Botanica Marina 50 (2007): 438–450 © 2007 by Walter de Gruyter • Berlin • New York. DOI 10.1515/BOT.2007.046

Review

Invasive seaweeds: global and regional law and policy responses

Meinhard Doelle*, Moira L. McConnell and David L. VanderZwaag

Marine & Environmental Law Institute and Dalhousie Law School, Dalhousie University, Halifax, NS, Canada, B3H 4H9, e-mail: Meinhard.Doelle@dal.ca

* Corresponding author

Abstract

We consider law and policy responses to invasive seaweeds at global and regional levels. Key global regimes considered include the 1982 United Nations Convention on the Law of the Sea, the Convention on Biological Diversity, the Ramsar Convention and the Bonn Convention on Migratory Species. Contributions from the Food and Agriculture Organization and the International Maritime Organization are also considered in the global context. At a regional level, examples of efforts in North America and Europe are offered to illustrate challenges and opportunities for regional responses to invasive seaweeds. We conclude with law and policy recommendations, most notably the need to approach the issue of invasive seaweeds in a manner consistent with the precautionary principle.

Keywords: global; law and policy; precaution; regional.

1. Introduction

As demonstrated in a number of the articles in this Special Issue, the introduction of alien invasive species poses one of the most serious threats to both terrestrial and marine biodiversity. In fact, habitat loss, climate change, and alien invasive species are generally considered to top the list of biodiversity threats. Concern about invasions is not limited to biodiversity *per se* but extends to its broader socio-economic impacts on agriculture, forests, fisheries, aquaculture, and other human activities dependent on the stability of living resources in a particular ecosystem. As a result, invasive species pose almost incalculable economic, socio-cultural and human health security risks. Estimates of the cost of responding to this problem around the globe vary widely. One estimate of the cost to the US economy is US$137 billion per year (Murray et al. 2004).

Although concern about the issue of introduction of alien species was evident in the late 1970s, the scope of the problem only gained widespread attention of law and policy makers in the 1990s. Most of the effort in policy development to date has been on terrestrial invasive species, particularly in relation to intentional introductions, and has taken the form of border control or quarantine measures. On the aquatic side, attention appears to have been focused more on intentional introductions of fish species and on specific sectoral pathways or vectors for the unintentional transfer of these and other species including pathogens. To date, however, law and policy efforts have tended to be generic and focused on managing pathways rather than on the problems posed by particular species or organisms, such as seaweeds. Although these efforts in part impact on the problem, invasive seaweeds nevertheless pose a serious threat in the context of unintentional transfer and introduction through shipping, aquaculture, the aquarium trade, fishing activities, and the opening of new canals and waterways. Some of these activities also involve intentional transfer of invasive seaweeds.

Here we provide an overview of law and policy responses to aquatic alien invasive species generally and invasive seaweeds more specifically. We are primarily concerned with the, arguably, more difficult regulatory problems posed by *unintentional* pathways for species transfer and introduction. While a comprehensive analysis of law and policy responses at the global and regional level is not possible here, we describe key global and selected regional efforts to deal with invasive species to demonstrate the challenge of developing a comprehensive and coordinated response to the threat of invasive species. Sectoral and selected regional and sub-regional efforts are also highlighted. In the process, the fragmented nature of the response at the global and regional level is exposed. Finally, national responses are not considered. However, it should be noted that states such as Australia and New Zealand are recognized as leaders in terms of domestic law and policy responses (Doelle 2003, Hewitt et al. 2004).

As explained in the other articles in this Special Issue, terminology varies greatly in both law and academic literature on this topic, with the terms alien species, alien invasive species, non-native species, non-indigenous species, or harmful aquatic organisms used, often interchangeably. Here we use the terms “invasive species” or “invasive seaweeds” unless the context requires otherwise. Similarly, we do not attempt to distinguish between various species but simply use the term “seaweed”.

In section 2 we point out that at least two global regimes provide an international framework for States to take action preventing the introduction and spread of aquatic invasive species, viz. the 1992 Convention on

Biological Diversity (CBD), and the 1982 United Nations Convention on the Law of the Sea (UNCLOS). The two main sectoral responses at an international level to the problem of transfer and introduction of invasives as an unintentional consequence of ships' operations (ballasting and hull fouling) and fisheries and aquaculture are also outlined.

An overview of regional responses set out in section 3 is followed with a generic discussion of what could be done at the national level to implement the principles developed internationally as the basis of an effective response to the threat. We argue that even though the global and regional law and policy responses are, as yet, neither comprehensive nor coordinated, this problem needs not be replicated at a national level. It proposes the adoption of a precautionary and integrated approach to regulatory design and implementation at a national level to address the problem of invasive species, including invasive seaweeds. Precaution has emerged as a key principle in the response to the problem of invasive species at both the global and regional level. Consistent with precaution, there has been a general recognition internationally that prevention is the best and, in many cases, the only effective defense against invasions: eradication, control and containment are risky at best, in most cases very costly and, more often than not, ineffective. The implications of building a national response on these principles are explored in the last part of this article.

This article is, therefore, based on the view that the harm arising from this problem, including both socio-economic and biodiversity impacts and costs, are such that prevention-oriented strategies are the best regulatory approach. In cases of doubt, precaution and prevention rather than eradication or containment or control is the way to deal with activities that are likely to be a vector or pathway for the introduction of invasive species.

Note: As the law in this area is constantly changing, we would like to emphasize that the materials are current up to 10 January, 2006, the date of submission of this article.

2. Global responses to invasive organisms such as seaweeds

While numerous international instruments and institutions are concerned with invasive species (McNeely et al. 2001), this chapter briefly discusses four of the main global agreements targeting invasives and highlights sectoral attempts by the Food and Agriculture Organization (FAO) and the International Maritime Organization (IMO) to address the problem of introductions of alien species in the contexts of fisheries and aquaculture, and shipping, respectively.

2.1. Four main global agreements

The four global agreements of special relevance to controlling invasive marine species fall into three sub-categories. UNCLOS, which, *inter alia,* addresses the issue of State obligations to protect and preserve the marine environment from pollution from both land and ocean-based activities, provides the general legal framework for addressing the problem of marine invasive species. The 1992 CBD casts a wide net to address the impacts of introduction of "alien species" [article 8(h)] on broad biodiversity protection. The 1971 International Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention) and the 1979 Convention on Migratory Species of Wild Animals (Bonn Convention) tangentially aim to curb the introduction of alien species in the context of specific area and species conservation.

2.1.1. General legal framework Considered the "Constitution of the Oceans", UNCLOS, with its 320 articles and nine annexes, devotes just one article specifically to the problem of "introduction of species, alien or new". Article 196(1) states:

> "States shall take *all measures necessary to prevent, reduce and control pollution of the marine environment* resulting from the use of technologies under their jurisdiction or control, or *the intentional or accidental introduction of species,* alien or new, to a particular part of the marine environment, which may cause significant and harmful changes thereto."(emphasis added)

There has been some debate as to the precise meaning of this provision, which is found in Part XII of UNCLOS, the part that deals with preservation of the marine environment. The question is whether on a strict reading it can be interpreted as meaning that the introduction of potentially harmful alien species is pollution of the marine environment, or whether this constitutes some other category of environmental harm (McConnell 2002, Firestone and Corbett 2005).

Article 1 of UNCLOS defines "pollution of the marine environment" as:

> "(4) […] the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities."

Although this distinction may have some implications for national level regulatory responses, particularly in connection with international shipping, the obligation, under Article 196(1), on Parties to UNCLOS to take steps to address the problem of transfer and introduction of alien or new species into the marine environment is clear.

