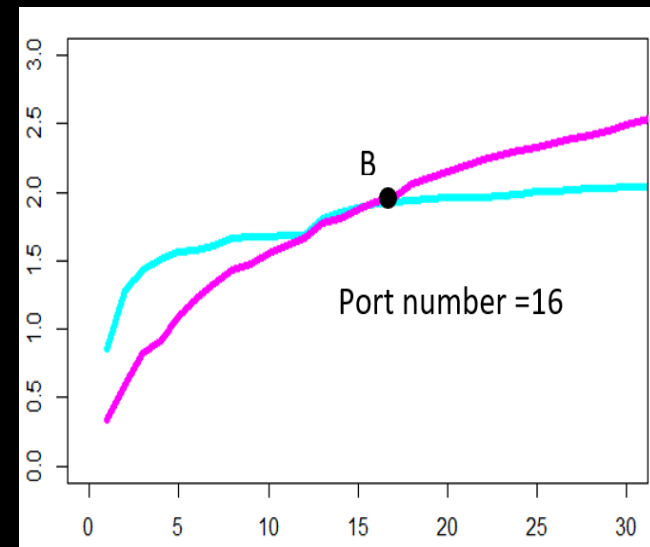
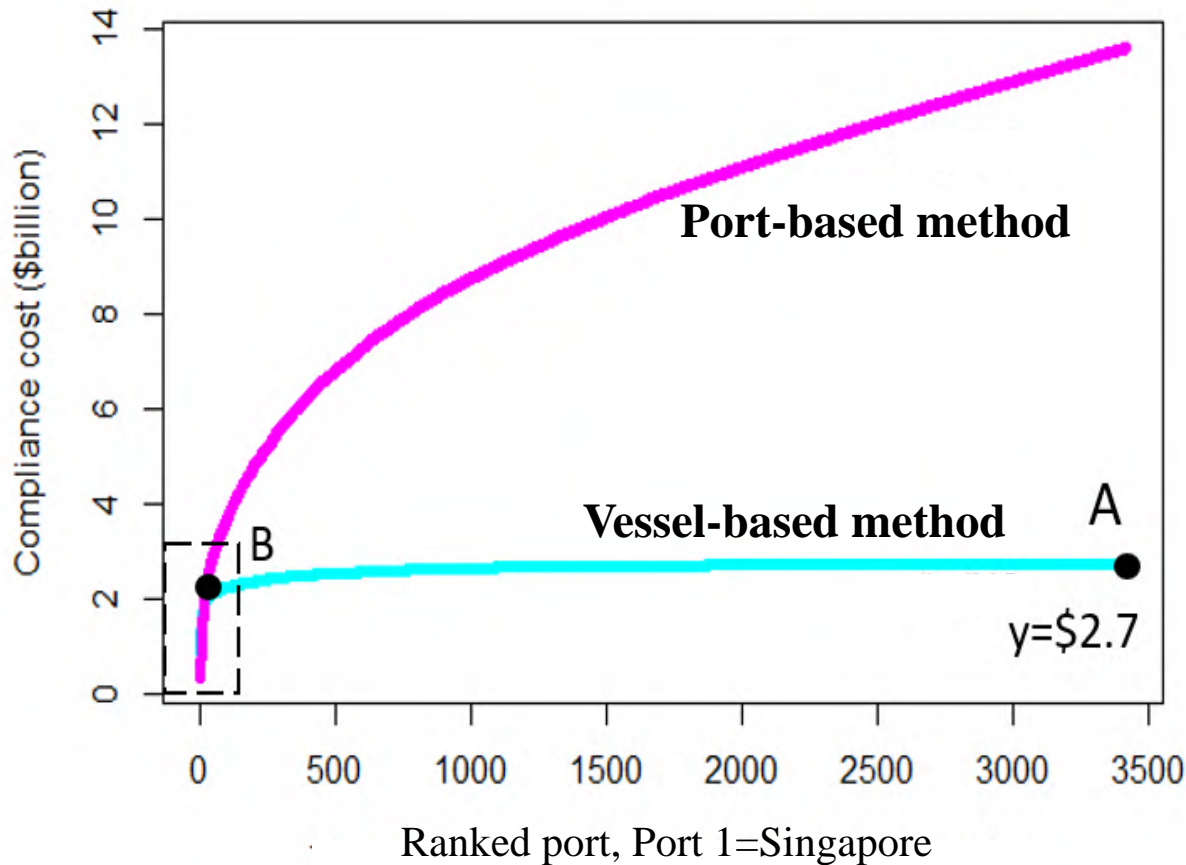


# Results

Current regulation:

