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PATHWAYS OF INTRODUCTION OF INVASIVE SPECIES, THEIR PRIORITIZATION AND MANAGEMENT

Note by the Executive Secretary

I. INTRODUCTION

1. The Guiding Principles for the Prevention, Introduction and Mitigation of Impacts of Alien Species that threaten Ecosystems, Habitats and Species (the Guiding Principles) annexed to decision VI/23** provide all Governments and organizations with guidance for developing effective strategies to minimize the spread and impact of invasive alien species. In particular, the Guiding Principles highlight the importance of identifying pathways of introduction of invasive species in order to minimize such introductions, and call to assess the risks associated with such pathways.

2. The Conference of the Parties, in paragraph 14 of decision VI/23,** urged the Global Invasive Species Programme and other relevant organizations to evaluate known and potential pathways for the introduction of invasive alien species and identify opportunities to minimize incursions and manage risk. In paragraph 24 (c) of the same decision, the Conference of the Parties urged Parties, Governments and relevant organizations, at the appropriate level, with the support of relevant international organizations to promote and carry out, as appropriate, research and assessments on the importance of various pathways of introduction of invasive alien species.

3. Aichi Biodiversity Target 9 specifies: "By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment". Thus, with relation to pathways, the Target contains three elements: to ***identify*** pathways; to ***prioritize*** pathways; and to ***manage*** pathways.

* UNEP/CBD/SBSTTA/18/1.

** One representative entered a formal objection during the process leading to the adoption of this decision and underlined that he did not believe that the Conference of the Parties could legitimately adopt a motion or a text with a formal objection in place. A few representatives expressed reservations regarding the procedure leading to the adoption of this decision (see UNEP/CBD/COP/6/20, paras. 294-324).

*** Reposted on 26 June with technical changes to paragraph 23.

4. The request by the Conference of the Parties to the Executive Secretary, in paragraph 25 (b) of decision XI/28, addresses these three elements. Specifically, it requests the Executive Secretary, in collaboration with partners, to prepare a preliminary list of the most common pathways for the introduction of invasive alien species, propose criteria for use at regional and subregional levels or other ways by which they may be prioritized, and identify a range of tools that may be used to manage or minimize the risks associated with these pathways. These three elements are addressed in turn in the remaining subsections of this Note.

5. Practically, the identification, prioritization and management of pathways should be carried out at the national and regional (or subregional) levels as the risk of invasion differs between the geographic regions. Nonetheless criteria and tools identified at the global level can support such activities.

II. IDENTIFICATION AND CATEGORIZATION OF PATHWAYS

6. The Conference of the Parties has identified a number of pathways for the introduction of alien species, largely in the context of its work to identify and address gaps and inconsistencies in the international regulatory frameworks at global and regional levels. An ad hoc technical expert group had been established for this purpose on gaps and inconsistencies of the international regulatory framework, in which the following separate pathways of introduction and spread of invasive alien species were mentioned: conveyances; aquaculture/mariculture; marine biofouling, particularly hull-fouling; civil air transport; military activities; emergency relief, aid and response; international development assistance; scientific research; tourism; biocontrol agents; *ex-situ* animal breeding programmes; inter-basin water transfer and navigational canals; and pets, aquarium and terrarium species, live bait and live food (UNEP/CBD/SBSTTA/11/INF/4). Additional pathways identified by the Conference of the Parties include: agricultural and biomass production, including biofuel feedstocks and for carbon sequestration (paragraph 6 of decision X/38); hunting and fishing (paragraph 8 of decision X/38); international web-based market places (paragraph 6 of decision XI/28); escapes of animals from commercial zoos and safari parks, and breeding and trade centres; release or escape of individuals of captive-bred alien populations and genotypes of pets, aquarium and terrarium species, or species used as live bait and live food (paragraphs 7 and 8 of decision XI/28).

7. In addition, under the International Plant Protection Convention (IPPC) the following pathways are covered: wood packaging material, commodities (e.g., grains), horticulture, agriculture and forestry. Live animal trade is covered by the World Organisation for Animal Health (OIE).

8. Other pathways not related to international trade include: dredging; recreational boating; fishing; and fouling from offshore oil and gas platforms.

9. There is, therefore, a large number of pathways described, often using inconsistent and overlapping terminology. A common categorization would help to organize information on pathways and thereby facilitate the development of response options. It could also facilitate analysis of pathways and their relative importance for prioritizing management, as requested by the Conference of the Parties in decision VI/23,** and contribute to the development of interoperability of different online databases, as encouraged in decision XI/28.

10. In order to facilitate the identification and prioritization of pathways by Parties, within the framework of the Convention's Global Invasive Alien Species Information Partnership (GIASI Partnership), the Invasive Species Specialist Group of IUCN's Species Survival Commission (IUCN SSC-ISSG), in collaboration with the UK's Centre for Ecology and Hydrology (CEH), CAB International (CABI) and other partners, has carried out an analysis and mapping of existing categorizations for pathways of introduction of invasive alien species, with the aim of developing a categorization or framework of pathway types using standard terminology that may be broadly applicable at a global scale.

The technical scope of this assessment has been the development of a comprehensive classification that can integrate data across all taxonomic groups and habitat types (terrestrial, marine, freshwater) without distinction.

11. This categorization was developed studying and comparing different available classifications of pathways of spread for the sake of comprehensiveness and accuracy. Key resources include the IUCN SSC-ISSG Global Invasive Species Database (GISD), the Invasive Species Compendium (ISC) of CABI, Delivering Alien Invasive Species Inventories for Europe (DAISIE) and peer-reviewed literature.[1] Decisions of the Conference of the Parties, as well as standards and recommendations adopted by the International Plant Protection Convention, have been taken into account.

12. A hierarchical approach has been adopted to describe the pathways, based on the framework developed by Hulme et al. (2008). Alien species may arrive and enter a new region through three broad mechanisms: importation of a commodity, arrival of a transport vector, or spread from a neighbouring region. These result in six principal pathways:

*Related to transport of a **commodity**:*

(1) **Release** in nature refers to the intentional introduction of live alien organisms for the purpose of human use in the natural environment. Examples include for biological control, erosion control (and dune stabilization), for fishing or hunting in the wild; landscape "improvement" and introduction of threatened organisms for conservation purposes.

