COMMENT

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ALAMY

Hong Kong offers subsidies and reduced berthing fees for ships that switch to low-sulfur fuel in its harbour.

Four routes to better maritime governance

Challenges in preventing pollution from ballast water highlight reforms needed in global shipping regulation, write **Zheng Wan** and colleagues.

Sea freight carries more than 90% of global trade — and thousands of unwelcome passengers. The ballast water that stabilizes marine vessels is the greatest source of harmful bacteria and invasive species in aquatic ecosystems. About 10 billion tonnes of ballast are transported globally each year, with 7,000 species carried onboard every day[1].

This is damaging marine biodiversity and public health. For example, the imported Chinese mitten crab (*Eriocheir sinensis*) is endangering native European and North American crayfish and salmon. Transported algae can seed blooms that smother or poison aquatic life, contaminate seafood and foul drinking water[2]. As the world's shipping lanes expand into a warmer Arctic, invasive species will spread to waters that were previously unreachable[3].

Managing ballast discharge requires worldwide legislation and enforcement. International shipping traverses the high seas, where there is no local jurisdiction. A vessel registered in one country can operate thousands of kilometres away.

Global action has been slow. The 8 September accession of Finland to the International Convention for the Control and Management of Ships' Ballast Water and Sediments ended a 27-year slog to bring the treaty into force ▶

(see 'Too little, too late'). With 52 members of the International Maritime Organization (IMO) signed up — crossing the threshold of more than 35% of the world's shipping tonnage — the treaty will finally come into force on 8 September 2017. After that date, any ship from a signatory state found to be violating the convention within regulated waters will be warned, fined or detained.

This month, the IMO council meets in London to coordinate and plan the organization's activities. We argue that it must take a close look at the ballast-water convention, whose inadequacies highlight fundamental problems with international maritime governance. The lessons learned might steer other global environmental policies, from reductions in greenhouse-gas emissions to mitigating acoustic and light pollution. Going forward, the IMO should develop strategies to ensure that nations enter into its conventions promptly and to coordinate regional actions. It should establish market instruments to provide incentives and reform how maritime data are collected and used.

THE PROBLEM

The IMO's ballast-water convention was shaped largely by polluters, not their victims. As of 1 January 2015, the top 35 ship-owning regions — including Greece, Japan and China — control almost 95% of the world's shipping by tonnage. Yet more than 70% of their total capacity is registered under foreign flags, usually of nations with lower environmental standards (see 'Tonnage top ten').

Some of the first nations to sign up to the convention were the Maldives, Spain and Nigeria, countries with strong interests in marine ecology but tiny fleets. Nations that are invested in the shipping industry have been lethargic. Panama, for example, which has more than 18% of the world's registered tonnage, acceded to the convention only in October, owing to strong industry lobbying.

A few nations have made individual efforts to limit ballast-water damage. Since 2001, Australia has prohibited trading ships from dumping foreign ballast water within its coastal limits. Incoming vessels must flush their tanks in the open ocean, and report and verify that they have done so. Brazil, Canada and Israel have similar measures[4].

"The lessons learned might steer other global environmental policies."

The United States has gone further. It requires that any foreign ballast water dumped in its waters by commercial vessels must meet the IMO standards, but coastal states may set controls, too[5]. California has proposed the most stringent limit: no detectable living organisms more than 50 micrometres across. Because this is impossible to meet with current treatment technologies, this standard has been postponed until 2020.

Such uncertainties and more rigorous testing by the US Coast Guard are slowing down the approval of ballast-water treatment systems. As of the most recent listing in May 2016, none of the 65 designs approved by the IMO had received US approval. Until some do, ships with IMO-approved systems may not comply with US standards. As an interim measure, by July, the US Coast Guard had listed 56 IMO-approved systems that can be used in its waters for a 5-year grace period.

Meanwhile, the owners of 70,000 ships globally do not know what to invest in. Ballast-water treatment equipment is expensive. It involves physical and chemical processes such as filters, chlorine, ozone or ultraviolet light. A unit can cost US$1 million, with adaptation and maintenance costs on top. Early adapters will be penalized because they will have to pass on those costs to cargo owners.