Vessel-based method is the best way to comply with current regulation

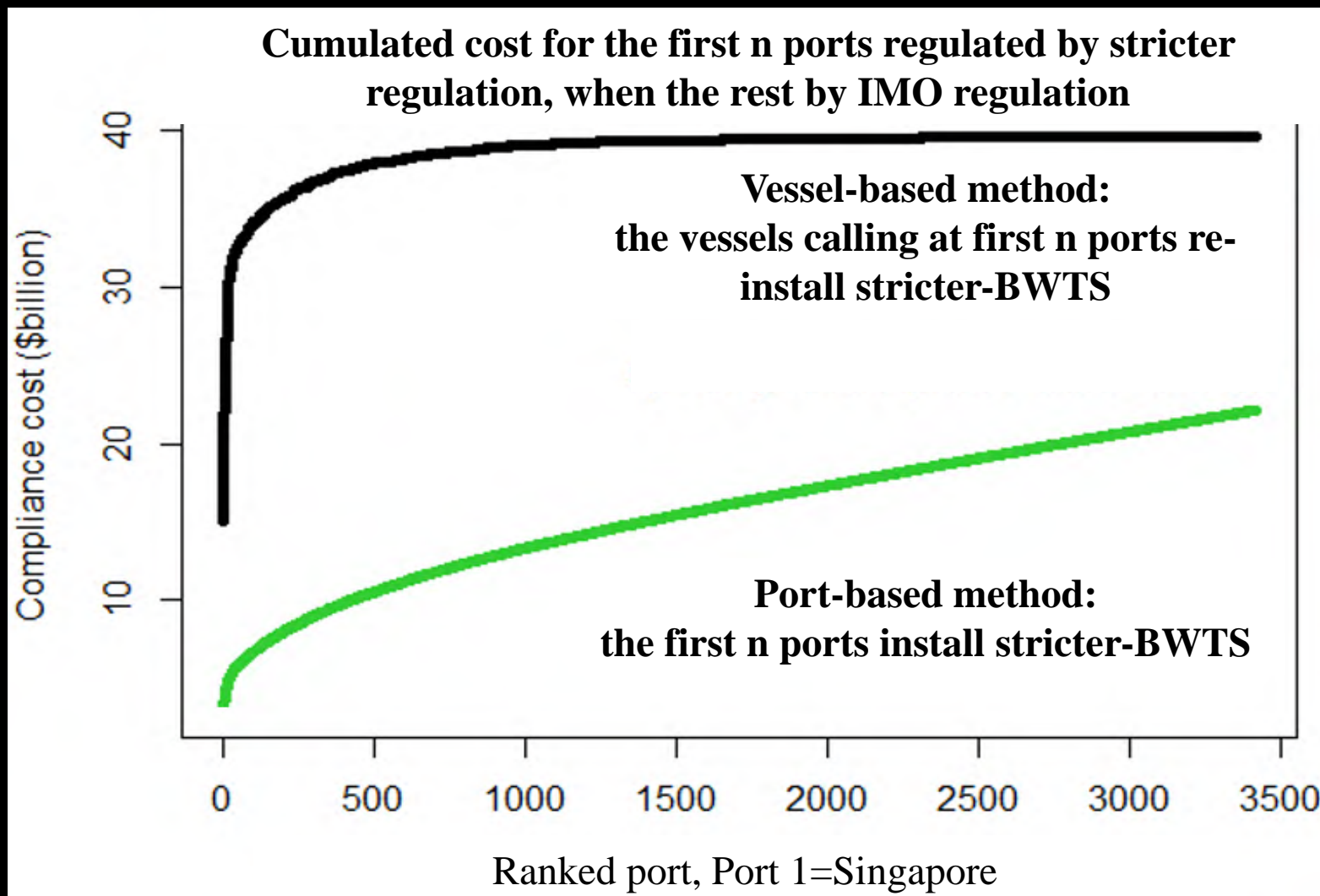
**Cumulated cost for the first n ports regulated by IMO regulation, when other ports are not regulated**



# Results

Future regional stricter regulation: **vessels have IMO-BWTS onboard by 2024**

The feasibility of barge-based method



# Case study

US ports adopt stricter regulation, all other ports follow current IMO standards

- 257 US ports; 9088 unique vessels

World cost	Better protection in the U.S. (current cost + extra cost)
Method 1: Vessel-based	\$2.7 + \$8.2 billion
Method 2: Port-based	\$2.7 + \$0.7 billion

- Barge-based BWTS costs less for US to adopt stricter regulation at US port
- It costs \$0.7 billion more to do better protection in US waters

# Implications for next level of policy-making

## --where would you begin to establish stricter policy?

- **Port-based** technology is better to comply with more stringent standards
- However, IMO sets policy for vessels, cannot set port policy
  - Each party shall require ships **flying its flag** to comply with the Convention (Article 3.2)*
- Three ways for future regulations
  - (1) Individual States set policy consistent with international law (UNCLOS)
  - (2) by voluntary port applications, like California
    - In this way, ports do not need to come down to IMO for permission to avoid the heavy burden of having to achieve the consensus at IMO
  - (3) special areas designated by IMO
    - However, currently there is nothing in the Convention allows that; a new **amendment** at IMO is required.
    - Draft amendments could be put forward for consideration at MEPC 79 (in 2022) based on data gathering, data analysis and Convention review*



Thank you very much!

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