In addition to this specific provision on species introduction, UNCLOS imposes a general duty on all States to protect and preserve the marine environment (Article 192). This obligation includes a duty to prevent pollution of the marine environment and to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life from all sources of pollution [Article 194(1) (5)] (Firestone and Corbett 2005).

An environmental impact assessment requirement is also set out in Article 206 for activities, which may cause pollution or significant and harmful changes to the marine

environment. This language may capture intentional introductions of seaweed for cultivation:

"When States have reasonable grounds for believing that planned activities under their jurisdiction or control may cause substantial pollution of or significant and harmful changes to the marine environment, they shall, as far as practicable, assess the potential effects of such activities on the marine environment […]."

It may also have implications for assessing the effect of any approaches adopted to address unintentional introductions. The use of the term "may" emphasizes the need to take action where a material risk is indicated.

The Convention also establishes a continuing obligation for States to protect and preserve the marine environment through global and regional cooperation, which might be the foundation for filling regulatory gaps in addressing invasive seaweeds. Article 197 provides:

"States shall cooperate on a global basis and, as appropriate, on a regional basis, directly or through competent international organizations, in formulating and elaborating international rules, standards and recommended practices and procedures consistent with this Convention, for the protection and preservation of the marine environment, taking into account characteristic regional features."

If indeed introduction of alien species (under Article 196) can be considered a form of pollution, then numerous other UNCLOS provisions would apply (McConnell 2002, Firestone and Corbett 2005). For example, Article 194(2) includes an obligation regarding protection of the environment of other States.

"Article 194 Measures to prevent, reduce and control pollution of the marine environment
[…]
2. States shall take all measures necessary to ensure that activities under their jurisdiction or control are so conducted as not to cause damage by pollution to other States and their environment, and that pollution arising from incidents or activities under their jurisdiction or control does not spread beyond the areas where they exercise sovereign rights in accordance with this Convention."[1]1

States might also be obliged to notify other States of the potential for invasive seaweeds to cause transboundary damage (Article 198). States would be urged to develop joint contingency plans for responding to seaweed invasions (Article 199). States would have an obligation to ensure that alien species that may/can harm do not spread beyond areas of national jurisdiction [Article 194(2)]. States might also be liable for transboundary invasions of invasive species (Article 235).

2.1.2. Biodiversity protection The CBD, calling for preventative and precautionary approaches to addressing the causes of biodiversity losses, has one provision specifically aimed at addressing the issue of introduced invasive species or alien species, as they are described in the CBD (and in later discussion, "marine alien species"). Article 8(h) calls on Parties to "prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species."

To the extent that it deals specifically with marine biodiversity, the CBD can be seen as building upon and elaborating the State obligations set out in UNCLOS concerning conservation and preservation of the marine environment. Article 22 (2) of the CBD specifically notes this relationship:

"Contracting Parties shall implement this Convention with respect to the marine environment consistently with the rights and obligations of States under the Law of the Sea."

The Conference of the Parties (COP), having agreed in 1995 to a program of action called the Jakarta Mandate on Marine and Coastal Biological Diversity, in 1998 adopted a program of work with one of five thematic areas being devoted to invasive alien species (CBD Secretariat, undated). The program of work has become a "living tree" spawning numerous initiatives to address the threat of introduction of alien species to ecosystems. For example, in Decision VI/23 (2002) on alien species that threaten ecosystems, habitats or species, the COP urged Parties to develop national invasive alien species strategies and action plans and to develop regional strategies where appropriate. The Decision also adopted, through an Annex (Guiding Principles for the Prevention, Introduction and Mitigation of Impacts of Alien Species That Threaten Ecosystems, Habitats or Species), setting out 15 guiding principles for the prevention and mitigation of impacts of alien species. Besides embracing the precautionary approach and ecosystem approach for dealing with invasive species, the Guiding Principles urge a three-stage hierarchical approach involving prevention as a first priority, followed by eradication and containment.

The Ad Hoc Technical Expert Group on Gaps and Inconsistencies in the International Regulatory Framework in Relation to Invasive Alien Species (AHTEG), established at the request of the Conference of the Parties in Decision VII/13 (2004), met in New Zealand in May 2005 and issued an informative report (Subsidiary Body on Scientific, Technical and Technological Advice 2005). Inadequate national implementation of international obligations and limited national capacity were identified as key impediments for addressing the introduction and spread of invasive alien species (paragraphs 17, 35). The AHTEG emphasized the need for capacity building efforts including technology transfer and training in relation to invasive species. The Expert Group noted that liability regimes for damages caused by invasive species may be an important issue and recommended that the issue be raised at the Experts Meeting on Liability and Redress under the Convention scheduled for October 2005.[2]

[1] Similar wording as to state responsibility is found in Article 3 of the CBD. An Expert Group has linked this obligation to invasive species (Subsidiary Body on Scientific, Technical and Technological Advice 2005).

[2] The Group of Legal and Technical Experts on Liability and Redress in the Context of Paragraph 2 of Article 14 of the Convention, met from 12 to 14 October 2005 in Montreal and while finding it premature to recommend development of a liability protocol, the Group initiated discussions about the numerous legal issues including how to define damage to biological diversity and how to value damage to biodiversity (CBD 2005).

The AHTEG urged Parties to take seriously their responsibilities under Article 3 of the Convention, that is, not allowing activities within their jurisdiction or control to cause damage to the environment of other States or areas beyond national jurisdiction. Various export controls were listed as examples, including notifying potential importing countries about particular species that may be invasive and prohibiting the export of some species.

The AHTEG highlighted the many specific gaps and inconsistencies in the international regulatory framework. While the COP, through Decision VII/5 (2004) on marine biological diversity, recommended that Parties use native species and subspecies in aquaculture, the Expert Group noted there are no specific binding international requirements addressing impacts, including transboundary impacts, regarding the use of alien species in aquaculture or in relation to the problem of transfer of invasive species through ships, fouling of ships and on other equipment and vessels. The exclusion of certain ships from IMO regulatory treaties was also viewed as a gap, as were other potential pathways for the introduction of invasive species including scientific research, tourism and the aquarium trade.

2.1.3. Specific area and species conservation The Ramsar Convention was signed in Ramsar, Iran in 1971 and has been amended by two Protocols (in 1982 and in 1987) (Ramsar Convention 1971). It committed Parties to establish nature reserves on wetlands and to include at least one wetland on the List of Wetlands of International Importance. It has largely addressed the issue of invasive species, through hortatory resolutions. Resolution VII.14 on invasive species and wetlands, adopted at the 7th Conference of Contracting Parties in 1999, urged Parties to: prepare inventories of alien species in wetlands; establish control and eradication programs; review existing legal and institutional measures relating to invasive species control; and, where necessary, adopt legislation and programs to prevent the introduction of "new or environmentally dangerous alien species" (Ramsar Conference 1999). Resolution VIII.18, adopted at the 8th Conference of the Parties in 2002, urged Parties to: undertake risk assessments of alien species which may pose a threat to the ecological character of wetlands; identify the presence of invasive alien species in wetlands and for listed sites to report to the Ramsar Bureau the nature of the invasion; and cooperate in preventing and controlling transboundary invasions including those in shared coastal/marine zones (Ramsar Conference 2002).

The 1979 Bonn Convention is aimed at protecting endangered migratory species (Bonn Convention, Appendix I) and listed migratory species having an unfavorable conservation status or which would significantly benefit from international cooperation (Bonn Convention, Appendix II). The Convention establishes quite general obligations on Parties in relation to invasive species. Pursuant to Article III (4)(c) of the Convention, Range States (of a migratory species listed in Appendix I as endangered) are required to endeavor:

"To the extent feasible and appropriate to prevent, reduce or control factors that are endangering or are likely to further endanger the species, including strictly controlling introduction of, or controlling or eliminating, already introduced exotic species."