Naturally, the maritime industry prefers to wait and see. There is no economic incentive to do otherwise. Plus, many countries, especially developing ones, lack the technology to test the quality of ballast water and the capacity to punish those who flout the law.

Risk assessments that would allow targeted solutions are missing. The consequences of invasive marine species vary between regions, and depend on traffic volume and ships' ports of call[6]. Data are scant. We need to know which species live in particular ports or waters, how temperature and salinity influence species' survival elsewhere and where and how often vessels move.

Emerging technologies could help, but are limited. For example, the Automatic Identification System publicly transmits a ship's identity and position in real time to avoid collisions at sea[7]. But not all ships are equipped, and the system is prone to human error. Historical data are expensive for researchers to acquire because they are provided by commercial vendors, and mainly to big shipping companies.

THE FIX

Implementing the following four reforms would improve global maritime governance and marine biodiversity conservation.

Speed entry into force. The IMO should activate future conventions faster and more fairly. Lowering the minimum registered tonnage limit would bring forward implementation[8]. For example, had the ballast-water convention required coverage of at least 30%, rather than 35%, of the world's shipping tonnage, it would have been triggered in 2013 by Germany's accession (the 37th signatory). Increasing the minimum number of states to sign up at the same time would also rebalance voting weights and raise the priority of environmental protection over fleet size.

Coordinate regional actions. The IMO should harmonize standards at least regionally. It should provide technical assistance and guidance so that coordinated actions are constructive, coherent and well-administered. Regional actions can have a wider influence and encourage more data-driven and evidence-based policies. For example, European Union regulations adopted in 2015 that set out a legal framework for monitoring,

TOO LITTLE, TOO LATE

A decades-long crawl to global consensus

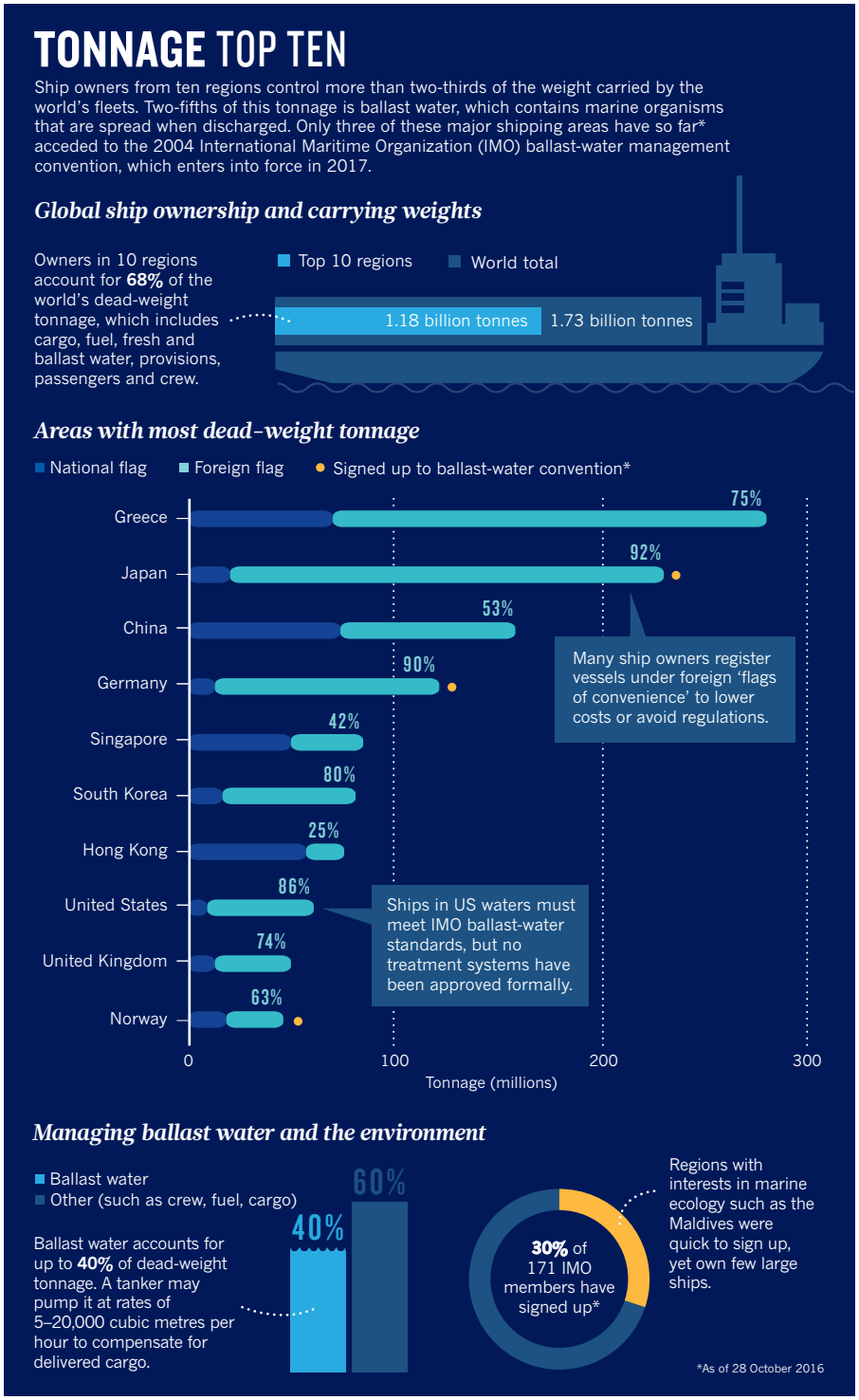
In 1969, the World Health Organization (WHO) adopted rules for trade and travel to prevent the global spread of epidemics such as plague and cholera through ships and aircraft.

