



2015 Invasive Species Webinar Series

Frontiers for Ballast Water Treatment at the Intersection of Science, Technology and Policy

Monday, April 27, 2015
1:00pm-3:00pm Eastern Time
(speaking will begin at 1:03)

Co-hosted by the Environmental Law Institute &
The National Invasive Species Council

This webinar is made possible by the generous support of the Turner Foundation.

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NOW SPEAKING:

Read Porter

Director, Invasive Species Program,
Environmental Law Institute



Read Porter is Director of the Invasive Species Program and a senior attorney with the Environmental Law Institute. Mr. Porter has published widely on a range of invasive species topics, including state law, federalism, and bioenergy; as well as on fisheries, aquaculture, natural resources law enforcement, third-party certification, and regulation of emerging technologies. Prior to joining ELI in 2006, Mr. Porter served as a law clerk for the Honorable Julia Smith Gibbons on the United States Court of Appeals for the Sixth Circuit and was Editor-in-Chief of the Harvard Environmental Law Review. Mr. Porter holds a J.D. from Harvard Law School and a B.A. in geology from Amherst College.



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INTRODUCING:

Kathy Metcalf

Director of Maritime Affairs,
Chamber of Shipping of America



Kathy Metcalf is the Director of Maritime Affairs for the Chamber of Shipping of America, a maritime trade association which represents a significant number of U.S. based companies that own, operate or charter oceangoing tankers, container ships, and other merchant vessels engaged in both the domestic and international trades. She has held this position since 1997 and in her capacity represents maritime interests before Congress, federal and state agencies and in international fora. Prior to coming to the Chamber of Shipping, Kathy served in various positions in the energy industry including deck officer aboard large oceangoing tankers, marine safety and environmental director, corporate regulatory and compliance manager and state government affairs manager. Kathy is a 1978 graduate of the US Merchant Marine Academy (BS in Marine Transportation and Nautical Sciences) and a 1988 graduate of the Delaware Law School (JD).

Ballast Water Management

**ELI Webinar
April 27, 2015**

**Kathy Metcalf
Director, Maritime Affairs
Chamber of Shipping of
America**

LAY OF THE LEGAL LANDSCAPE



- Finalized IMO Convention
- Development of IMO Guidelines
- Multi-national type approvals issued
- US Legislative Initiatives (Fed/State)
- Regulatory Initiatives (Fed/State/Local)
- Multitude of technology developers all assuring their “silver bullet”

IMO Ballast Water Convention

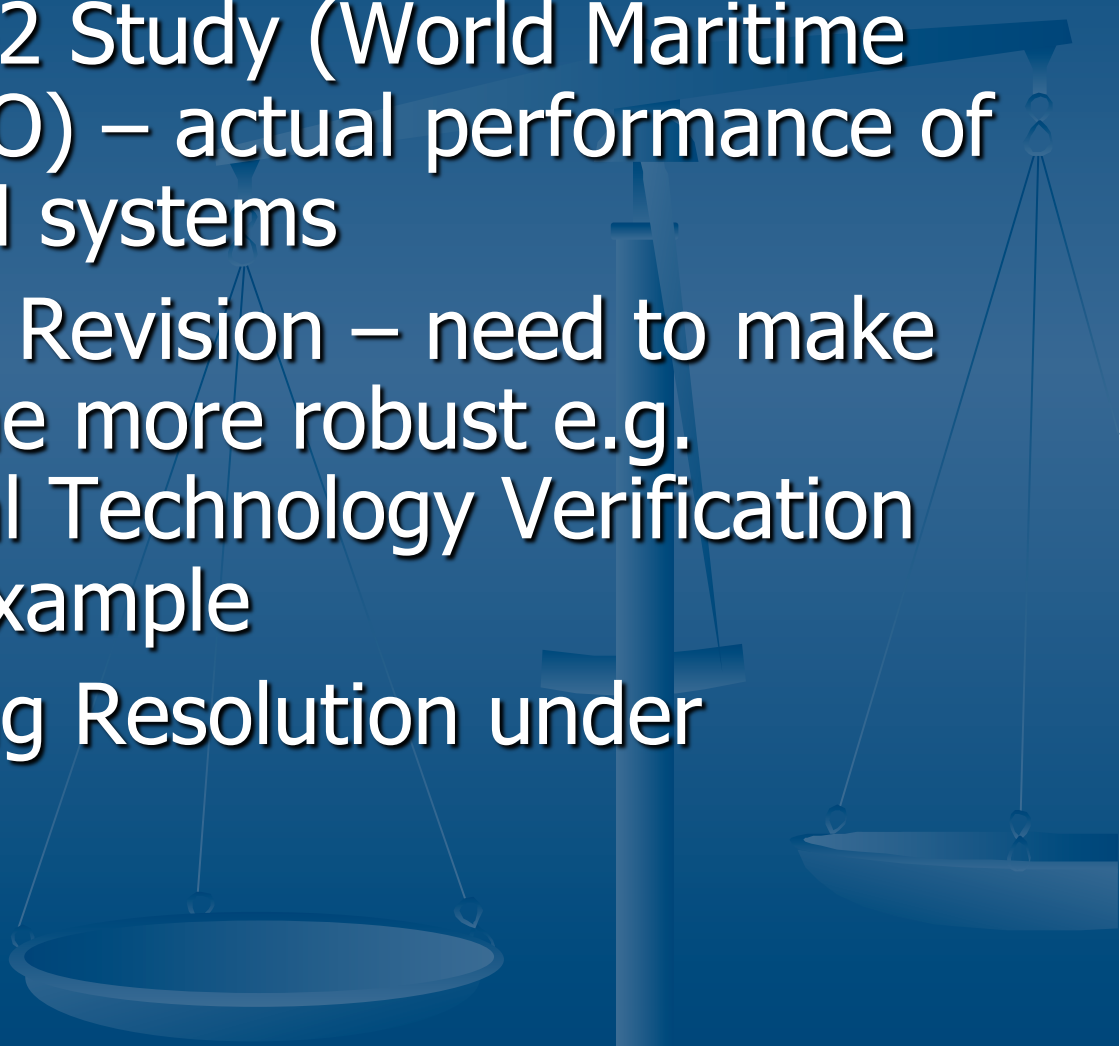
- Adopted 13 February 2004
- Entry Into Force provisions – 12 months after ratification by 30 states representing 35% of global commercial tonnage
- Current – 44 states representing 32.86% of global commercial tonnage (4/10/15)
- US has not ratified
- 51 treatments systems with Type Approvals by national administrations (10/30/14)

IMO BW Guidelines

- 15 guidelines in total
- Supplemental information for use by governments in implementing the Convention
- Key guidelines:
 - Sampling (G-2)
 - Type Approval of ballast water management systems (G-8)
 - Procedures for approval of “active” substances (G-9)
- For more information see:
<http://www.imo.org/OurWork/Environment/BallastWaterManagement/Pages/Default.aspx>