"Range States" are defined in the Convention to include states that exercise jurisdiction over any part of the range of the migratory species and states whose flag vessels are engaged outside national jurisdictional limits in taking the migratory species.

For migratory species listed in Appendix II, Range State Parties are encouraged to conclude Agreements to restore or maintain migratory species at a favorable conservation status. In particular agreements are encouraged to include provision for protection of habitats from disturbances, "including strict control of the introduction of, or control of already introduced, exotic species detrimental to the migratory species" [Article V(5)(e)]. The potential impact of invasive seaweeds on the ecology of habitats of protected species would raise concerns relevant to this obligation.

2.2. Global sectoral initiatives

2.2.1. The FAO and invasives in the fisheries and aquaculture sectors The FAO has accepted a Code of Conduct for Responsible Fisheries (FAO 1995), a non-binding document setting out principles and standards for fisheries and aquaculture practices. It directly addresses the introduction of non-native species only in the context of aquaculture and intentional introductions. Article 9.2.3 proposes that States adhering to the Code consult with the neighboring States before introducing non-indigenous species into transboundary aquatic ecosystems. Article 9.3.1 urges States to minimize the harmful effects of introducing non-native species or genetically altered stocks used for aquaculture. The Code may, however, be relevant to the issue of intentional and unintentional introductions of invasive seaweeds through its general habitat protection and research exhortations. Article 6.8 urges States to protect and rehabilitate all critical fisheries habitats in marine and freshwater ecosystems. Article 12 calls for strengthening national research capacities and for assessing the impacts of environmental changes on fish stocks and aquatic ecosystems.

Perhaps of greater relevance in addressing invasive species than the Code of Conduct itself is the development of the non-binding Technical Guidelines on the Precautionary Approach to Capture Fisheries and Species Introductions (FAO 1996). The Guidelines equivocate over what a precautionary approach should mean to species introductions. After noting in paragraph 104 that a strictly precautionary approach would not permit deliberate species introductions and would require strong measures to prevent unintentional introductions, the Guidelines proceed to suggest moderated versions of the precautionary approach, especially for deliberate introductions of species. Rather than prohibiting intentional new species introductions, the Guidelines suggest "controlled introductions" where proponents of introductions shall be required to demonstrate caution through following the non-binding ICES Code of Practice on the Introduction and Transfer of Marine Organisms, or a similar code, where a risk assessment approach is followed and

pilot/experimental introductions supported. For unintended introductions, for example, by ballast water discharge, aquarium trade, or biologically contaminated fishing gear, the Guidelines recommend that authorities should "establish regulations to reduce these risks, commensurate with the severity of potential adverse impacts" (paragraph 129). The Guidelines also suggest the development of an accessible database on ballast or fouling organisms that have an impact upon fisheries and the creation of a network of experts charged with identifying introduction problems and areas of impact (paragraph 131). The Guidelines encourage the development of effective non-biocidal antifouling paints or treatments to reduce the risk of introduction from ship fouling (paragraph 137). This approach can, in part, be seen as complementary to the international obligations in the Anti-fouling Convention, discussed in the next section.

2.2.2. The IMO and the regulation of shipping as a vector for invasive species Shipping has been recognized as one of the primary vectors for the national and international transfer of "harmful aquatic organisms", which are defined in Article 1, paragraph 8, of the International Convention on the Control and Management of Ship's Ballast Water and Sediment 2004 (BWM Convention 2004), as:

"[…] aquatic organisms or pathogens which, if introduced into the sea including estuaries, or into fresh water courses, may create hazards to the environment, human health, property or resources, impairment of biological diversity or interfere with other legitimate uses of such areas."

This vector will be partly regulated at an international level by the BWM Convention 2004, when it comes into force[3], and, when finalized, the associated Guidelines for implementation (IMO, Guidelines 2004). This Convention, which took many years to negotiate, is under the auspices of the IMO. The BWM Convention 2004 is based, in part, on a 1997 Resolution of the IMO General Assembly, A. 868(20), Guidelines for the Control and Management of Ships' Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens. It is part of a web of regulatory Conventions, such as the International Convention for the Prevention of Pollution from Ships 73/78, more commonly known as MARPOL 73/78, developed by the IMO member States, to meet its mandate of securing "safer shipping and cleaner seas" by regulation of the shipping industry through the implementation of standards for many of the flag State obligations found under UNCLOS (Articles 91, 94). Under international law, and as codified by UNCLOS, a "flag State"[4] has the primary responsibility for regulating the operation of ships flying its flag, irrespective of where they operate in the world.

The BWM Convention 2004 is one of the newer generation of IMO regulatory Conventions, in that it includes more coastal State responsibilities and rights in the regulation of this sector.[5] The regulatory system set out in the BWM Convention 2004 adopts the formula that is now well established in many Conventions developed by the IMO to help prevent many different ship-based sources of marine pollution. This involves a combination of initial and on-going compliance inspections, certification, coastal zoning and alternative discharge options. It is an important step forward in addressing concerns about the introduction of potentially harmful organisms (including invasive species) by transport in ballast water and in sediment in the bottom of ships' ballast water tanks. It can be seen as a specific delineation of State obligations under both UNCLOS and the CBD, discussed above, to adopt and implement national laws to address this problem. However, it is suggested that it may not be an effective regulatory response to either prevention of or reducing the risk of spread of invasive seaweeds by ships.

A recent study of invasive seaweeds on the Pacific Coast of North America (Murray et al. 2004, pp. 1, 2) noted that:

"[…] the major pathways or vectors of introducing marine NIS [non-indigenous species] into non-native waters are: 1) shipping transport, either in ballast water or as hull fouling organisms; 2) aquaculture enterprises, either as targeted species or as unintentional hitch-hiker associates […] Besides canals and waterways, the most significant vectors for seaweed NIS appear to be: 1) aquaculture […]; 2) shipping, *mostly as fouling organisms attached to hulls and other ships' parts*; […] Seaweeds appear to be *much less likely* than other marine NIS to be introduced through the discharge of ballast water but are very likely to be moved along the coast as fouling organisms on ships' hulls or other marine gear." [emphasis added]

This comment highlights a regulatory gap, largely related to the dynamics of international institutions and lawmaking. It means that not all aspects of shipping that can serve as vectors for the unintentional introduction of harmful organisms are regulated under the BWM Convention 2004. As the foregoing quote indicates, potentially harmful organisms, such as invasive seaweeds, are transferred between countries in other ways related to ships' operations. These include attaching to the ship's hull (a process called fouling), the ship's sea chest (Cawthron 2004), attaching to the anchor and other parts of a vessel as well as cargo, cargo packaging and loading equipment. These may be considered, along with ballast water, as unintentional transfers in the sense that they are by-products of the operation of shipping, as distinct from intentional transfers of alien species, albeit on board a ship. Concerns have been expressed about these other unintentional or operational vectors in various fora, but so far there is no specific international regulatory devel-

[3] On the ratification by 30 States whose combined merchant fleets constitute not less than thirty-five percent of the gross tonnage of the world's merchant shipping fleet. It is implemented through a multifaceted phase in system for the standards linked to the date of construction (before or 2009 or 2012) and the size of the ship's tanks (Annex, Section B, Regulation B-3).

[4] A "flag State" is generally the State in which a ship is registered (although a ship can be on more than one registry, it can only fly one flag at a time).