In 1990, Canada and Australia put the issue of ballast water on the agenda of the International Maritime Organization (IMO) when they became concerned about invasions by Eurasian zebra mussels (*Dreissena polymorpha*) and Japanese dinoflagellates. The IMO issued a voluntary protocol suggesting that ships flush their ballast tanks 200 nautical miles (370 kilometres) from land. Few ship owners took notice. Following the 1992 United Nations Earth Summit and the adoption of the Convention on Biological Diversity, the IMO began to develop an internationally binding instrument.

In 2004, the IMO adopted the International Convention for the Control and Management of Ships' Ballast Water and Sediments. It includes a roadmap for signatories to phase out existing methods (such as tank flushing) in favour of stringent standards of water treatment — an upper limit to the permitted concentration of organisms that can remain in treated ballast water depending on ship type.

For example: ships should discharge fewer than 10 viable organisms per cubic metre for organisms measuring 50 micrometres or larger, or 10 organisms per millilitre for those 10–50 micrometres in size. Limits are also set on the numbers of specific microbes, such as *Escherichia coli* and intestinal enterococci.

Ship owners must invest in water-cleansing equipment that filters large particles and kills organisms and pathogens by exposing them to ultraviolet light, ozone or chlorine.



reporting and verifying greenhouse-gas emissions from shipping have inspired the IMO to develop a similar policy.

Develop market instruments. Today's IMO conventions for pollution prevention and control are technology-oriented — they stipulate standards, but say little about how to fund or achieve those measures. Industries need a mixture of technical standards and market instruments to provoke them to transform[9]. Incentives could include reduced port-usage fees, priority access to port facilities and tax rebates for early adapters. For example, more than 12% of the vessels visiting Hong Kong since 2012 have switched to low-sulfur fuel while berthed, in exchange for lower port fees and subsidies. Developed countries should provide technical and funding aid for developing countries.

Reform data usage. The IMO and regional maritime bureaucracies must improve how data are collected, shared and used. Developments in ship tracking, global-positioning sensors, the Internet of Things and 'big data' should be incorporated into models that predict maritime pollution. By analogy, Singapore's road-pricing scheme uses devices to detect cars and to debit fees, as well as big-data analytics to calculate the optimal toll for controlling traffic.

Real-time data analyses would help ship operators and authorities to detect malfunctions in pollutant treatment systems (such as for sewage, garbage or gas emissions) more quickly, without inspections or business disruptions. The shipping industry will benefit from more-efficient operations and smarter decision-making on energy saving and pollution control.

Governmental funding will be needed to set up platforms and protocols for data collection and sharing. But investments will be offset by savings from avoiding self-reporting, which is labour-intensive, burdensome and unreliable.

As the pace of global change and trade accelerates, we cannot afford to wait decades to negotiate how to deal with each type of maritime pollution. ■

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