IMO BW Convention

Ongoing Issues

- Regulation D-2 Study (World Maritime University/IMO) – actual performance of installed BWM systems
 - Guideline G-8 Revision – need to make initial guideline more robust e.g. Environmental Technology Verification Program as example
 - Grandfathering Resolution under development
- 

USCG Final Rule

- Final rule published March 23, 2012
- Docket Number USCG-2001-10486
- Performance standards aligned with IMO
- Requirements for Ballast Water Management Plan expanded to include crew training, safety, biofouling and sediment management practices

USCG Final Rule

- Provisions for extension of compliance date if compliance is not possible (shipowner requests on vessel specific basis)
- Extensions are NOT recognized by EPA under VGP program
- Legitimate reasons for extension request – no US type approval available, availability of treatment systems, availability of shipyard for installation
- Addition of provisions for acceptance of alternate management systems (AMS)

USCG Final Rule

- AMS is bridging strategy to allow for temporary recognition (5 yrs beyond implementation date) of BWTS that has already obtained a non US type approval
- Type approval must have been issued consistent with the IMO BW Convention G-8 Guidelines
- US will require US type approval
- Note extension process is vessel owner driven; AMS process is vendor driven

Summary

- Final VGP and USCG rule still have some inconsistencies (better than it was but still not ideal)
- Need for federal legislation for consistent set of requirements
- For more information see:

<https://homeport.uscg.mil/mycg/portal/ep/channelView.do?channelId=-18361&pageTypeId=13489>

EPA'S VESSEL GENERAL PERMIT (VGP)

- **Why?** Court case (NW Environmental Advocates et al vs. EPA)
- **What?** Decision ruled that EPA's original regulation exempting discharges incident to the normal operation of a vessel exceeded agency's authority under the Clean Water Act
- **When?** Originally December 19, 2008 but extended to February 6, 2009

CLEAN WATER ACT

- “discharge of a pollutant” generally prohibited without a permit (CWA 301(a))
- National Pollutant Discharge Elimination System (NPDES) permits (CWA 402)
- Permit not to exceed 5 years
- State authorization to implement
- State may add more stringent requirements

VGP “2.0” Major disconnects with USCG final regs

- ▶ Now in second iteration of VGP
- ▶ Generally aligns with USCG ballast water regulations except for:
 - Extensive monitoring and sampling requirements for ballast water treatment systems (functional, biological efficacy, residuals)
 - “high” quality vs. “low” quality certifications (no automatic recognition of other nations’ type certifications) vs. USCG AMS process
 - No provisions for grant of extensions if no US type approvals exist per USCG regulations
 - State 401 certifications add more stringent standards (CA, Great Lakes states)

VGP “2.0”

- ▶ For more information see:

<http://water.epa.gov/polwaste/npdes/vessels/Vessel-General-Permit.cfm>

US Legislative Initiatives

Shipping Industry Fundamentals

- Need for internationally accepted mandatory BW management program
- Consistency between international and domestic programs
- Solutions must provide real benefit to the environment
- We are experts in vessel operations, not marine/invasion biology

US Legislative Initiatives

Historical Perspective

- 1990 – Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA)
- 1996 – National Invasive Species Act (NISA)
- Above statutes led to finalization of current USCG regulations
- Multiple legislative attempts over past 15 years.....no success
- Currently legislation introduced in Senate and House (S 373 and HR 980)

US Legislative Initiatives

S 373/HR 980 (1)

- US Coast Guard and EPA as lead agencies
- Initial performance standard = IMO/USCG
- More stringent standard (100 X IMO) no later than 1 January 2022 if technically feasible
- Would require periodic review of technology efficacy and invasive species biology to assess need for more stringent standards

US Legislative Initiatives

S 373/HR 980 (2)

- Grandfathering text permitting use of currently installed systems for service life of system
- Extensions program as currently implemented
- Federal preemption of state requirements except....
- Savings clause permits state programs existing at enactment to continue if deemed technologically achievable



Contact Information

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INTRODUCING:

Joel Brammeier

President and CEO,
Alliance for the Great Lakes



Joel Brammeier is president and CEO of the Alliance for the Great Lakes, a regional organization for policy reform and personal stewardship. The Alliance for the Great Lakes is committed to the idea that water is our region's most precious natural asset. Joel manages a staff of 24 professionals and works with more than 15,000 volunteers dedicated to protecting and restoring clean water, educating citizens and youth, and building a sustainable future for the Great Lakes. He has assisted in the development of strategies, laws and regulations to prevent invasive species in several Great Lakes states and published a first-of-its-kind report describing options for permanent separation of the Great Lakes from the Mississippi River. He advises the state governors on the long-term protection of the Great Lakes water supply and is a member of the governance board of the Healing Our Waters – Great Lakes Coalition. Prior to his work at the Alliance, he worked for the American Medical Association. He received his master's degree from the University of Michigan's School of Natural Resources & Environment and his bachelor's degree from Valparaiso University.