[5] The term "coastal State" is a shorthand term usually used to refer to the interest of a State in protecting its coastline and resources in the waters under its jurisdiction. States often have a ship owning/regulation interest (flag State) and a coastal State interest (coastal and marine environment and resource management) and a port State role (a specific regulatory/enforcement role vis a vis the other two interests).

opment.[6] For example, in 2000 concern was expressed about this piecemeal, gap-filling approach to dealing with related issues in the meetings relating to the CBD (e.g., Invasive Alien Species, Options for Future Work, SBSTTA VI/8, 20 December 2000, and SBSTTA/6/ paragraphs 20–22; McConnell 2002).

More recently, concern has been expressed in the Report of the AHTEG meeting, discussed elsewhere in this article (Subsidiary Body on Scientific, Technical and Technological Advice 2005; at paragraphs 64–70). In particular the AHTEG noted the need to encourage the IMO to address the issue and also, to address the issue in connection with the Antarctic Treaty area. The need to raise the issue with respect to the United Nations open-ended Informal Consultative Process on Oceans and the Law of the Sea (INICPOLOS) was also noted at paragraph 70(g).

A further, perhaps ironic, complication in connection with the transport of invasives, such as seaweeds that attach to the exterior of the ship and its equipment (hull fouling), arises as a result of the fact that the problem may be exacerbated by the adoption and implementation of another recent IMO marine environmental protection Convention, the International Convention on the Control of Harmful Anti-fouling Systems on Ships 2001 (Anti-fouling Convention). The Anti-fouling Convention is aimed at eliminating harmful biocides such as tributyl tin (TBT) used in the coating, paint, surface treatment, surface, or devices on a ship to control or prevent attachment of unwanted organisms. This may then result in use of less effective surface treatments and increased hull fouling and risk of transport of organisms such as invasive seaweeds.

The BWM Convention 2004, once it comes into force and is implemented at a national level, may, over time, be an effective response, to the extent that seaweeds are transported and introduced through ballast water and sediment discharges. However, to avoid the spread of species along the coastline within a country, and to adjoining countries, regulation of ships on international voyages should be coupled with regulation of domestic and any regional trade fleets. In addition, once adopted, the Convention's Guidelines (IMO, Subcommittee on Bulk Liquids Cases 2004 2.2.2) will also include coastal/port responsibilities, which could help prevent the risk of ships encountering seaweeds that may attach to hulls and equipment. Port area authorities are expected to identify and warn ships of areas where ballast should not be taken up or discharged. These include areas of phytoplankton blooms, outbreaks, infestations or known populations of harmful aquatic organisms, including pathogens, as well as any particularly sensitive areas or activities. The process of identifying the "harmful aquatic organisms" in or near coastal and port waters can be taken into account in evaluating "risky ships" by the next port. Although a few countries have adopted regulations to address transport of organisms such as invasive seaweeds by hull fouling, it is not yet entrenched as an acceptable port or coastal State practice under a specific international agreement, although it could perhaps be supported on the basis of more general UNCLOS or CBD obligations to protect the marine ecosystems.[7]

3. Comparative regional coordination and cooperation

In the absence of a comprehensive global response to invasive seaweeds, and given the regional nature of the problem in many respects, it is worth considering the effectiveness of regional efforts to deal with aquatic invasive species generally and invasive seaweeds more specifically. To this end, this section considers regional efforts to respond to the threat of invasive species. Regions recognized by the United Nations Environment Program (UNEP) include Europe, North America, Latin America and the Caribbean, Asia and the Pacific, and West Asia. It is important to recognize that there are regional efforts to address invasive species in most regions of the world (McNeely et al. 2001). A complete overview of regional efforts on this issue is, however, not possible here. Instead, regional efforts in North America and Europe are used to illustrate what has taken place to date, and to consider the challenges and opportunities associated with a regional approach to invasive species such as seaweed.

By way of introduction, a regional approach can, in theory, have advantages over both global and national responses to invasive species. In comparison to global efforts, the regional approach has the advantage of allowing law and policy responses to be tailored to the unique circumstances of each region. It also allows States within a region to cooperate in the absence of global consensus. Even where this may not be a viable regulatory response for all vectors, e.g., international shipping, it can be an important component to ensure the effectiveness of international regimes. Regional approaches have potential advantages over national efforts in that they may be better able to tailor responses according to ecological boundaries as opposed to political ones. Furthermore, regional approaches may have

[6] An electronic list serve posted a notice in early July 2001 of a proposed "Planning Meeting: Workshop on Ship Fouling and Biological Invasions in Aquatic Ecosystems". The Workshop was proposed by a member of the US Navy, Naval Surface Warfare Center and a member of the USCG Environmental Standards Division. The proponents note that: "Historically, hull fouling has been the most important means by which shipping has transported non-indigenous species […] impending limitations on the use of the most effective antifouling paint [organotin based] and on the conduct of hull cleanings, may result in increased fouling of ships and the subsequent transport of non-indigenous species."

[7] The Northern Territory of Australia has recently implemented mandatory hull fouling checks on recreational and fishing vessels seeking entry into any of the enclosed marinas. These guidelines are being evaluated by the National Introduced Marine Pest Coordination Group for implementation in either a voluntary or regulatory framework. New Zealand has developed a Voluntary Code of Practice for vessels departing the two main Islands for the sub-Antarctic Islands, Chatham Islands and transiting to Fiordland (South Island). In addition, a comprehensive research program examining hull fouling across all international vessel sectors (recreational, commercial merchant, commercial fishing, passenger cruise, petroleum and slow moving barges) to underpin a risk evaluation has commenced.

the advantage of minimizing competitiveness otherwise associated with law and policy responses that either prohibit or increase the cost of certain economic activities.

The following sections consider whether there are indications that regional efforts in Europe and North America have been able to materialize on these theoretical advantages.

3.1. North American cooperation

Cooperation in the North American context means cooperation among Canada, the United States of America, and Mexico. Any regional cooperation involving all three countries is likely to involve the Commission for Environmental Cooperation (CEC) established under the (1992) North American Free Trade Agreement (NAFTA) to encourage cooperation on environmental issues of interest to the three countries. Beyond this, there are opportunities for bilateral or sub-regional cooperation on the Pacific, the Atlantic, and to some extent the Arctic Oceans. In addition, there are opportunities for cooperation on aquatic invasive species in freshwater ecosystems, most notably the Great Lakes system. An interesting issue with respect to regional and sub-regional cooperation in North America is the role of First Nations peoples, and the role of states and provinces in the US and Canada respectively, particularly given the confusing jurisdictional picture with respect to environmental and aboriginal issues in Canada and the US.

3.1.1. Regional cooperation in North America: the CEC The CEC has been actively involved in coordinating action of aquatic invasive species since it held a workshop on the topic in March 2001 (CEC Proceedings 2001). At this workshop, representatives of interested departments and agencies from the three member states identified a number of objectives as well as some specific steps to be taken to improve regional cooperation on this issue. Topics discussed at the workshop included cooperation with respect to science and information sharing, including prediction and modeling work, as well as public awareness issues.

The other main area for discussion was the response to the threat of aquatic invasive species through regulatory and voluntary measures to prevent and respond to invasions. Possible areas of cooperation include joint processes for prediction, identification and response to invasions. On the regulatory side, consistent rules to discourage intentional and unintentional behavior that may lead to invasions was seen as important to help reduce the risk of invasions in a manner that equally distributed potential costs involved in eliminating high risk activities. With respect to actions that require no outside motivation, voluntary measures were seen as serving to bring about the desired behavior to reduce or eliminate the risk of invasions without the need for regulations.