(2) **Escape** refers to the movement of (potentially) invasive alien species from confinement (e.g., in zoos; aquaria; botanic gardens; agriculture; horticulture; aquaculture and mariculture facilities; scientific research or breeding programmes; or from keeping as pets) into the natural environment. Through this pathway the organisms were initially purposefully imported or otherwise transported to the confined conditions, but then escaped from such confinement, unintentionally. This may include accidental or irresponsible release of live organisms from confinement, including cases such as the disposal of live food into the environment or the use of live baits in an unconfined water system.

(3) Transport–**Contaminant** refers to the unintentional movement of live organisms as contaminants of a commodity that is intentionally transferred through international trade, development assistance, or emergency relief. This includes pests and diseases of food, seeds, timber and other products of agriculture, forestry, and fisheries as well as contaminants of other products.

*Related to a transport **vector**:*

(4) Transport–**Stowaway** refers to the moving of live organisms attached to transporting vessels and associated equipment and media. The physical means of transport-stowaway include various conveyances, ballast water and sediments, biofouling of ships, boats, offshore oil and gas platforms and other water vessels, dredging, angling or fishing equipment, civil aviation, sea and air containers. Stowaways of any other vehicles and equipment for human activities, in military activities, emergency relief, aid and response, international development assistance, waste dispersal, recreational boating, tourism (e.g., tourists and their luggage) are also included under this pathway.

[1] Hulme et al. (2008) Grasping at the routes of biological invasions: a framework for integrating pathways into policy, Journal of Applied Ecology, 45: 403–414; Panov VE, Alexandrov B, Arbačiauskas K, Binimelis R, Copp GH, Grabowski M, Lucy F, Leuven RSEW, Nehring S, Paunović M, Semenchenko V, Son MO (2009) Assessing the risks of aquatic species invasions via European inland waterways: from concepts to environmental indicators. Integrated Environmental Assessment and Management 5:110–126; and Wilson JRU, Dormontt EE, Prentis PJ, Lowe AJ, Richardson DM. Something in the way you move: dispersal pathways affect invasion success. Trends Ecol. Evol. 2009; 24:136–144.

Related to ***natural spread from a neighbouring region:***

(5) **Corridor** refers to movement of alien organisms into a new region following the construction of transport infrastructures in whose absence spread would not have been possible. Such transbiogeographical corridors include international canals (connecting river catchments and seas) and transboundary tunnels linking mountain valleys or oceanic islands.

(6) **Unaided** refers to the secondary *natural* dispersal of invasive alien species that have been introduced by means of any of the foregoing pathways. This pathway is referred to in Guiding Principle 4.[2] While the secondary dispersal is unaided it can only take place because of a previous human intervention. Information on the mechanisms of secondary spread of invasive alien species, after their introduction, are relevant to define the best response measures.

13. Deliberate releases tend to be understood to include vertebrate pathways, contaminants to include invertebrates and escapes to include plants. Pathogenic microorganisms and fungi are generally introduced as contaminants of their hosts. The corridor and unaided pathways are often ignored in pathway assessments but warrant further detailed consideration (Hulme et al., 2008).

14. The six main categories listed above reflect different human involvements: “release in nature” is defined as “intentional introduction” while the other categories generally refer to “unintentional introductions”, albeit with some differences. An “escape from confinement” is defined as “unintentional” even if the primary movement of the species to confinement was intentional. The “contaminant” category includes “unintentional introduction” as a contaminant in specific commodities which are intentionally traded.

15. Based on this work, the categorization in table 1 is presented.

[2] Guiding Principle No. 4: “The role of States: In the context of invasive alien species, States should recognize the risk that activities within their jurisdiction or control may pose to other States as a potential source of invasive alien species, and should take appropriate individual and cooperative actions to minimize that risk, including the provision of any available information on invasive behaviour or invasive potential of a species. Examples of such activities include: the intentional transfer of an invasive alien species to another State (even if it is harmless in the State of origin); and the intentional introduction of an alien species into their own State if there is a risk of that species subsequently spreading (with or without a human vector) into another State and becoming invasive; activities that may lead to unintentional introductions, even where the introduced species is harmless in the state of origin. To help States minimize the spread and impact of invasive alien species, States should identify, as far as possible, species that could become invasive and make such information available to other States”.

Table 1: Categorization of pathways for the introduction of alien species

	Category	Subcategory	COP decision
Movement of COMMODITY	**RELEASE** IN NATURE (1)	Biological control	VIII/27
		Erosion control/ dune stabilization (windbreaks, hedges, …)	
		Fishery in the wild (including game fishing)	VIII/27; X/38
		Hunting	X/38
		Landscape/flora/fauna "improvement" in the wild	
		Introduction for conservation purposes or wildlife management	
		Release in nature for use (other than above, e.g., fur, transport, medical use)	
		Other intentional release	
	ESCAPE FROM CONFINEMENT (2)	Agriculture (including Biofuel feedstocks)	X/38
		Aquaculture / mariculture	VIII/27; IX/4
		Botanical garden/zoo/aquaria (excluding domestic aquaria)	XI/28
		Pet/aquarium/terrarium species (including live food for such species)	VIII/27, X/38, XI/28
		Farmed animals (including animals left under limited control)	VIII/27
		Forestry (including afforestation or reforestation)	
		Fur farms	
		Horticulture	
		Ornamental purpose other than horticulture	
		Research and *ex-situ* breeding (in facilities)	VIII/27
		Live food and live bait	
		Other escape from confinement	
	TRANSPORT – **CONTAMINANT** (3)	Contaminant nursery material	
		Contaminated bait	
		Food contaminant (including of live food)	VIII/27; XI/28
		Contaminant on animals (except parasites, species transported by host/vector)	XI/28
		Parasites on animals (including species transported by host and vector)	XI/28
		Contaminant on plants (except parasites, species transported by host/vector)	XI/28
		Parasites on plants (including species transported by host and vector)	XI/28
		Seed contaminant	VIII/27
		Timber trade	
		Transportation of habitat material (soil, vegetation,…)	
VECTOR	TRANSPORT - **STOWAWAY** (4)	Angling/fishing equipment	VIII/27
		Container/bulk	VIII/27
		Hitchhikers in or on airplane	VIII/27, IX/4
		Hitchhikers on ship/boat (excluding ballast water and hull fouling)	
		Machinery/equipment	VIII/27
		People and their luggage/equipment (in particular tourism)	VIII/27
		Organic packing material, in particular wood packaging	
		Ship/boat ballast water	VIII/27
		Ship/boat hull fouling	VIII/27; IX/4
		Vehicles (car, train, …)	
		Other means of transport	
SPREAD	**CORRIDOR** (5)	Interconnected waterways/basins/seas	VIII/27
		Tunnels and land bridges	
	UNAIDED (6)	Natural dispersal across borders of invasive alien species that have been introduced through pathways 1 to 5	