Environmental Law Institute

April 27, 2015

Joel Brammeier
President & CEO
jbrammeier@greatlakes.org



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Our Approach

Protect against the most critical threats

Restore the lakes with enduring on-the-ground change

Support a culture of water locally and regionally

Decades of Transformation

Great Lakes Legacy Act

Great Lakes Water Resources

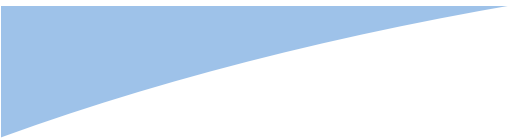
Compact and Agreement



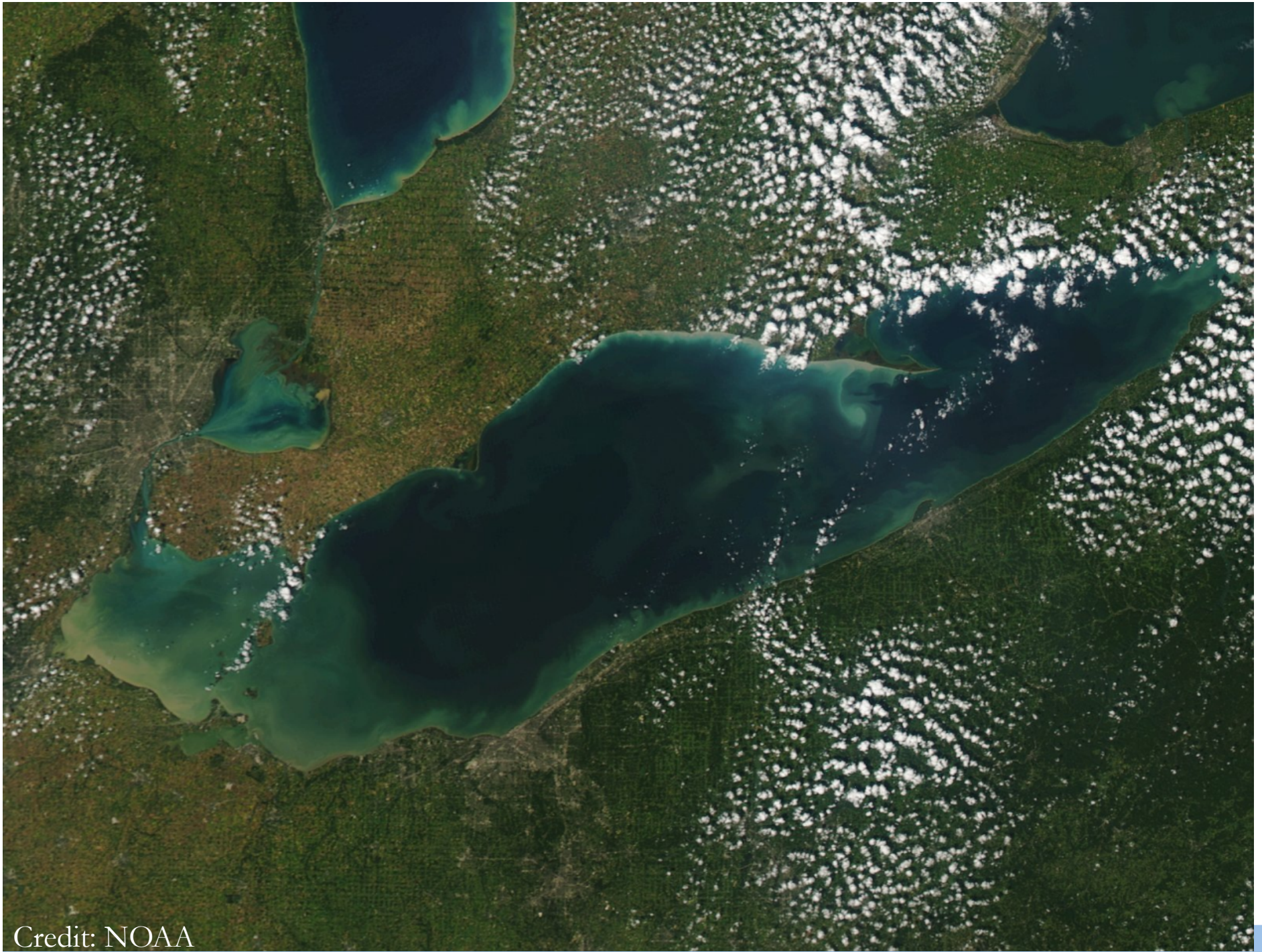
Great Lakes



Restoration Initiative

- 
- Ballast and the Lakes
 - Responses From Our Region
 - Future Statute Proposals





Credit: NOAA



Economic Impact

- ~\$200 million in losses annually due to invasions caused by shipping – University of Notre Dame
- “Hundreds of millions” in annual impact from invasions overall, including costs to water treatment facilities, tourism industries, energy production – The Nature Conservancy



Credit: Scudder Mackey

The Great Lakes

The shipping news

Despite problems, a revival in shipping on the Great Lakes is expected

Feb 2nd 2013 | From the print edition

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WHEN spring arrives and the frozen shores of the Great Lakes are long thawed, the St Lawrence Seaway, North America's liquid superhighway, should witness the greatest renewal of its shipping fleet in 30 years. Craig Middlebrook, the deputy administrator of the St Lawrence Seaway Development Corporation (which operates and maintains the American portion of seaway) reckons about 30 new ships are being built to ply its waters.

One of the latest to be launched was the *Federal Satsuki* commissioned by the Fednav Group, based in Montreal. She set sail from Cleveland in December. Part of the reason for this fleet renewal is the removal of duty on Canadian flagships built abroad in places like China and Japan. Another is that currency fluctuations have made it cheaper to acquire new vessels.

Yet as Rod Jones, the CEO of CSL Group, a shipping firm, says, "we have been waiting for a buying opportunity." And the reason that many other companies feel the same way is that there is a widely held view that the Great Lakes region is poised for long-term economic growth. The shipping companies want to be ready for it.

Mr Middlebrook says the rebirth of American heavy manufacturing, led by the automotive industry, has been a bright spot for shipping recently. Furthermore, in the long term, the development of shale gas and oil looks as though it will not only increase demand to move heavy extraction equipment into Great Lakes state but is expected to power a lot more

In this section

[Washington learns a new language](#)[The little dipper](#)[Obama oversteps](#)

Feedback

A photograph of a rocky beach with waves crashing against the shore under a blue sky with white clouds. The text is overlaid on the image.

Preventing New Invasions Is Possible

Controlling An Existing Invasion Is Usually Impossible

Treat Ballast Like the Pollutant It Is – Treat It!

State Approaches

- Michigan
 - Technology or no oceangoing discharge; also in 401 certification
- Minnesota
 - Existing & new laker vessels – IMO by 2018, sync with USCG and USEPA on oceangoing
- Multiple requirements for ballast water exchange in state NPDES 401 permit certifications
- MI, MN, NY – federal standard insufficient to protect water quality

Great Lakes Technology Implementation

- FedNav – BallastAce on new vessels – not yet type approved
- Lake - only vessels – some members of trade seeking long term exemptions, one company and NPS testing options
- Lake - St. Lawrence River vessels – data shows risk of movement of species from river and coastal voyages



Problems With Vessel Incidental Discharge Act

- Preempts state regulation
- Carves invasive species out of the Clean Water Act
- Creates path to exempt laker vessels from standards
- Creates roadblocks that undermine stronger standards
- BWE was absent, amended to include

Correcting the Record on VIDA

- USCG and USEPA have been working collaboratively for years
- Invasive species are legally a pollutant in the U.S.
- IMO and U.S. standards are not shown to be preventive of new invasions
- Freshwater and coastal vessels can increase spread of invasions – 1000+ miles from Duluth to Quebec City
- BWE is the best we have until proven otherwise



Recommendations

- Goal #1: implementation of standards that protect the Great Lakes
- Aggressive review and revision of technology availability driven by requirement to achieve Goal #1
- Avoid any action that freezes IMO in place

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Learn more about the Alliance:

www.greatlakes.org

Takeaction.greatlakes.org





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INTRODUCING:

Nicole Dobroski

Environmental Program Manager, Marine Invasive Species Program
California State Lands Commission



Nicole Dobroski is the Environmental Program Manager for the California State Lands Commission's Marine Invasive Species Program. She has worked for the Commission since 2006. As Marine Invasive Species Program Manager, Nicole develops and implements strong science-based management strategies to prevent non-native species introductions to California waters from commercial vessel vectors. Prior to arriving at the Commission, Nicole spent a year as Program Representative for the West Coast Ballast Outreach Project with the California Sea Grant Extension Program. She also spent five years as a teaching assistant with the Williams College – Mystic Seaport Maritime Studies Program under the leadership of Dr. James T. Carlton. Nicole received a Bachelor of Arts in Biology from Pomona College and a Master of Science in Biological Sciences from the University of Rhode Island.