Within the CEC, discussions on how to achieve regional cooperation through information sharing, regulation, voluntary measures, and awareness raising, are ongoing. At the March, 2001 workshop, participants identified five priority areas for regional cooperation:

(1) A North American Invasive Species Information Network;
(2) A directory of legal and institutional frameworks for the prevention and control of invasive species;
(3) Identification of invasive species and pathways, particularly those of potential concern to more than one country;
(4) Tools for raising awareness;
(5) Tools to provide economic incentives to take voluntary action to reduce the risk of invasions (CEC Proceedings 2001, p. 49, 50).

Efforts to implement these priorities are ongoing; however, there are no concrete results to report. With respect to invasive seaweeds, the CEC recently commissioned a report on the status of seaweed invasions on the Pacific coast of North America (Murray et al. 2004). The Report, referred to above in section 2 on shipping, which is currently in draft form, considers the environmental threats of identified invasions, and makes some general science and policy recommendations.

3.1.2. Sub-regional cooperation in North America Sub-regional cooperation is generally ecosystem driven and often involves various levels of government with responsibility for a threatened ecosystem. In North America, there are at least three examples of sub-regional cooperation, one involving the Pacific Ocean, one involving the Great Lakes system, and one involving the Gulf of Maine. The Western Regional Panel is considered in more detail below as an example of sub-regional cooperation in the North American context. In the Gulf of Maine, institutions for inter-jurisdictional cooperation are well established in the form of the Gulf of Maine Council. As discussed below, however, there has been limited action on invasive species to date. With respect to the Great Lakes, the International Joint Commission has been active in promoting cooperation on the response to aquatic invasive species in the Great Lakes Region. The focus of these efforts has been on invasions resulting from shipping, specifically ballast water and hull fouling.

3.1.2.1. Western regional panel on aquatic nuisance species The Western Regional Panel on Aquatic Nuisance Species was initially called for in Section 1203 of the US National Invasive Species Act of 1996 (NISA). The Panel was set up following a meeting in autumn 1996. It was made up of representatives from four existing advisory groups on invasive species, including one with representation from British Columbia, Canada (Annual Report, 2000–2001, at 1). Membership of the Panel includes representatives from federal, state and provincial governments in Canada and the United States. In addition, there are members from aboriginal organizations, industry, conservation groups, academia, and other related interests. An interesting aspect of the Panel is that it includes jurisdictions from two countries, however, its statutory base is federal legislation in the United States.

The US National Invasive Species Act of 1996 goes beyond requiring the establishment of the Panel. It also dictates its goals. They include the following:

- Identify priorities for the Western Region with respect to aquatic nuisance species;
- Make recommendations to the US Federal Task Force on Invasive Species regarding an education, monitoring (including inspection), prevention, and control program to prevent the spread of the zebra mussel west of the 100th Meridian;
- Coordinate, where possible, other aquatic nuisance species program activities in the western region that are not conducted pursuant to the NISA;
- Provide advice to public and private individuals and entities concerning methods of preventing and controlling nuisance species infestations;
- Submit annual reports to the Task Force.

The work of the Panel to implement these goals is ongoing. Based on the 2000/2001 Annual Report (the most recent report available), the work of the Panel is in its early stages. Concrete law and policy recommendations on how to prevent, eradicate or control aquatic invasions have so far not been brought forward by the Panel. The focus so far has been on information sharing, voluntary cooperation and coordination.

3.1.2.2. Gulf of Maine Council On the Atlantic coast of North America, the Gulf of Maine Council on the Marine Environment has been the main vehicle for regional cooperation on marine environmental protection. With respect to aquatic invasive species, the focus to date has been on education and awareness raising. In fact, the current action plan (Gulf of Maine Action Plan 2001) provides for awareness raising and improved management as the two pillars of its aquatic invasive species strategy. On the management side, the plan focuses on information sharing as an initial step toward more effective responses within the Gulf of Maine.

The bottom line in North America is that it is too early to tell whether opportunities associated with regional approaches will materialize. The CEC is still in the early stages of trying to engage the member states in taking a coordinated approach to the problem. Similarly, sub-regional efforts are in the early stages, too early to assess guiding principles let alone evaluate law and policy responses to the threat of invasions.

3.2. European initiatives on aquatic invasive species

The multitude of jurisdictions in Europe generally, and in various aquatic ecosystems at risk of invasions more specifically, has resulted in considerable pressure for regional and sub-regional cooperation in Europe, perhaps more than anywhere else. As pointed out in other papers in this issue, aquatic invasions have, for some time, been documented in marine ecosystems throughout Europe, including the Mediterranean Sea, the Baltic Sea, and the Caspian Sea. It is to be expected, therefore, that efforts at regional cooperation may have advanced further in Europe than in other parts of the world.

3.2.1. Regional cooperation in Europe under the Bern Convention Efforts at regional cooperation on aquatic invasive species in Europe generally have been based on global efforts under the CBD, but have been coordinated through the 1979 Bern Convention on the Conservation of European Wildlife and Natural Habitats, which came into force in 1982. The Bern Convention has certainly been the main legal instrument to guide regional cooperation on this issue.

The Convention initially did not deal in any detail with invasive species, but it does include provisions in Article 11 that bring the issue within the mandate of the Convention. Specifically, Article 11(2)(b) requires each party to "strictly control the introduction of non-native species". This provision, in combination with numerous invasions documented in various ecosystems in Europe, has caused the parties to the Convention to consider the need for regional action on the issue. This has led to the preparation of a European Strategy on Invasive Alien Species prepared on behalf of the Standing Committee under the Bern Convention (Bern Convention 1979).

The Strategy was presented to the Standing Committee at its December 2003 meeting in Strasbourg. The Strategy was endorsed by the Standing Committee in Recommendation 99 at the December meeting (Standing Committee Proceedings 2003). Recommendation 99 recommends that all parties to the Bern Convention implement national strategies in light of the European Strategy endorsed by the Standing Committee, and report back to the Standing Committee on progress. Observers (non-parties) are also invited to implement the Strategy.

The Strategy is largely based on work carried out on invasive species under the CBD. It adopts the terminology from the CBD, and generally cross references work done under the CBD throughout the document. Areas covered include awareness raising, research and information sharing, and the importance of legal, policy and institutional frameworks. The Strategy furthermore highlights the role of regional cooperation, and endorses the hierarchy of prevention, eradication and control. The Strategy accepts as its basis the precautionary and ecosystem approaches.

3.2.2. Sub-regional cooperation in Europe Due to the significant number of invasions and the multitude of jurisdictions with a stake in responding to those invasions as well as taking measures to prevent future ones, it is not surprising that there are a number of sub-regional efforts to deal with aquatic invasions. There are efforts underway in the Mediterranean Sea, the Baltic Sea, and the Caspian Sea. Such efforts at multi-jurisdictional cooperation are generally carried out under regional agreements, such as the 2003 Framework Convention for the Protection of the Marine Environment of the Caspian Sea (Article 12), the 1995 Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean Sea, and the 1992 Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea Area.

4. National level law and policy options

One clear message from the foregoing overview of international efforts on invasive species is that regional and global efforts are fragmented in terms of both regulatory

responses and at an institutional level. Furthermore, it is left to national governments to implement specific law and policy measures to implement the general principles that have been developed at a global and regional level. It is at the national level, therefore, that we can expect to see the results of the global and regional efforts to develop effective responses to the threat of invasions.

It will not come as a surprise that the problem of fragmentation does not stop at national borders. Few countries have developed integrated strategies on invasive species that consider long-term local and global harm and benefits of the activities involved and the invasions linked to those activities. A country that has taken this issue more seriously than most is New Zealand (Wotton and Hewitt 2004). In many States, the responsibility is assigned to agencies with a focus on a particular aspect of the problem, usually either associated with the utility of the activity involved, or with a mandate to protect ecosystems or components of ecosystems threatened by invasions.