16. The categorization in table 1 is consistent with the pathways identified in decisions of the Conference of the Parties, albeit with some different terms and realignment of categories or subcategories. For example:

(a) The term “conveyances” used in paragraphs 16 and 18 of decision VIII/27 is described in the decision as including, for example, vessels, floating timber, equipment and machinery, household goods, packaging and containers, waste materials, air transport vessels, tourist vessels, etc. It therefore corresponds to the “stowaway” pathway;

(b) Concerning “pets, aquarium and terrarium species, live bait, live food”, the proposed categorization considers “pets, aquarium/terrarium species” as one subcategory of a potential escape pathway;

(c) “Tourism”, identified by the Conference of the Parties as a pathway (paragraphs 49-51 of decision VIII/27), is included in table 1 under the stowaway pathway in the “people and their luggage/equipment” subcategory in order to be more explicit;

(d) The Conference of the Parties refers to “emergency relief, aid and response” and “military activities” (paragraphs 38-42 of decision VIII/27). Upon close examination it appears that the different activities which bear the risk of introduction of an invasive alien species can be subsumed under the contaminant pathway (subcategories: food contaminant; contaminant on animals; contaminant on plants) or under the stowaway pathway (subcategories: container/bulk, hitchhikers in or on airplane or ship/boat; machinery/equipment; people and their luggage/equipments; or vehicles). Therefore, “emergency relief, aid and response” and “military activities” are not included as categories themselves; further examination would be needed to identify the actual pathway and subcategory;

(e) “Unintended protection of invasive alien species”, “inconsistency in terminology”, and “international web-based market places” as referred to by the Conference of the Parties in decisions VIII/27 and XI/28 also seem to pertain to elements which exacerbate the risks of the introduction of invasive alien species rather than separate pathways.

17. The comprehensiveness and scope of this categorization has been so far tested with the mapping of data stored in the GISD and DAISIE. Ninety-nine per cent of GISD data and 81 per cent of DAISIE data directly matched with the available categories and subcategories of the schema. In the remaining cases (1 per cent for GISD, 19 per cent for DAISIE) the definitions of pathways in the source data sets did not permit a direct reclassification of the data, and an additional step of revision by experts was required. In no case were the pathways of introduction in the two data sets found not to be covered by the proposed categorization.

18. It must be stressed that the categorization provides a general description of the pathways of introduction, and the development of more detailed descriptive categorizations for specific areas of interest should be encouraged. However, adopting a common categorization would facilitate a comparison of data at all scales, providing a basis for ranking pathways in respect to their relevance, and eventually for prioritizing action as requested by the Aichi Biodiversity Target 9.

19. An analysis of the pathway data contained in IUCN/ISSG GISD, CABI ISC, DAISIE, and the Great Britain Non-Native Species Secretariat (GB NNSS) using the pathway classification is under way and preliminary results will be presented at the eighteenth meeting of the Subsidiary Body.

III. PRIORITIZATION OF PATHWAYS

20. As noted above, each country or regional group will need to prioritize the most important pathways to address through preventative measures.

21. One criterion to inform this prioritization is the frequency of past invasion events. Experts have further analyzed the data stored in the Global Invasive Species Database (GISD) and a regional database in Europe (DAISIE) to identify the most common pathways (figures 1a, 1b, 2a and 2b below) at global and regional levels.

22. The highest number of introductions occurred through the "escape" pathway both globally (figure 1) and within Europe (figure 2). The second and third highest incidences of introduction are observed for transport-contaminants and intentional release to nature.

23. The frequency of introduction through "transport-stowaway" appeared relatively lower than cases of "transport-contaminants". The contribution of "corridors" to the spread of alien species seemed to be less common in comparison to the other pathways; though according to the IUCN Invasive Species Specialists Group. These results may be due to an underrepresentation of marine species in the data set. In fact, in some areas, for example in the Mediterranean basin, corridors are a pathway of arrival of invasive alien species.[3]

Figure 1a. Frequencies of introduction pathways of known cases of introduction of over 500 invasive alien species profiled in the Global Invasive Species Database (GISD); level 1 categories.

[3] Galil B.S. (2009). Biol Invasions 11:359–372.