Marine Invasive Species Management in the United States: A State's Perspective

ELI Webinar - April 27, 2015

Nicole Dobroski
Marine Invasive Species Program
California State Lands Commission





Gaps in Current U.S. Federal Management of Vessel Vectors of NIS

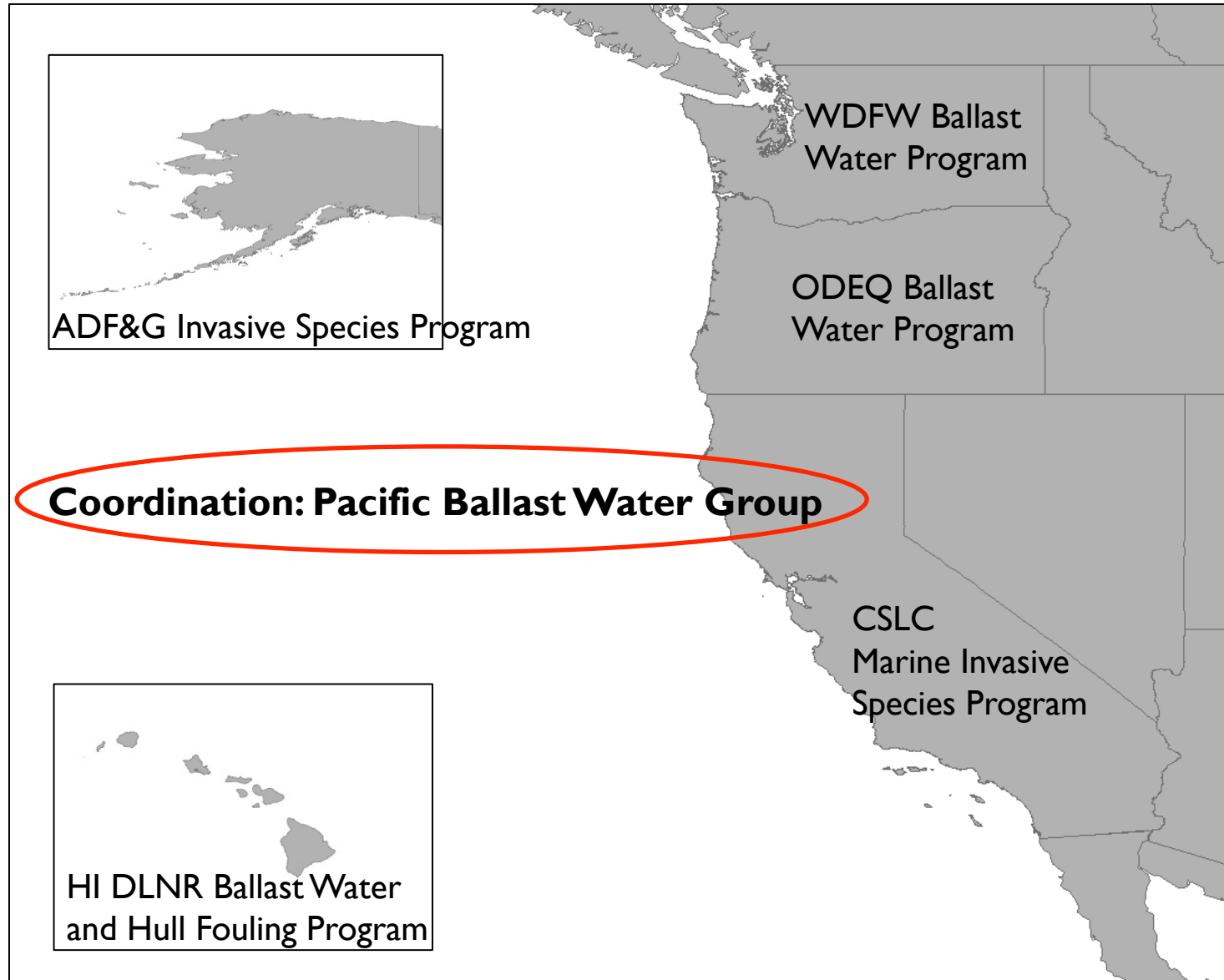
- Operation within one Captain of the Port Zone (COTP)
- Crude oil tankers engaged in coastwise trade
- Deviation and delay of voyage
- Coastal voyages (within 200 NM of land)
- Vessel inspection rate
- Biofouling management



Proposed U.S. Legislation (S 373/HR 980)

- Challenges from state perspective
 - Preemption of state authority
 - Circumvention of the Clean Water Act
 - Insufficient discharge standards
 - Lack of public/stakeholder comment
 - Infeasible requirements to revise standards in 2022
 - Certification without enforcement
 - Exemption for same COTP Zone

Coordinated Regional Management



California Marine Invasive Species Program: Authority & Origins



1999 Ballast Water Management Control for Nonindigenous Species Act

- Authority: Vessels over 300 GRT capable of carrying ballast water
- Foreign ballast water

2003 Marine Invasive Species Act (Reauthorization & Expansion)

- Coastal ballast water
- Vessel biofouling
- Ballast water performance standards

Mandate: Work expeditiously to eliminate the discharge of NIS into California waters



California Coastal Ecosystems Protection Act of 2006

- Required implementation of performance standards for the discharge of ballast water
 - Standards and implementation schedule set in statute
- Required reports assessing efficacy, availability, and environmental impacts, including impacts on water quality, of currently available ballast water treatment technologies



Performance Standards

Organism Size Class	California	IMO Regulation D-2/ U.S. Federal
Organisms greater than 50 µm in minimum dimension	No detectable living organisms	< 10 organisms/m ³
Organisms 10 – 50 µm in minimum dimension	< 0.01 living organisms/ml	< 10 organisms/ml
Living organisms less than 10 µm in minimum dimension	< 10 ³ bacteria/100 ml < 10 ⁴ viruses/100 ml	
<i>Escherichia coli</i>	< 126 cfu/100 ml	< 250 cfu/100 ml
Intestinal enterococci	< 33 cfu/100 ml	< 100 cfu/100 ml
Toxicogenic <i>Vibrio cholerae</i> (O1 & O139)	< 1cfu/100 ml or < 1cfu/gram wet weight zoological samples	< 1 cfu/100 ml or < 1 cfu/gram wet weight zooplankton samples