4.1. General considerations

This section will consider in very general terms the issues facing domestic law and policy measures. It is assumed for purposes of this overview that the starting point for national measures will be those commitments, obligations and principles developed under the various international instruments described elsewhere in the article. Given the limited success in addressing the problem globally and regionally, implementation of international agreements is only the starting point at a national level. An effective national response clearly has to go beyond the implementation of international commitments. A national level precautionary approach to regulatory system design is needed. This means that a clear identification and understanding of the problems and gaps found in the international system and the implications for national implementation is needed.

The overall message from international efforts on this issue seems clear. Prevention is the most effective way of slowing the increasing rate of invasions. In many cases, prevention has proven to be the only effective way of avoiding the invasion from becoming permanent. This means any effective strategy on invasive species will consider available preventative measures first. Such measures can fall into two categories; they can involve changes to the activity that leads to the invasion to make it safe, or it can involve prohibition of the activity. Whether either of these options can reasonably be implemented with respect to a particular pathway will depend on a number of factors, including the utility of the activity, the availability of an alternative method of achieving the utility of the activity, and the cost of implementing alternatives. In the context of both unintentional and intentional transfer of invasive species, the international character of many of the activities inherently places some limits on the ability to regulate, other than through border control measures that are acceptable under international law.

In case of pathways where current conditions do not reasonably allow for measures to prevent the risk of invasions, a combination of measures to reduce the risk and motivate further efforts to reduce and even, perhaps, eliminate the risk in the future would constitute a second level of response. An example might be invasions from hull fouling and ballast water. In using this example as a starting point for the discussion of possible national level responses, it is important to take into account the unique characteristics of the activity involved.

The example of international shipping is one involving an unintentional introduction from a long-established activity which most would consider as providing an essential service to society. This means that the prohibition of shipping is generally not considered a reasonable response to this threat. As was discussed in section 2, implementation of international agreements, such as the BWM Convention 2004, can be effective in reducing the risk of invasions that may result from ballast water and sediment discharge. This leaves the question of what can or should be done about other risks related to shipping, and about other vectors such as those associated with the aquarium trade and fishing.

One part of the answer would be to motivate research and development on ways to prevent invasions resulting from shipping. Another would be the allocation of responsibility for compensation for damages arising from invasions that do occur in spite of measures to those who benefit from the activity. However, this can be problematic because a causal connection can be difficult to establish in that an invasion may not be apparent for many years and, if baseline data on the relevant ecosystem are not available, difficult to prove.

Responses to risks that are deemed unavoidable as a result of the utility of the activity and the absence of alternatives have the potential to serve a dual function. They can serve to motivate those who benefit from the activity responsible for the risk to look for ways to reduce or eliminate that risk. They can also serve to fund efforts for responding to invasions that do take place by funding efforts to identify responses as early as possible, and by funding eradication, control or containment of invasions to reduce the long-term damage.

An effective national level response to the risk of invasions from vessel traffic might therefore consist of the following components:

- Identification of reasonable measures to reduce the risk of invasions from ship traffic, including those set out in international agreements;
- Regulation and enforcement to ensure all reasonable measure to reduce or eliminate the risk are being taken;
- Identification of the residual risk;
- Internalization of the cost of the residual risk (erring on the side of overestimating the risk and the resulting cost);
- Use of the funds generated from the process of internalization for early identification, eradication, control, and containment.

Assuming this approach works for well established activities with clear utility resulting in unintentional introductions, how would the response have to be adjusted

to deal with differences in these basic characteristics? Clearly, the less the utility of an existing activity, and the higher the risk associated with it, the greater the pressure to respond to the threat by prohibiting the activity.

With respect to new activities, the main difference is that there is an opportunity to implement the precautionary approach in a more direct manner, by delaying or preventing the activity until or unless it can be proven to be sufficiently safe by its proponent. While interpretative debates have surrounded the precautionary approach (VanderZwaag 1998, Ellis and FitzGerald 2004, Scott 2005), a strong version of precaution would place the burden of proof on the proponent of an activity to meet some requisite standard of proof (Hildreth et al. 2005), such as "no significant" threat to ecosystem health. Principle 10 in the CBD Guiding Principles for the Prevention, Introduction and Mitigation of Imports of Alien Species, discussed above, suggests that the burden of proof should be with the proposer of intentional introductions of potentially invasive species to show the introduction will be unlikely to threaten biological diversity.

In principle, whether the activity is a new or existing activity, this decision would be made based on the same precautionary approach. The reason for considering them separately is not to diminish the importance of applying a precautionary approach in case of existing activities, but to highlight the opportunity to do so for new activities in a manner that avoids the difficult question of how to turn back the clock and eliminate an activity that has become accepted and relied upon within a society.

This leaves the issue of intentional *versus* unintentional introductions. It is important to first define the boundary between intentional and unintentional introductions. Introductions from ships clearly fall into the unintentional category. On the other hand, fish stocking is the clearest example of an intentional introduction. In between is a range of activities whose classification really depends on the level of effort applied to prevent the escape and/or establishment of an invasive or alien species.

In the mariculture context for example, one could consider all non-native mariculture to be intentional. Alternatively, depending on the level of effort made in a particular operation to prevent the spread of a species used in mariculture, it is possible to consider the introduction to be unintentional. Examples might be mariculture in closed systems on land, or in cages, as opposed to in the open sea without barriers to prevent the spread of the species.

For purposes of this discussion of appropriate law and policy responses, it is suggested that nothing turns on where the line between intentional and unintentional introductions is drawn. Rather, the issue is one of whether a strategy has been developed whereby the risk of an invasion can be identified and how well it can be evaluated. Having said this, a precautionary approach to invasive species would generally result in the prohibition of intentional introductions in the sense of an introduction of a non-native species without any barriers to prevent its spread, unless the species by its nature is known not to be invasive, something that is generally accepted to be difficult to establish.

4.2. Institutional issues

Having considered the range of decisions that may have to be made at a national level to implement an effective response to invasive species, how should these decisions be made? Inevitably, the decision-making responsibility will have to fit within an existing institutional framework. Even so, existing frameworks may need to be modified to facilitate appropriate decisions on issues ranging from whether to allow an activity, what conditions to impose on an activity to minimize the risk of invasion, to how to ensure motivation to reduce the risk and to ensure that the cost of any invasion is born by those who benefit from the activity that is creating the risk.

The fundamental choice is between the creation of a new decision-making agency and the use of one or a combination of existing decision makers, ideally operating within an integrated framework. Some countries, such as New Zealand, Australia, and the United States, have created new agencies to either oversee the national implementation by existing agencies, implement directly, or a combination of both. Other countries have focused on imposing decision-making responsibilities on existing departments and agencies.

Existing decision makers typically fall into one of two categories. The first consists of regulators of the sectoral activities that pose a risk of invasions. These generally include departments of fisheries, aquaculture, transportation, and agriculture. The other includes decision makers with an environmental protection and conservation focus. These generally include departments responsible for environmental protection, biodiversity, resource conservation, and agencies responsible for processes such as environmental approval and environmental assessment processes.

It is not surprising that one of the main challenges with the reliance on existing decision-makers is how to ensure that the objective of preventing, reducing and controlling invasive species receives sufficient weight when compared to the pre-existing mandate of the decision maker. This problem also arises in the context of environmental decision-making superimposed on government decision makers through environmental assessment processes that are based on the self assessment model. A precautionary approach here would suggest that decision-making responsibility should not rest with regulators of the activity involved, but with decision makers whose primary mandate is as closely as possible connected to the prevention of invasions.