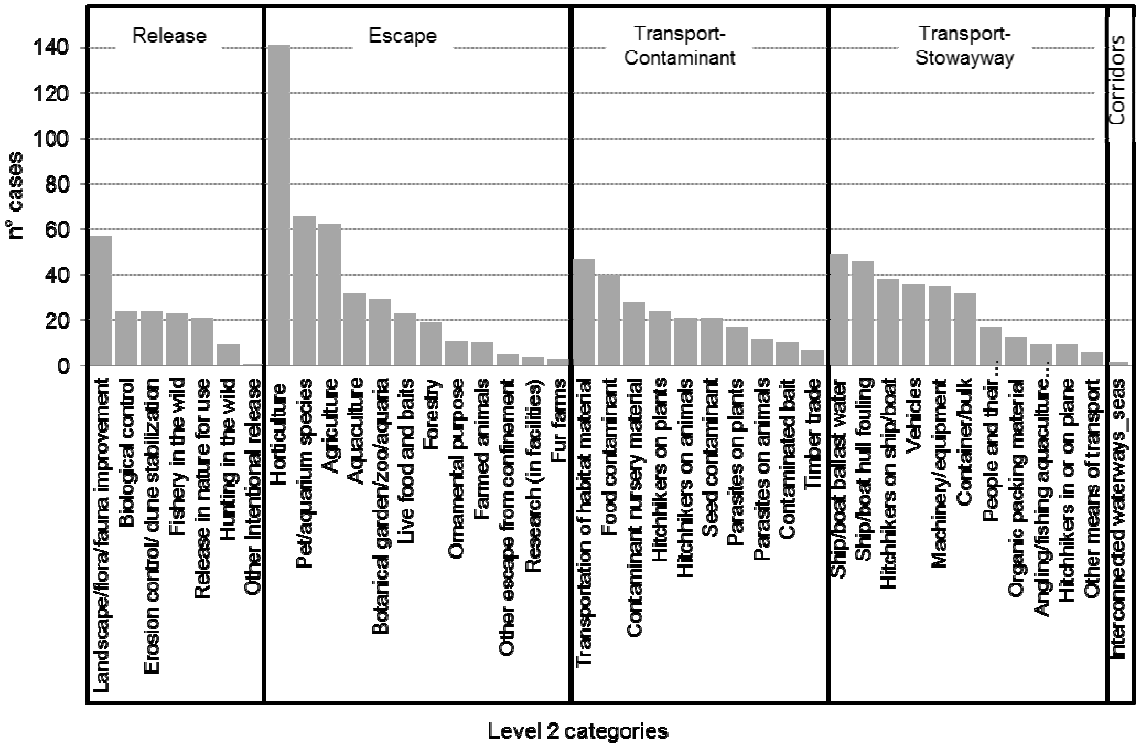

Figure 1b. Frequencies of introduction pathways of known cases of introduction of over 500 invasive alien species profiled in the Global Invasive Species Database (GISD); level 2 categories.

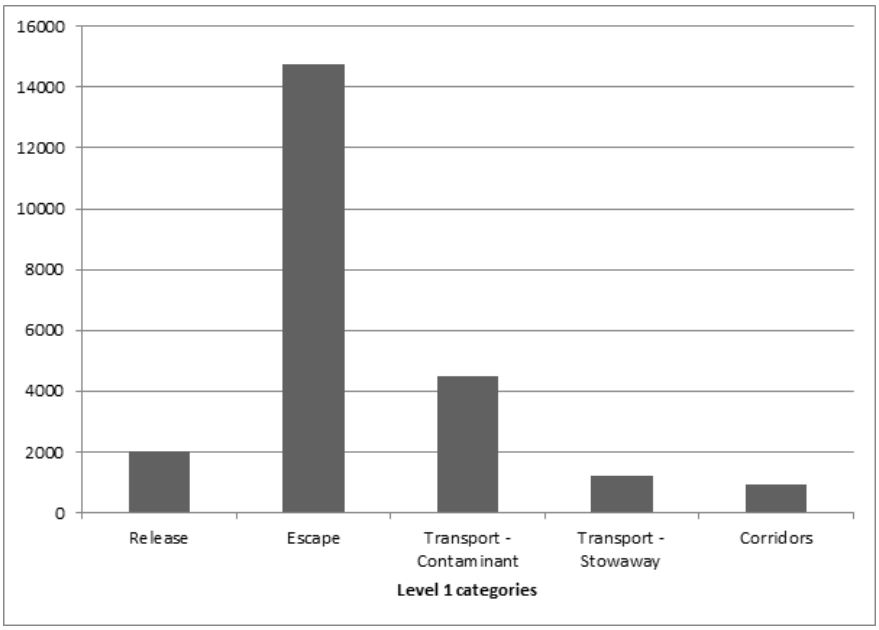

Figure 2a. Frequencies of introduction pathways of known cases of introduction of over 14,000 invasive alien species profiled in the Delivering Alien Invasive Species Inventories for Europe.