California Implementation Schedule

Ballast Water Capacity of Vessel	Standards apply to new vessels in this size class constructed on or after	Standards apply to all other vessels in this size class beginning on
< 1500 metric tons	January 1, 2016	January 1, 2018
1500 – 5000 metric tons	January 1, 2016	January 1, 2016
> 5000 metric tons	January 1, 2016	January 1, 2018



Meeting the CA Discharge Standards

- No required installation of treatment systems
- Options to meet standards:
 - Retain all ballast water on board
 - Most protective management strategy available
 - 84% vessel arrivals at CA ports retain
 - Alternative methods
 - Case-by-case basis
 - Water from U.S. or Canada Public Water System
 - Shipboard or shore-based ballast water treatment technologies



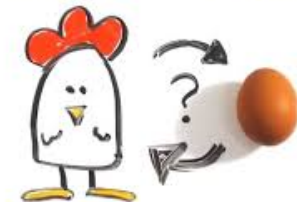
2014 BW Treatment Technology Assessment Report

- No shipboard treatment systems available to meet California performance standards
 - Efficacy data does not demonstrate that systems can meet all of CA standards
 - Multiple caveats
- No shore-based ballast water treatment facilities for NIS available in U.S.
 - Commission funded study of feasibility of shore-based ballast water treatment in California (early 2016)

Challenges

- Lack of data on in-service operation of shipboard treatment systems
 - Seeking vessels to participate in research
- No USCG type approved systems available
 - CA does not require use of USCG type approved systems, but...
- Type approval testing (USCG, IMO) does not address some of CA standards
- Limits of detection/methods for select standards
 - 10-50 μ m, total living bacteria, viruses
- Absence of compliance assessment protocols
 - Chicken and egg situation

"THE CHICKEN - OR - THE CHICKEN EGG"



Use of Shipboard BW Treatment Systems in California

Vessel Type	Treatment Method	2012b	2013a	2013b	2014a
Container	electrochlorination				12,837
Bulk	ultraviolet radiation				6,119
Bulk	ultraviolet radiation				10,066
Passenger	ultraviolet radiation				392
Passenger	ultraviolet radiation			367	
Bulk	electrochlorination				33,296
Bulk	electrochlorination				23,603
Other	biocide	563		2,971	4,928
Passenger	ultraviolet radiation				2,322
Tank	electrochlorination				4,858
Bulk	ultraviolet radiation		6,147		
General	ultraviolet radiation				2,378
Total Volume Discharged (MT)		563	6,147	3,338	100,799

(a = January through June, b = July through December)



Commission Funded Research

- 2005 – Installation on *Moku Pahu*
- 2007 – Installation on *APL England*
- 2008 – Support development of Golden Bear Facility
- 2010 – Plankton bulk viability assay
- 2011 – Ballast water sampling tool
- 2013 – Contingency ballast water treatment
- 2015 – Virus identification and enumeration in ballast water



California Assembly Bill 1312

- Standards remain the same
- Proposed change in implementation date to January 1, 2020
 - Construction on or after
 - First dry dock on or after
- Extend date for application for use of experimental treatment systems
 - 5 year equivalency to standards
- Additional items
 - Biofouling sampling and enforcement authority
 - Clean-up provisions



Key to Implementation of Standards: Compliance Assessment

- Mandate – inspect at least 25% of arriving vessels
 - Field offices in N. and S. California
 - 2199 inspections in 2013
- Inspection components
 - Administrative
 - Reporting forms, BW Log, Management Plan
 - Operational
 - BW management, sampling
 - Development of compliance assessment protocols for standards (rulemaking 2016)
 - Indicative tests
 - Full biological sampling
- Draft enforcement regulations
 - Rulemaking summer 2015

Vessel Biofouling

- Direct attachment and associated mobile organisms
- Responsible for up to 60% NIS in CA coastal waters
- Most important marine vector of NIS in Hawaii
- All ships pose a risk of biofouling introductions



Why Manage Vessel Biofouling?

Hull biofouling = ↑ Drag = ↑ Fuel consumption = ↑ \$\$\$

Manage Entire Vessel as Vector of NIS

- USCG BW discharge standard $>50 \mu\text{m}$ size class = 10 organisms per cubic meter
- How many biofouling organisms per square meter?



Vessel Biofouling Management

California State Lands Commission
 Marine Invasive Species Program
 Hull Husbandry Reporting Form
 Public Resources Code – 71205(e) and 71205(f)
 June 6, 2008
 Part I: Reporting Form

Vessel Name:	
Official / IMO Number:	
Responsible Officer's Name and Title:	
Date Submitted (Day/Month/Year):	

Hull Husbandry Information

1. Since delivery, has this vessel ever been removed from the water for maintenance?
 Yes No

a. If Yes, enter the date and location of the most recent out-of-water maintenance:

Last date out of water (Day/Month/Year):		
Port or Position:	Country:	

b. If No, enter the delivery date and location where the vessel was built:

Delivery date (Day/Month/Year):		
Port or Position:	Country:	

2. Were the submerged portions of the vessel coated with an anti-fouling treatment or coating during the **out-of-water** maintenance or shipbuilding process listed above?

Yes, full coat applied <input type="checkbox"/>		
Yes, partial coat <input type="checkbox"/>	Date last full coat applied (Day/Month/Year)	
No coat applied <input type="checkbox"/>	Date last full coat applied (Day/Month/Year)	

3. For the most recent **full coat** application of anti-fouling treatment, what type of anti-fouling treatment was applied and to which specific **sections** of the submerged portion of the vessel was it applied?

Manufacturer/Company:		
Product Name:		
Applied on (Check all that apply):	Hull Sides <input type="checkbox"/>	Hull Bottom <input type="checkbox"/>
	Sea Chests <input type="checkbox"/>	Sea Chest Gratings <input type="checkbox"/>
	Propeller <input type="checkbox"/>	Rope Guard/Propeller Shaft <input type="checkbox"/>
	Previous Docking Blocks <input type="checkbox"/>	Thrusters <input type="checkbox"/>
	Rudder <input type="checkbox"/>	Bilge Keels <input type="checkbox"/>

Assembly Bill 740 (2007)

- Regular removal of biofouling
- Develop form & collect hull husbandry information
- Develop regulations

Hull Husbandry Reporting Form

- Adopted 2008
- Annual submission
- Hull husbandry and operational practices of arrivals at CA ports



Proposed Biofouling Management Regulations

- Develop and implement a ship-specific strategy
 - BF Management Plan and Record Book
- Manage biofouling on the hull
 - Use coatings appropriately, or
 - Satisfy 5% cover threshold
- Manage biofouling on niche areas
 - Manage in some way and document it
- Extra management requirements for high-risk vessels
 - Obviously excessive biofouling
 - Extended Residency Periods (45+ days)



Biofouling Rulemaking Timeline

- Publication: May 1, 2015
 - 45-day comment period
- Public Hearing: June 16, 2015
 - Port of Long Beach
- Information posted www.slc.ca.gov

Thank you!