4.3. Regulatory tools

A domestic regulatory response to prevent the transfer of harmful aquatic organisms and pathogens should be based on a principled approach with sustainability as the ultimate objective. The following principles initially developed in the shipping context provide a sound basis for a national response to invasive seaweeds more generally:

- Responses to an ecological problem in the context of an international activity, such as shipping, should be based on an approach that seeks to fulfill international responsibilities to protect the global environment,

integrates economic and ecological protection concerns and is based on international cooperation to develop rules and technological or other solutions to environmental problems arising out of the globalization of the economic system.
- A precautionary approach should be adopted for both regulatory design and implementation. For example, all regulatory determinations must, as much as possible, be based on scientific research and an analysis of both local and global ecological implications of any action, with preference given to measures designed to ensure either no, or the least possible, long-term negative impact on the environment.
- Risks to the ecosystem[8] should be minimized by designing and adopting measures that are commercially and practically viable and that encourage compliance rather than avoidance and conflicts.
- Responses should allow for and explicitly encourage continuous technological and operational improvement to better protect the marine ecosystem.
- It will be important to ensure transparency, sustainability and integration of agency responses.
- Responses should encourage the involvement of all parties affected by the issue (and any decisions about regulating the issue), including the regulated sectors and other sectors, in helping to develop a solution.
- Compliance should be encouraged by making use of a range of modern regulatory devices such as economic incentives and voluntary compliance agreements.
- There should be a focus on measures to prevent the uptake of harmful organisms and pathogens at the source as well as preventing their introduction.
- It will be important to develop local and regional contingency responses and compensation plans for all those negatively affected by the activity, based on a "polluter-pay" model.
- Requirements should be put in place that are environmentally safe, practicable, designed to minimize cost and delays to the shipping industry and, as much as possible, based on the internationally accepted standards such as the IMO Guidelines and the BWM Convention 2004 and any guidance developed under it.
- Requirements operating at a national level also need to take into account ecosystem differences within each country, and must be applied in a fair, uniform and consistent manner in each port.
- It will be important to ensure that there is ongoing review and monitoring to evaluate the impact of any action that is taken.

Goals to be achieved in designing a regulatory system, including legislation, might include:

- Preventing the problem at the earliest possible point and with the highest level of effectiveness possible;
- Maximizing opportunities for risk assessment and prevention;
- Maximizing administrative efficiency and cooperation through holistic approaches and integrated management;
- Reducing unnecessary costs to the public and the regulated industry;
- Avoiding unnecessary conflicts between shipping and other coastal zone users and amongst regulatory agencies;
- Minimizing uncertainty for all affected parties;
- Ensuring transparency;
- Maximizing accountability – internationally, regionally and nationally;
- Ensuring flexibility to respond to and incorporate developments in scientific information, technology or the development of new related concerns, and to accommodate local ecosystem conditions and requirements in a harmonized manner (McConnell 2002).

Having now considered the substance of the decisions that would have to be made at the national level as well as some basic choices about the decision maker, this leaves the question of the regulatory tools that may be used to implement the decisions made. The traditional tool for environmental protection is generally known as command and control. This refers to the general process of identifying what should or should not be done, setting out those requirements in law, imposing penalties for not following those requirements, and then designing and implementing effective enforcement mechanisms to ensure that legal obligations are observed.

A common regulatory tool is the permitting process, which requires individuals who wish to engage in an activity to seek approval, and allows regulators to specify conditions for approval on a case by case basis. Another common form of regulating activities is through standards imposed through regulations. Here those engaged in activities are required to meet the standard set in the regulation rather than to be forced to individually apply for permission. Anyone who complies with the standards set in the regulation is entitled to engage in the activity in question.

There are a number of alternatives to the traditional command and control approach that have evolved over time. Of most interest in this context is what has become known as economic instruments. They are of interest here in particular with respect to activities that are permitted to continue in spite of an ongoing risk of invasions, presumably due to the utility of the activity and the absence of an alternative that would eliminate the risk without eliminating the utility. Economic instruments provide the opportunity to ensure that the cost of the risk of invasion is borne by those who engage in or otherwise benefit from the activity. This can be done through user fees, requirements for insurance, security requirements, or the establishment of a liability fund. The common thread is the objective of quantifying the cost of the risk of invasion, and requiring that the cost be paid by those who benefit from it. This process is often referred to as "internalizing the cost".

An alternative use of the same range of economic instruments is to motivate those engaged in the activity to find ways to reduce or eliminate the risk. While this can be achieved by internalizing the cost, it only does so

[8] This includes the environment or ecosystem of the enacting State and other States and common areas as noted in Guiding Principle 4.

if the cost cannot be passed on easily and if the cost is sufficiently high to create a motivation to invest in finding ways to reduce or eliminate the risk. If the primary objective of an economic instrument is therefore the ultimate elimination of the risk, rather than the internalization of the cost, the price will be set based on what is required to motivate research and development, not based on the cost of responding to invasions.

5. Conclusion: the need for a precautionary integrated approach to regulatory design and implementation decisions

The development of an effective law and policy response to the threat of invasive seaweeds is still in its early stages. Efforts to move towards an effective global response are ongoing. While these efforts do show some promise, the current state is one of fragmentation. Similarly at the regional level, much remains to be done. Some jurisdictions have made significant progress, while others are just starting to take the problem of invasive species seriously. There is little indication to date of the specific issue of invasive seaweeds as a distinct challenge that has been identified in many jurisdictions or regions, let alone at the global level. At the same time, law and policy makers do have a solid basis of principles and potentially powerful regulatory tools to draw upon.

References

International agreements and documents

Bern Convention on the Conservation of European Wildlife and Natural Habitats, September 19, 1979, Council of Europe – ETS no. 104. Online: <http://conventions.coe.int/Treaty/EN/Treaties/Html/104.htm>.

Convention on Biological Diversity of the United Nations Conference on the Environment and Development, June 5, 1992, 31 I.L.M. 818 (1992).

Convention on Migratory Species of Wild Animals, June 23, 1979, 19 I.L.M. 15 (1980).

Convention on the Protection of the Marine Environment of the Baltic Sea Area, April 9, 1992. Online: <http://www.helcom.fi/Convention/en_GB/text/>.

Convention on Wetlands of International Importance especially as Waterfowl Habitat, February 2, 1971, 11 I.L.M. 963 (1972).

International Convention on the Control of Harmful Anti-fouling Systems on Ships (Anti-fouling Convention), February 1, 2002, IMO AFS/CONF/26 (2001). Online: <http://www.imo.org/>.

International Convention for the Prevention of Pollution from Ships (MARPOL 1973), November 2, 1973, 1340 U.N.T.S. 184 (1973), 1978 Protocol, 17 February 1978, 1340 U.N.T.S. 6.

International Convention on the Control and Management of Ship's Ballast Water and Sediment, June 1, 2004, IMO BWM/CONF/36 (2004). Online: <http://www.imo.org/>.

North American Free Trade Agreement, December 17, 1992, 32 I.L.M. 289 (1993), 32 I.L.M. 605 (1993).

North American Agreement on Environmental Cooperation, September 14, 1993, 32 I.L.M. 1480 (1993).

Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean, June 10, 1995. Online: <http://www.oceanlaw.net/texts/unepmap2.htm>.

Rio Declaration on Environment and Development, June 13, 1992, 31 I.L.M. 874 (1992).

The Framework Convention for the Protection of the Marine Environment of the Caspian Sea, November 4, 2003. Online: <http://www.caspianenvironment.org/NewSite/Convention-FrameworkConventionText.htm>.

United Nations Convention on the Law of the Sea, December 10, 1982, 21 I.L.M. 1261 (1982).