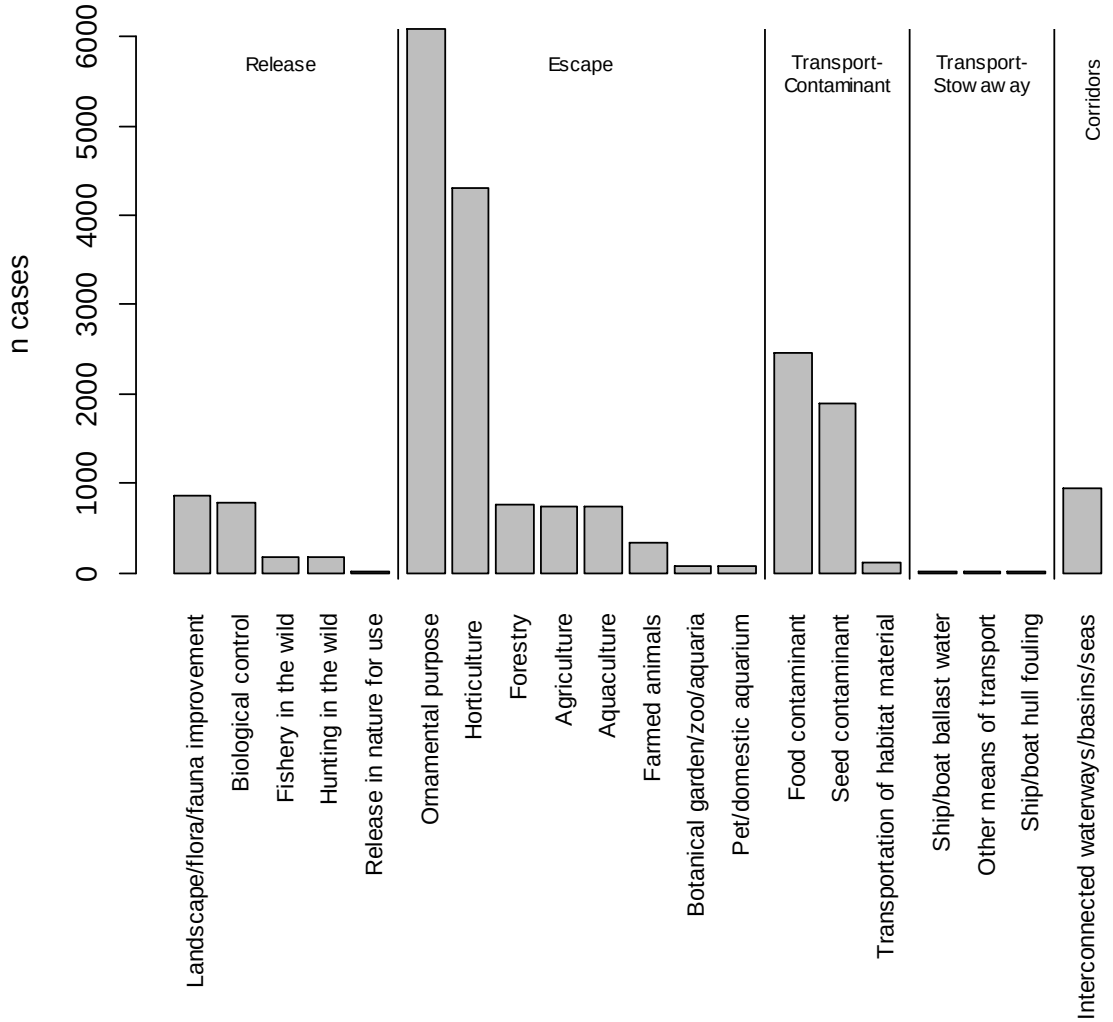

Figure 2b. Frequencies of introduction pathways of known cases of introduction of over 14,000 alien species profiled in the Delivering Alien Invasive Species Inventories for Europe (DAISIE); level 2 categories.

24. As noted above, more detailed analysis on common pathways facilitating establishment of alien species to date, based on the standard terminology for pathways described above, is under preparation by the partners and experts participating the Global Invasive Alien Species Information Partnership. The study above will be presented as information to the eighteenth meeting of the Subsidiary Body.

25. As databases are improved, including through the Convention's Global Invasive Alien Species Information Partnership, more information will become available to inform prioritization of pathways by Parties at the regional and subregional level.

26. Also, as data on the degree of impact of invasive species on biodiversity and ecosystems[4] are better linked with pathway data, it should be possible to generate pathway analyses that consider not only the number of invasion events, but also the severity of those events.

27. Considering the global data presented above, the following points, among others, could be taken into account in prioritizing pathways in the absence of more country or region specific information:

(a) Given the evidence of high incidences of introduction of alien species and invasive species through the **escape** pathway, in particular through horticulture, measures to ensure confinement of alien species should be a high priority to implement, globally;

(b) **Transport-contaminants** appears as the second most frequent pathway of introduction. This pathway is associated with increasing human activities in international trade. Countries where the volume of import is large, particularly for agricultural and forestry products, and live bait and food, should prioritize the application of sanitary and phytosanitary measures to manage this pathway;

(c) **Transport-stowaway** is also associated with a high frequency of international trade, shipping and other human activities of moving vessels. Countries which receive large numbers of vessels in both terrestrial and aquatic environments may need to prioritize management of this pathway, particularly in port areas.

28. It is also notable that the number of alien species recorded in Europe has reached 12,122 species that and 15 per cent of the alien species were reported as invasive species.[5] At global level, the CABI Invasive Species Compendium covers over 1,500 invasive species. The Global Invasive Species Database currently stores 37,970 invasion occurrences of 890 species impacting particularly on biodiversity. The FAO database on Introductions of aquatic species (DIAS) showed that over 5600 aquatic species have been introduced globally for fishing, aquaculture, ornamental purposes, biocontrol or other purposes. About 207 species (4 per cent) of them are known to have negative ecological effects[6] although the socio-economic impacts were reported to be more often beneficial. These regional and global observations indicate that alien species that have already been established and become invasive need to be continuously monitored to minimize their impacts by escapes, unintentional releases or unaided spread to a neighbouring region.

IV. MANAGEMENT OF PATHWAYS

29. Different management and regulatory approaches may be suitable for each of the pathways. For example:

(a) Regulation of the deliberate **release** pathway often places responsibility on the *applicant* for release of an alien species who, in order to secure a permit for such release must demonstrate that the risk of invasiveness is minimized;

(b) Regulation of the **escape** from confinement pathway often places responsibility on the *importer* of an alien species who must demonstrate that the risk of escape is minimized or that the consequences of escape are not important (i.e., the species is not invasive). Management of the escape

[4] A system for classifying alien species according to the magnitude of their environmental impacts, based on the mechanisms of impact used to code species in the IUCN Global Invasive Species Database, is being developed.

[5] See http://www.europe-aliens.org/default.do.

[6] See http://www.fao.org/fishery/topic/13599/en.

pathway also often requires cooperation of the industry (e.g., pet shops) and the general public (e.g., pet owners);

(c) Regulation of the **contaminant** pathway is very closely tied to international trade, and international standards play an important role in balancing the need for control with the need to avoid undue trade disruption. The *importing* country may use border controls and quarantine procedures. The *exporter* will often take measures to demonstrate that sanitary and phytosanitary standards are respected;

(d) The carrier plays a major role on managing the **stowaway** pathway to reduce the risks from transport vectors;

(e) For the **natural spread from a neighbouring region** pathway, monitoring for early detection and rapid response to evidence of species occurrence and spread are important.

30. In the categorization described above, alien species may arrive and enter a new region through three broad mechanisms, which result in six principal pathways that, in turn, can be further divided into subcategories of pathways. For each of the three levels of pathways, a number of tools are available that may be used to manage or minimize associated risks.

31. Tools to manage or minimize associated risks include multilateral agreements, standards and voluntary guidance developed by international institutions, and regional agreements and standards.

Tools applicable to multiple or all pathways

32. Some of the available tools are general and apply to all three broad mechanisms: (i) importation of a commodity, (ii) arrival of a transport vector; (iii) and/or natural spread from a neighbouring region. Some of the Guiding Principles for the Prevention, Introduction and Mitigation of Impacts of Alien Species that Threaten Ecosystems, Habitats or Species (annex to decision VI/23**) fall under this category. Guiding Principle 1 on the precautionary approach is one example; others are Guiding Principle 3 on the ecosystem approach and Guiding Principles 4, 5, 6 and 8 on the role of States, research and monitoring, education and public awareness, and exchange of information.