Nicole Dobroski
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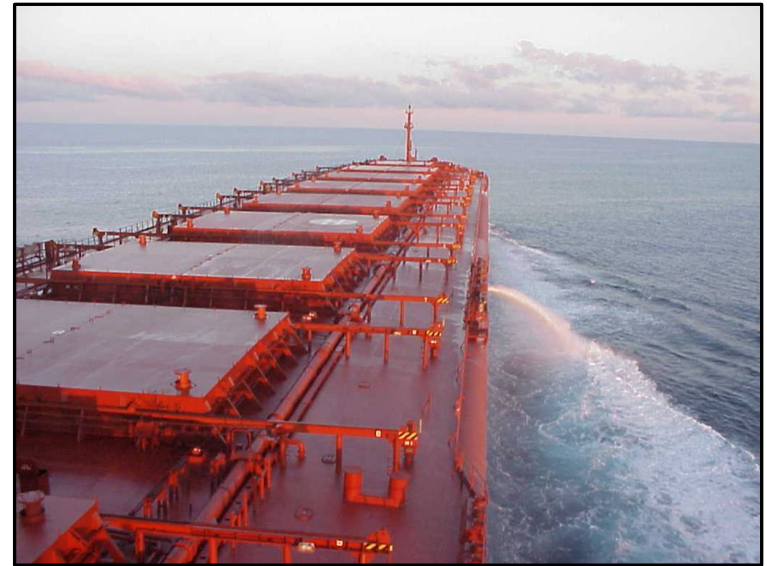


Photo courtesy: Smithsonian Environmental Research Center



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Dr. Mario Tamburri

Director, Maritime Environmental Resource Center
University of Maryland



Dr. Mario Tamburri received a Bachelors degree from University of California Santa Barbara and a Ph.D. from the University of South Carolina in biology and marine science. He is now a Research Professor at the University of Maryland Center for Environmental Science, and Director of both the Maritime Environmental Resource Center and the Alliance for Coastal Technologies. A marine ecologist by training, much of Dr. Tamburri's research over the past 10 to 15 years has focused on approaches to prevent the transport of invasive species by commercial vessels and on sensor innovations for environmental monitoring.

Implementation of Ballast Water Regulations as a “Technology Forcing” Strategy



Mario Tamburri and Dennis King
University of Maryland
Maritime Environmental Resource Center



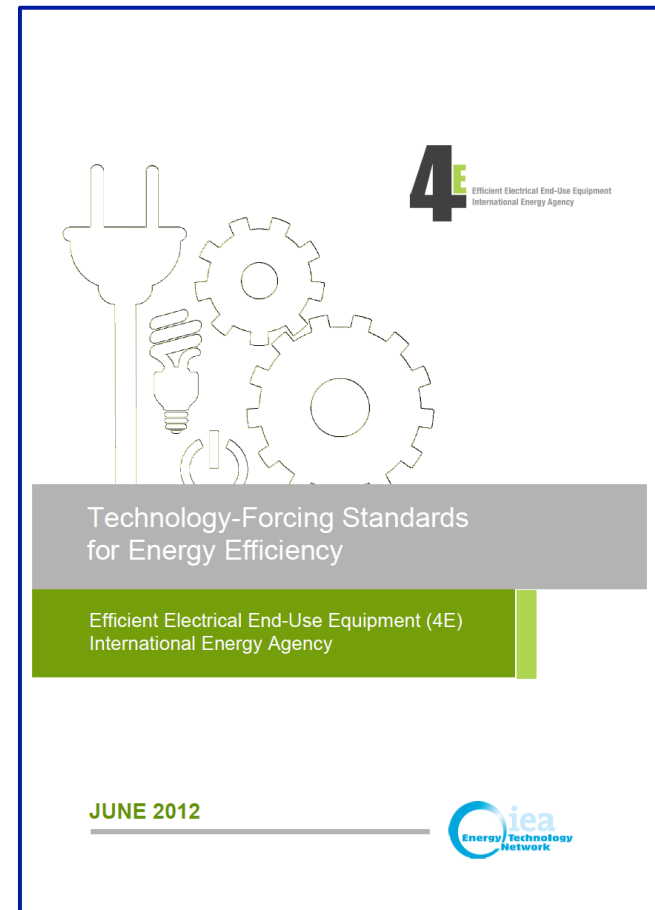
Implementation of Ballast Water Regulations

- **Technology Forcing Strategy**
- **Five Stages of Implementation**
- **Status of Ballast Water Management Systems**
- **Solutions to Remaining Challenges**



Technology Forcing Strategy

- **TF regulations set uniform standards to meet, typically using two different approaches: performance standards and technology standards**
- **TF regulations can require meeting performance levels not feasible using current technologies, or can require adopting emerging technologies that, when perfected, will achieve the standards**
- **Generally TFS are known to be successful in driving technological innovations that are not necessarily profitable, but achieve beneficial environmental or public health objectives**



Technology Forcing Strategy

- **Auto industry claimed that US Clean Air Act could do “irreparable damage” but the 90% pollutant reduction requirement in emissions eventually led to catalytic converters, three-way catalysts, and thermal management and onboard diagnostic systems**



- **Banning the use of halogenated CFCs from aerosol resulted in the development of non-fluorocarbon propellants and new cheaper aerosol pumping systems**



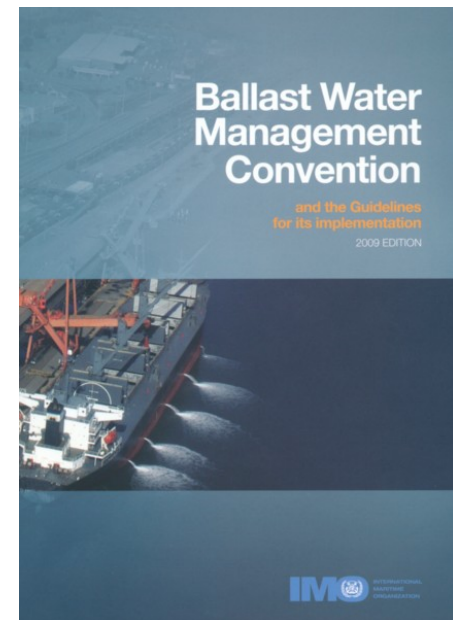
- **Unlike other successful examples**
 - **The regulated ballast water industry is not necessarily also the technology developer/provider**
 - **Regulations require both meeting standards and certified BWMSs**