Other sources

Cawthron Institute, "Cawthron reveals unwelcome 'Octopus Garden'". Press release. December 14, 2004. Online: <http://www.cawthron.org.nz/news/news_sea_chests_PR.htm>.

CBD Secretariat, "Jakarta Mandate Marine and Coastal Biodiversity – Introduction". Online: <http://www.biodiv.org/programmes/areas/marine/default.asp>.

CBD Secretariat, Report of the Group of Legal and Technical Experts on Liability and Redress in the Context of Paragraph 2 of Article 14 of the Convention on Biological Diversity. 2005. UNEP/CBD/COP/8/27/Add.3. Online: <http://www.biodiv.org/doc/metings/cop/cop-08/official/cop-08-27-add3-en>.

Doelle, M. 2003. The quiet invasion. Law and policy responses to invasive species in North America. 2003. *Int. J. Mar. Coast. Law 18*: 261–294.

Ellis, J. and A. FitzGerald. 2004. The precautionary principle in International Law: lessons from Fuller's internal morality. *McGill Law J. 49*: 779–800.

European Strategy on Invasive Alien Species, Bern Convention on the Conservation of European Wildlife and Natural Habitats Standing Committee. December 2003. Online: <http://www.coe.int>.

FAO, Code of Conduct for Responsible Fisheries. 1995. Online: <http://www.fao.org/fi/,default.asp>.

FAO, Precautionary approach to capture fisheries and species introductions. FAO Technical Guidelines on the Precautionary Approach to Capture Fisheries and Species Introductions No. 2. 1996. Online: <http://www.FAO.org/documents/show_cdr.asp>.

Firestone, J. and J.J. Corbett. 2005. Coastal and port environments: international legal and policy responses to reduce ballast water introductions of potentially invasive species. *Ocean Dev. Int. Law 36*: 291–316.

Globallast, Global Ballast Water Management Programme website. Online: <http://globallast.imo.org>.

Gulf of Maine Council on the Marine Environment, Action Plan, 2001–2006. Online: <www.gulfofmaine.org>.

Hildreth, R.G., M.C. Jarman and M. Langlas. 2005. Roles for a precautionary approach in marine resources management. *Ocean Yearb. 19*: 33–61.

Hewitt, C.L., J. Willing, A. Bauckham, A.M. Cassidy, C.M.S. Cox, L. Jones and D.M. Wotton. 2004. New Zealand marine biosecurity: delivering outcomes in a fluid environment. *NZ J. Mar. Freshw. Res. 38*: 429–438.

ICES, Code of Practice on the Introduction and Transfer of Marine Organisms, International Council for the Exploration of the Sea, 2005, available online at <http://www.ices.dk/>.

IMO, Resolution A.868(20) Guidelines for the Control and Management of Ships' Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens, 1997. Online: <http://globallast.imo.org/resolution.htm>.

IMO, Sub-Committee on Bulk Liquids and Gases. Development of Guidelines for Uniform Implementation of the 2004 BWM Convention. Note by the Secretariat, IMO Doc. BLG 9/11, November 12, 2004.

Invasive Alien Species, Options for Future Work, SBSTTA VI/8 and SBSTTA/6/ paras 20–22, 20 December 2000. Online: <http://www.biodiv.org>.

March 2001 CEC Workshop Proceedings, Workshop to Identify Cooperative Opportunities for Preventing the Introduction and Spread of Aquatic Invasive Species, North American

Commission for Environmental Cooperation. Online: <http://www.cec.org/programs_projects>.
McConnell, M.L., GloBallast Legislative Review, 2002 Final Report, Globallast Monograph Series, International Maritime Organization No. 1. London. 121 pp. + app. 2002. Online: <http://globallast.imo.org>.
McNeely, J.A., H.A. Mooney, L.E. Neville, P. Johan Schei and J.K. Waage. Global Strategy on Invasive Species. IUCN Gland, Switzerland and Cambridge, 2001. U.K. 50.
Notes of Standing Committee to the Bern Convention, 23rd Meeting, December, 2003, Strasbourg. Online: <http://www.coe.int/T/E/Cultural_Co-operation/Environment>.
Murray, S., L. Fernandez, J. Zertuche-Gonzalez. Status, Environmental Threats, and Policy Considerations for Invasive Seaweed for the Pacific Coast of North America, Commission on Environmental Cooperation (presentation) 2004. Online at <http://www.icais.org/pdf/21Tuesday/C/tues_c_e_am/Hans_Herrmann.pdf>.
Ramsar Conference, 1999. Resolution VII.14 on Invasive Species and Wetlands. Online: <http://www.ramsar.org/res/key_res_vii.14e.htm>.
Ramsar Conference, 2002. Resolution VIII.18 on Invasive Species and Wetlands. Online: <http://www.ramsar.org/res/key_res_viii_18_e.htm>.
Resolution VII.14 1999, Ramsar Convention COP7. Online: <http://www.ramsar.org/res/key_res_vii.14e.pdf>.
Resolution VIII.18, 2002, Ramsar Convention COP8. Online: <http://www.ramsar.org/res/key_res_viii_18_e.pdf>.
SBSTTA 2004, SBSTTA 2000 and other SBSSTA docs and COP decisions, Convention on Biological Diversity. Online: <http://www.biodiv.org/>.
Scott, D.N. Shifting the burden of proof: the precautionary principle and its potential for the "democratization" of risk. *In*: (Law Commission of Canada, ed.) 2005. *Law and risk*. UBC Press, Vancouver. pp. 50–85.
Subsidiary Body on Scientific, Technical and Technological Advice, Convention on Biological Diversity. Report of the Ad Hoc Technical Expert Group on Gaps and Inconsistencies in the International Regulatory Framework in Relation to Invasive Alien Species. 2005. UNEP/CBD/SBSTTA/11/INF/4.
US National Invasive Species Act of 1996, Pub. L. No. 104–332, 110 Stat 4073, available online at <http://thomas.loc.gov/cgi-bin/query/D?c104:13:./temp/~mdbsexmOl0::>.
VanderZwaag, D. 1998. The precautionary principle in environmental law and policy: elusive rhetoric and first embraces. *J. Environ. Law Practic. 8*: 355–375.
Western Panel on Aquatic Nuisance Species, 2000–2001 Annual Report. Online: http://www.fws.gov/answest/annualreport.htm>.
Wotton, D.M. and C.L. Hewitt. 2004. Marine biosecurity post-border management: developing incursion response systems for New Zealand. *N. Z. J. Mar. Freshw. Res. 38*: 553–559.

Internet resources

Baltic Marine Biologists (BMB). http://www.smf.su.se/bmb.
Baltic Sea Regional Project (BSRP). http://www.helcom.fi/helcom/projectsmeetings/GEF-BSRP.html.
Baltic Sea Transportation System Projects. http://www.oce.pg.gda.pl/oce2/eureka/index.htm.
Caspian Environment Programme (CEP). http://www.caspianenvironment.org.
CIESM Portal Programme. http://www.ciesm.org/people/task.html.
Global Ballast Water Management Programme. <http://globallast.imo.org>.
Nordic Network on Introduced Species (NNIS). <http://www.sns.dk/natur/nnis>.
The EU Northern Dimension. http://europa.eu.int/comm/external_relations/north_dim.
The Nordic Council. http://www.norden.org/search/sk/search.asp.
The Nordic Environmental Action Plan 2001–2004. http://www.norden.org/miljoe/sk/eng.pdf.
Working Group 30 on Non-indigenous Estuarine and Marine Organisms (BMB WG 30 NEMO). http://www.ku.lt/nemo/mainnemo.htm.
2003 HELCOM Bremen Declaration. http://www.helcom.fi/helcom/declarations.html.

Received 10 January, 2006; accepted 23 November, 2006