33. Guiding Principle 10 on intentional introduction applies to both release and escape, while Guiding Principle 11 on unintentional introductions applies generally to risks associated with contaminants, stowaways, the arrival of a transport vector, and/or natural spread from a neighbouring region. The Guiding Principles use the following definition for “introduction”: the movement by human agency, indirect or direct, of an alien species outside of its natural range (past or present); and “intentional introduction” as the deliberate movement and/or release by humans of an alien species outside its natural range. “Intentional” and “unintentional” introductions therefore do not form separate categories of pathways, but rather overlap with the three-level categorization introduced above.

34. Guiding Principle 10 on intentional introduction provides guidance that no first-time intentional introduction or subsequent introductions of an alien species already invasive or potentially invasive within a country should take place without prior authorization from a competent authority of the recipient State(s). An appropriate risk analysis, which may include an environmental impact assessment, should be carried out as part of the evaluation process before coming to a decision on whether or not to authorize a proposed introduction to the country or to new ecological regions within a country. Further, this Guiding Principle indicates that States should make all efforts to permit only those species that are unlikely to threaten biological diversity. The burden of proof that a proposed introduction is unlikely to threaten biological diversity should be with the proposer of the introduction or be assigned as appropriate by the recipient State. Authorization of an introduction may, where appropriate, be accompanied by conditions

(e.g., preparation of a mitigation plan, monitoring procedures, payment for assessment and management, or containment requirements).

35. The standards developed under the International Plant Protection Convention, the International Standards for Phytosanitary Measures (ISPMs), are recognized under the Agreement on the Application of Sanitary and Phytosanitary Measures of the World Trade Organization. Measures that conform to ISPMs are presumed to be consistent with the Agreement on the Application of Sanitary and Phytosanitary Measures of the World Trade Organization.

36. A number of ISPMs are generally relevant for minimizing risks associated with the importation of a commodity, while other ISPMs are only relevant for addressing risks associated with specific pathways or subcategories of pathways. ISPMs which are generally relevant include ISPM 1, which sets out phytosanitary principles for the protection of plants and the application of phytosanitary measures in international trade.

37. ISPM No. 2 provides a general framework for pest risk analysis, which forms the basis for any phytosanitary measure. Pest risk analysis consists of three stages: (1) the initiation stage, in which pests and pathways of concern and an area for pest risk assessment are identified; (2) the pest risk assessment stage, which includes determining whether the definition for a quarantine pest are satisfied, an assessment of the probability of its introduction and spread, and an assessment of its potential economic consequences (including environmental impacts); and (3) the pest risk management stage, where ways are identified to react to the risk identified in stage 2, in order to achieve the required degree of safety that can be justified and is feasible within the limits of available options and resources.

38. Stages 2 and 3 are addressed in more detail by ISPM No. 11, which provides details for the conduct of pest risk analysis. It describes an integrated process for risk assessment as well as the selection of risk management options. It is important to note that ISPM No. 11 considers invasive plants as pests and includes consideration of the consequences on the environment of the pests. ISPM No. 32 on the categorization of commodities according to their pest risk could also be applicable in general. A risk assessment in accordance with ISPM No. 11 provides the basis for designating a pest as “quarantine pest”, thereby allowing import regulations.

39. ISPMs No. 14 and No. 22 include guidelines for specific pest management options (the use of integrated measures in a systems approach, and establishment of areas of low pest prevalence).

40. Further relevant ISPMs include No. 19, which elaborates on the responsibility to maintain “pest lists”, including related prohibitions, restrictions or requirements, status of pests, results of pest risk analyses and taxonomy of pests. ISPMs No. 18 and No. 28 comprise guidelines for specific phytosanitary measures: the use of irradiation and phytosanitary treatments for regulated pests.

41. ISPM No. 25 describes procedures to identify, assess and manage pest risks associated with consignments of regulated articles which pass through a country without being imported, in order to justify phytosanitary measures in the country of transit. This ISPM may apply to escape, contaminants and stowaway.

42. Guiding Principle 7, border control and quarantine measures, may be a relevant tool to address risks associated with release, escape, contaminants, and stowaway.

43. The Guidelines for assessing the risks of non-native animals becoming invasive by the World Organisation for Animal Health address the movement of animals, and therefore can be relevant for addressing risks related to release and escape.

Tools applicable to the importation of a commodity

Release

44. Except for the Guiding Principles, in particular Guiding Principle 10 as described above, no specific tools of the types listed in paragraph 32 above are available that apply to release as a pathway generally.

45. With regard to the specific case of release of biological control agents, ISPM No. 3, guidelines for the export, shipment, import and release of biological control agents is available. In addition, available tools comprise specific guidance under the Food and Agriculture Organization of the United Nations, the FAO Technical Guidelines for Responsible Fisheries No. 13 on recreational fisheries, which address risks associated with fishery in the wild.

Escape

46. No specific tools of the types listed in paragraph 32 above are available that apply to escape as a pathway generally. Risks associated with aquaculture and mariculture are addressed by specific guidance under the Food and Agriculture Organization of the United Nations, including the FAO Fisheries and Aquaculture Technical Paper No. 519 (Understanding and applying risk analysis in aquaculture); FAO Technical Guidelines for Responsible Fisheries No. 2, on a precautionary approach to capture fisheries and species introductions; No. 5, supplement 4, on an ecosystems approach to aquaculture; No. 5, supplement 5, on use of wild fish as feed in aquaculture; and No. 5, supplement 6, on use of wild fishery resources for capture-based aquaculture; as well as the International Council for the Exploration of the Sea Code of Practice on the Introduction and Transfer of Marine Organisms. At the regional level, the Asia regional technical guidelines on health management for the responsible movement of live aquatic animals and the Beijing consensus and implementation strategy may be relevant.

47. Tools to manage or minimize risks associated with botanical gardens, zoos and aquaria include voluntary codes of conduct such as the European code of conduct on zoological gardens and aquaria and invasive species.