Technology Forcing Strategy

- **Main Benefits:**
 - Enabling investment in R&D
 - Providing regulatory certainty to lower risk
 - Proven effective (likely to produce significant innovation)
- **Main Reservations:**
 - Danger in not achieving required rate and/or performance of innovation and thus forcing costly, sub-optimal technologies
 - Risk regulations are not enforced thus disadvantaging technology developers, investors and early adopters
- **Keys to Success:**
 - Match performance standard to expectations for innovations
 - Match timing of implementation with technology and market development
 - Provide policy confidence
 - Support and provide incentives for R&D
 - Implement credible, comprehensive, and effective enforcement

Implementation of the Ballast Water TFS

- 1 Establish limits on numbers of living organisms in ballast water discharges that reduce risk and challenge technology innovation**
- 2 Impose regulations that require vessels to install and use BWMS that can meet these discharge standards**
- 3 Promote investments to develop innovations that can meet the discharge standards**
- 4 Promote investments in manufacturing and installation capacity to supply the global fleet**
- 5 Establish compliance monitoring and enforcement of regulations that will result in regulated vessels installing, maintaining, and using effective/certified BWMS**



Timing of BWMS Development Under the TFS

1990 - 2000	Phase 1 Proof of concept studies
	Phase 2 Basic science and engineering studies
	Phase 3 Early laboratory experimentation
2000 - 2010	Phase 4 Pilot-scale attempts to apply the new technology
	Phase 5 Comparisons of separate independent applications
	Phase 6 Early standardization of technology
	Phase 7 Development of specialized equipment and materials that improve effectiveness and/or reduce costs
2010 - 2015	Phase 8 Technology begins to be used outside of a research and development context by early adopters
	Phase 9 Commercial investments and economies of scale reduce costs of production
2015 - beyond	Phase 10 Technology widely available supporting adoption/diffusion

Ballast Water Management Systems

Physical Separation

- Filtration
- Hydrocyclone

Chemical Treatment (Biocides)

- Oxidizing – sodium hypochlorite, ozone
- Non-Oxidizing – menadione, alkylamines
- Most “neutralize” prior to discharge

Physical Treatment

- Cavitation
- Deoxygenation
- Flocculation
- Heat
- Ultrasound
- Ultraviolet Radiation

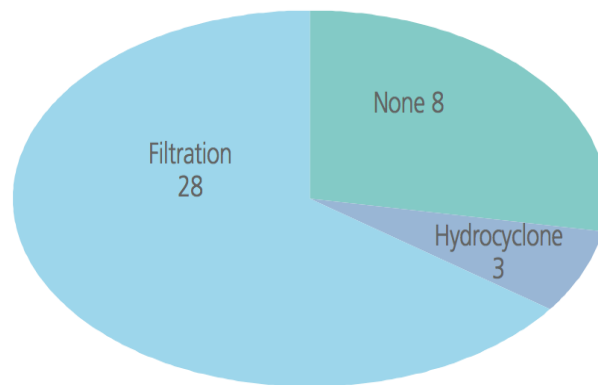


Most are Combinations

- e.g., Separation + Chemical
- Two to five phases
- Uptake, in-tank and discharge

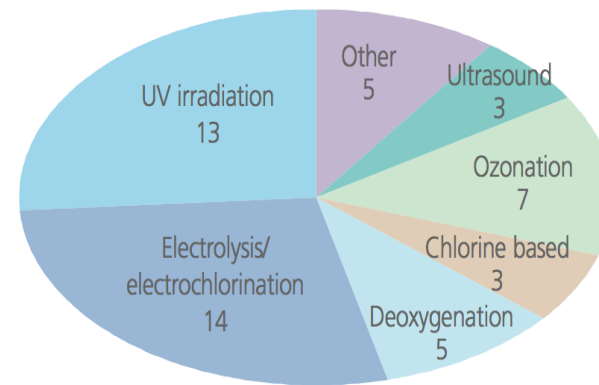
Ballast Water Management Systems

BWMSs	Number of Systems
Available or in development	80+
IMO Type Approval Certificates	51
USCG AMS Approvals	57
USCG Type Approval Certificates	0



(a)