Contaminants

48. ISPM No. 10 provides requirements for the establishment of pest free places of production and pest free production sites, which could be generally relevant to addressing risks associated with contaminants. This standard uses the concept of “pest freedom” to allow exporting countries to provide assurance to importing countries that plants, plant products and other regulated articles are free from a specific pest or pests and meet the phytosanitary import requirements when imported from a pest free place of production

49. To manage or minimize the risks associated with food contaminants and contaminants on animals, the OIE Aquatic Animal Health Code 2013, the OIE Manual of Diagnostic Tests for Aquatic Animal 2013, the OIE Terrestrial Animal Health Code 2013 and the OIE Manual of Diagnostic Tests for Terrestrial Animals 2013 may apply.

50. With regard to the specific cases of parasites on plants, ISPM No. 36 on plants for planting is available. ISPM No. 21 provides guidelines for conducting pest risk analysis for regulated non-quarantine pests. It describes the integrated processes to be used for risk assessment and the selection of risk management options to achieve a pest tolerance level. The concept of regulated non-quarantine pests is described in ISPM No. 16: pests that are not quarantine pests may be subject to phytosanitary measures because their presence in plants for planting results in economically unacceptable impacts.

51. Risks associated with contaminants of plant seeds may be addressed through the OECD schemes for the varietal certification of seeds.

52. Fruit flies, as food contaminants, can be addressed through ISPM 30 on establishment of areas of low pest prevalence for fruit flies (*Tephritidae*), and ISPM 28, Annex 1 on irradiation treatment for *Anastrepha ludens*, Annex 2 on irradiation treatment for *Anastrepha obliqua*, and Annex 7 on generic guidance for irradiation treatment of fruit flies.[7]

Tools applicable to the arrival of a transport vector - Stowaway

53. No specific tools of the types listed in paragraph 32 above are available that apply to stowaway as a pathway generally. To address risks associated with organic packing material, in particular wood packaging material, ISPM 15, Regulation of wood packaging material in international trade, is available.

54. A number of tools are available to manage or minimize the risks associated with ship/boat ballast water and ship/boat hull fouling. The main tool in these areas is the International Convention for the Control and Management of Ships' Ballast Water and Sediments (the Ballast Water Management Convention), which, however, has not entered into force so far. Several articles and regulations of the Ballast Water Management Convention refer to guidelines to be developed by the International Maritime Organization (IMO), and IMO Member States have developed 19 sets of Guidelines from 2005 to 2014, including on ballast water reception facilities, ballast water exchange and ballast water management systems (Annex 1).

55. The IMO also developed the 2011 Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic species, contained in resolution MEPC.207(62), and the Guidance for minimizing the transfer of invasive aquatic species as biofouling (hull fouling) for recreational craft (circular MEPC.1/Circ.792). In addition, Guidance for evaluating the 2011 Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species (circular MEPC.1/Circ.811) is available.

Tools applicable to the natural spread from a neighbouring region

56. No specific tools of the types listed in paragraph 32 above are available that address the risks associated with the natural spread from a neighbouring region, or corridors or unaided as specific pathways.

57. As a specific example for unaided as a pathways, fruit flies can be addressed through ISPM 30 on establishment of areas of low pest prevalence for fruit flies (Tephritidae), as this ISPM is also intended to minimize the spread of regulated fruit flies within an area.

Tools to address established invasive alien species

58. In addition, tools are available which, for all pathways, address invasive alien species once they have become established. For example, the Guiding Principles on mitigating the impacts of invasive alien species that have become established (Guiding Principles 2(2), and 12 to 15) generally apply to all pathways. Relevant ISPMs include No. 9, which contains guidelines for pest eradication programmes.

[7] Other Annexes to ISPM 28 address irradiation treatment for *Bactrocera jarvisi*, *Bactrocera tryoni*, *Cydia pomonella*, *Rhagoletis pomonella*, *Conotrachelus nenuphar*, *Grapholita molesta*, *Grapholita molesta* under hypoxia, *Cylas formicarius elegantulus*, *Ceratitis capitata*, and vapour heat treatment for *Bactocera cucurbitae* on *Cucumis melo* var. *reticulatus*.

Table 2: Tools and guidance to address pathways (see annex for more information)

	Guiding Principles	**ISPMs**	**OIE and other international tools**
GENERAL – all pathways	No. 1, 3, 4, 5, 6, 8, 9	No. 1, 2, 11, 32, 14, 22, 19, 18, 28	OIE Guidelines for assessing the risks of non-native animals becoming invasive
Importation of a commodity			
RELEASE	No. 7, 10		
Biological control agents		No. 3	
Release in nature for use			
Fishery in the wild			FAO Technical Guidelines for Responsible Fisheries No. 13 on recreational fisheries
ESCAPE	No.7, 10, 11	No. 25	
Agriculture, Horticulture		No. 21	Code of conduct on horticulture and invasive alien plants
Aquaculture and mariculture			FAO Fisheries and Aquaculture TP No. 519; Technical Guidelines for Responsible Fisheries No. 2; No. 5, suppl. 4; No. 5, suppl. 5; No. 5, suppl. 6; ICES Code of Practice on the Introduction and Transfer of Marine Organisms.
Botanical gardens, zoos and aquaria			European code of conduct on zoological gardens and aquaria and invasive alien species
CONTAMINANT	No. 7, 11	No. 25	
Food contaminant and contaminant on animals			OIE Aquatic Animal Health Code, Manual of Diagnostic Tests for Aquatic Animal, Terrestrial Animal Health Code; Manual of Diagnostic Tests for Terrestrial Animals
Fruit flies		No. 28, 30	
Contaminants on plants		No. 21, 36	
Seed contaminant			OECD schemes for the varietal certification of seeds
Arrival of a transport vector - STOWAWAY	No. 7	No. 25	
Organic packing material Wood-packaging material		No. 15	
Ship/boat ballast water			Ballast Water Management Convention and related IMO Guidelines
Ship/boat hull fouling			IMO Guidelines (Res. MEPC.207(62), MEPC.1/Circ.792, MEPC.1/Circ.811)
Natural spread from a neighbouring region			
Fruit flies		No. 30	

Annex

LISTS OF TOOLS AND GUIDANCE

Relevant Guiding Principles

(a) Guiding Principle 1: Precautionary approach;

(b) Guiding Principle 3: Ecosystem approach;

(c) Guiding Principle 4: The role of States;

(d) Guiding Principle 5: Research and monitoring;

(e) Guiding Principle 6: Education and public awareness;

(f) Guiding Principle 7: Border control and quarantine measures;

(g) Guiding Principle 8: Exchange of information;

(h) Guiding Principle 9: Cooperation, including capacity-building;

(i) Guiding Principle 10: Intentional introduction;

(j) Guiding Principle 11: Unintentional introductions;

(k) Guiding Principle 12: Mitigation of impacts;

(l) Guiding Principle 13: Eradication;

(m) Guiding Principle 14: Containment;

(n) Guiding Principle 15: Control.

Relevant Standards by the International Plant Protection Convention

(a) ISPM 1: 2006. Phytosanitary principles for the protection of plants and the application of phytosanitary measures in international trade (originally adopted in 1993, revised in 2006);

(b) ISPM 2: 2007. Framework for pest risk analysis (originally adopted in 1995, revised in 2007);

(c) ISPM 3: 2005. Guidelines for the export, shipment, import and release of biological control agents and other beneficial organisms (originally adopted in 1996, revised in 2005);

(d) ISPM 4: 1995. Requirements for the establishment of pest free areas;

(e) ISPM 11: 2013. Pest risk analysis for quarantine pests (originally adopted in 2001, revised in 2004 and 2013);

(f) ISPM 14: 2002. The use of integrated measures in a systems approach for pest risk management;

(g) ISPM 15: 2009. *Regulation of wood packaging material in international trade* (originally adopted in 2002, revised in 2009, Annex 1 and 2 revised in 2013);

(h) ISPM 16: 2002. Regulated non-quarantine pests: Concept and application;

(i) ISPM 18: 2003. Guidelines for the use of irradiation as a phytosanitary measure;

(j) ISPM 19: 2003. Guidelines on lists of regulated pests;

(k) ISPM 21: 2004. Pest risk analysis for regulated non-quarantine pests;

(l) ISPM 22: 2005. Requirements for the establishment of areas of low pest prevalence;

(m) ISPM 25: 2006. Consignments in transit;

(n) ISPM 28: 2007. Phytosanitary treatments for regulated pests;

(o) ISPM 30: 2008. Establishment of areas of low pest prevalence for fruit flies (Tephritidae);

(p) ISPM 32: 2009. Categorization of commodities according to their pest risk;

(q) ISPM 34: 2010. Design and operation of post-entry quarantine stations for plants;

(r) ISPM 36: 2012. Integrated measures for plants for planting.

Relevant Standards by the World Organisation for Animal Health

(a) OIE Aquatic Animal Health Code 2013;

(b) OIE Manual of Diagnostic Tests for Aquatic Animals 2013;

(c) OIE Terrestrial Animal Health Code 2013;

(d) OIE Manual of Diagnostic Tests for Terrestrial Animals 2013.

Relevant Guidelines under the Ballast Water Convention

(a) Guidelines for sediment reception facilities (G1) (resolution MEPC.152(55));

(b) Guidelines for ballast water sampling (G2) (resolution MEPC.173(58));

(c) Guidelines for ballast water management equivalent compliance (G3) (resolution MEPC.123(53));

(d) Guidelines for ballast water management and development of ballast water management plans (G4) (resolution MEPC.127(53));

(e) Guidelines for ballast water reception facilities (G5) (resolution MEPC.153(55));

(f) Guidelines for ballast water exchange (G6) (resolution MEPC.124(53));

(g) Guidelines for risk assessment under regulation A-4 of the BWM Convention (G7) (resolution MEPC.162(56));

(h) Guidelines for approval of ballast water management systems (G8) (resolution MEPC.174(58));

(i) Procedure for approval of ballast water management systems that make use of Active Substances (G9) (resolution MEPC.169(57));

(j) Guidelines for approval and oversight of prototype ballast water treatment technology programmes (G10) (resolution MEPC.140(54));

(k) Guidelines for ballast water exchange design and construction standards (G11) (resolution MEPC.149(55));

(l) Guidelines on design and construction to facilitate sediment control on ships (G12) (resolution MEPC.209(63));

(m) Guidelines for additional measures regarding ballast water management including emergency situations (G13) (resolution MEPC.161(56));

(n) Guidelines on designation of areas for ballast water exchange (G14) (resolution MEPC.151(55));

(o) Guidelines for ballast water exchange in the Antarctic treaty area (resolution MEPC.163(56));

(p) Information reporting on type approved ballast water management systems (resolution MEPC.228(65));

(q) Procedure for approving other methods of ballast water management in accordance with regulation B-3.7 of the BWM Convention (resolustion 206 (62));

(r) Installation of ballast water management systems on new ships in accordance with the application dates contained in the ballast water management convention (BWM Convention) (resolution MEPC. 188(60));

(s) Guidelines for ballast water exchange in the Antarctic treaty area (resolution MEPC. 163 (56)).

Other relevant Guidelines by the International Maritime Organization

(a) Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic species (resolution MEPC.207(62))

(b) Guidance for minimizing the transfer of invasive aquatic species as biofouling (hull fouling) for recreational craft (circular MEPC.1/Circ.792)

(c) Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species (circular MEPC.1/Circ.811)

Relevant Standards by the Food and Agriculture Organization of the United Nations

(a) Fisheries and Aquaculture Technical Paper 519/1, "Understanding and applying risk analysis in aquaculture";

(b) Technical Guidelines for Responsible Fisheries:

- No. 13. Recreational Fisheries;
- Aquaculture development No. 2. Precautionary approach to capture fisheries and species introductions.
- Aquaculture development. 4. Ecosystem approach to aquaculture;
- Aquaculture development. 5. Use of wild fish as feed in aquaculture;
- Aquaculture development 6. Use of wild fishery resources for capture-based aquaculture.