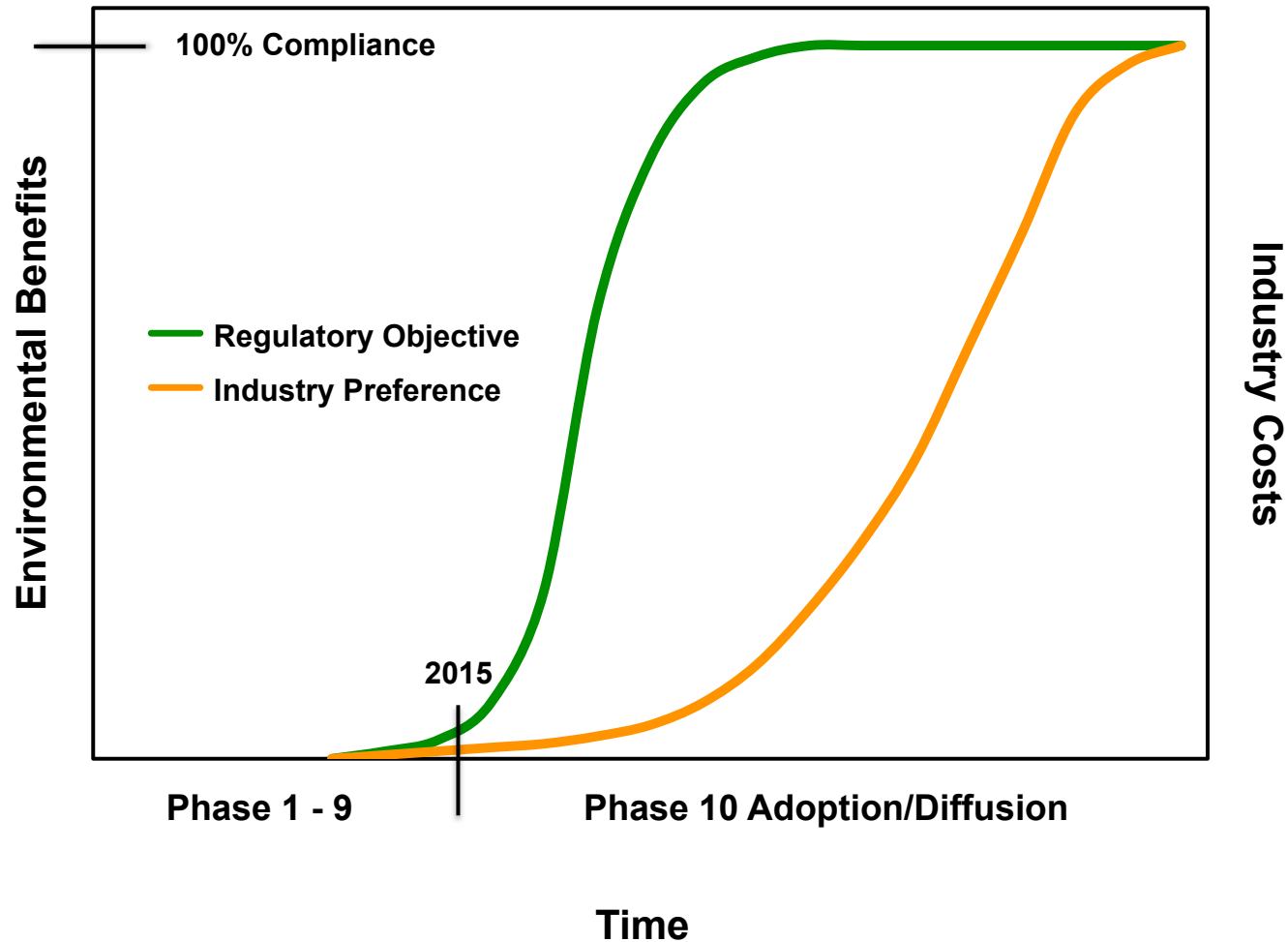
(a) Initial separation



(b)

(b) Secondary disinfection

Costs/Benefit Impacts on Adoption and Compliance



Factors Affecting Adoption and Compliance

- **Benefits of non-compliance (B_{nc}) = avoiding cost of:**

Purchase and installation of BWMS and/or

Operations and maintenance of BWMS

- **Costs of non-compliance (C_{nc}) =**

$$C_{nc} = (P_d \times P_p \times P_c) \times EP + \Sigma(P_d \times P_s) \times ES$$

P_d = Probability of violation being detected

P_p = Probability of detected violation being prosecuted

P_c = Probability of prosecuted violation resulting in conviction

P_s = Probability of detected violation resulting in indirect sanction

EP = Expected financial penalty for conviction

ES = Expected costs of indirect sanction for a violation, for example:

- inspection delays on current and/or future port visits
- corporate fines/penalties
- higher insurance rates / P&I sanctions
- impacts on captain/crew licenses
- impacts on vessel type approval

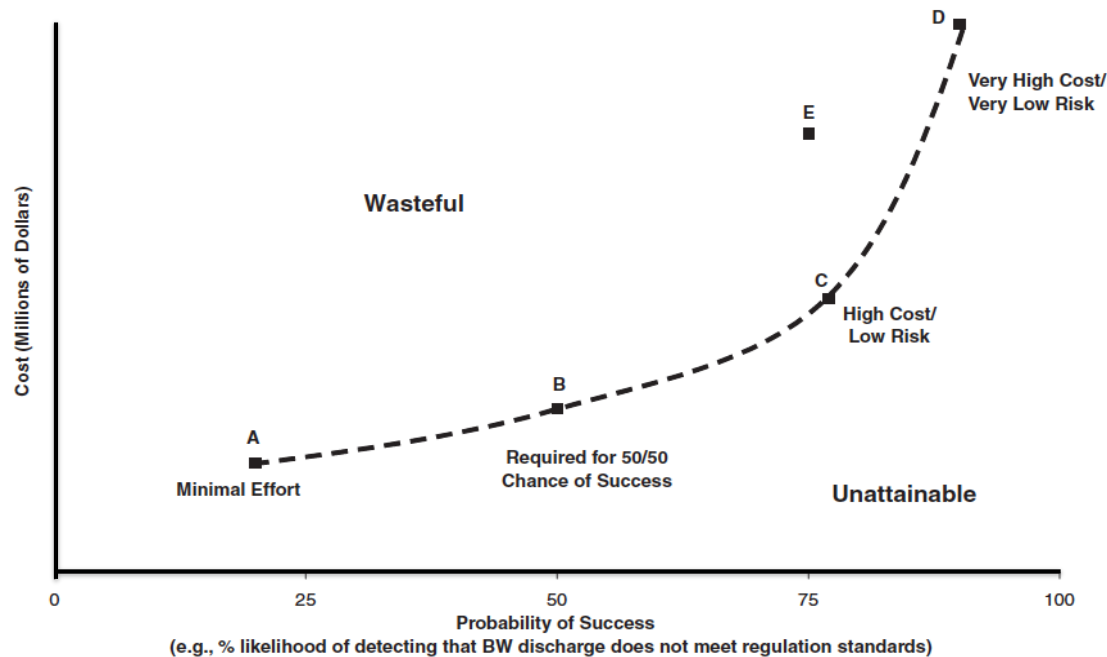
Detecting Violations: Phased Approach to Compliance Monitoring

- **Effective compliance is reliant on rigorous certification testing**
- **Initial assessments**
 - Review of vessel reporting
 - Review of Ballast Water Management Plan
 - Review of BWMS use and maintenance records
 - Visual inspection of BWMS
 - Interview crew
- **Expanded inspections**
 - Measures of BWMS performance
 - Indirect measures of exceedance
 - Direct measures of compliance



Compliance Monitoring Approaches

- **Direct measures of compliance (full biological sampling/analysis)**
 - Logistically challenging, time consuming, and costly
 - Not necessarily required to identify a violation
- **Options under consideration for indirect measure of exceedance**
 - Estimates of abundances and biological activity
 - None provide greater resolution than current certification testing



King and Tamburri, 2010

Validation of Compliance Monitoring Tools

Compliance monitoring tools also require extensive and rigorous testing prior to approval or selection for use

1 Proof-of-concept

Pilot studies or demonstrations on basic principles or the potential and capabilities of instruments or methods

2 Validation and verification

Independent evaluations (accuracy, precision, range, stability, reliability, etc.) of specific make/model under standardized protocols, against agreed to performance standard, and under diverse conditions

3 Feasibility and final selection

Data quality requirements, physical and performance characteristics, safety factors, cost, ease of use, maintenance, expertise/training requirements, etc.



Conclusions and Recommendations

- **Technology Forcing Strategy can be an effective regulatory approach to minimize the risks of ballast water invasive species**
- **TFS has resulted in innovative BWMSs that can meet discharge regulations but there are still critical steps ahead**
- **For the successful implementation of ballast water regulations**
 - **Provide the market with regulatory certainty and incentives**
 - **Establish effective comprehensive compliance monitoring and credible enforcement**





2015 Invasive Species Webinar Series

Frontiers for Ballast Water Treatment at the Intersection of Science, Technology and Policy

Monday, April 27, 2015 • 1:00pm-3:00pm ET

Q & A Session

Questions for the panelists? Submit via the “Questions” box or raise your hand by clicking on the hand icon.

Please visit the event page (<http://tinyurl.com/invasivesballast>) for background materials and resources.

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