ІНСТИТУЦІОНАЛЬНІ ІНСТРУМЕНТИ ЕКООРИЄНТОВАНОГО РОЗВИТКУ ВОДНОГО ТРАНСПОРТУ

Актуальність. За останні роки відбувається все більший тиск на морське та річкове середовище у зв'язку із нарошенням обсягів та глобалізаційними процесами у міжнародній торгівлі. Таке положення має свої наслідки у вигляді посилення негативного впливу на динаміку якості природного водного середовища шляхом збільшення розливів нафти, викидів хімічних та інших шкідливих речовин, забруднення повітря та опосередкованого навантаження цих процесів на водні масиви, шумове та радіоактивне навантаження. Прогнозне оцінювання динаміки розвитку світової економіки демонструє поступове зростання обсягів судноплавства через збільшення розливів нафти, викидів хімічних та інших шкідливих речовин, забруднення повітря та розливів нафт. У багатьох країнах приєдналися до цієї практики, сконцентрували увагу на питаннях наукового супроводження програм та планів протидії глобальним змінам, які впливають не лише на морські й річкові біоценози, а й мають наслідки на вигляді змін екосистемних каркасу всієї планети.

Мета та завдання. Метою статті є проведення аналізу наявних та потенційних інституціональних ресурсів запобігання техногенним загрозам від судноплавства та розвитку водного транспорту на засадах екоорієнтування.

Результати. Встановлено, що на сьогоднішньому етапі розвитку господарської діяльності транспорт виконує провідну роль, оскільки є важливою ланкою промисловості, сфери користування, сільського господарства. На водний транспорт покладено переважну частку міжнародних перевезень результатом чого є негативні наслідки його дії. Відомо, що будь-який від від водного транспорту, у тому числі морський, є одним з найбільших забруднювачів навколишнього середовища, але задоволення життєвих потреб людства не повинно відбуватися за рахунок майбутніх поколінь. Розв'язання проблем захисту природного середовища є відносно новим напрямом у науці управління, тим не менш, за останні десятиріччя багато країн приділяли до цієї практики, сконцентрували увагу на питаннях наукового супроводження програм та планів протидії глобальним змінам, які впливають не лише на морські й річкові біоценози, і ж активно використовували інструменти відповідь на зміни в екосистемі. Діяльність водного транспорту за своїми масштабами та наслідками поволі зростає, це потребує більшої уваги з боку урядових структур, які мають приєднуватися до міжнародних ініціатив для отримання позитивного результату від природозахисної діяльності та розширення діяльності іншими шляхами.

Висновки. У роботі досліджено та проаналізовано наявні організаційні і законодавчі запобіжні інструменти зменшення техногенного забруднення морського та річкового середовища, досліджено заходи
In recent years, there has been increasing pressure on the marine and riverine environment due to increasing volumes and globalization processes in international trade. This situation has the effect of increasing the negative impact on the dynamics of the natural aquatic environment quality by increasing oil spills, emissions of chemicals and other harmful substances, air pollution and the indirect impact of these processes on water resources, waste disposal, noise and radioactive load. The forecast assessment of the dynamics of the world economy shows a gradual increase in the volume of shipping due to the increase in the world's population and consumption.

Enhanced use of water basins requires new innovative management initiatives with the development of tools to ensure the ecological sustainability of marine and river ecosystems, taking into account the threats and risks of their introduction to the environment.

The peculiarity of protecting the marine and riverine environment from navigation is that ships do not always operate within the flag state, and the further the ship moves away from it, the less the state has the opportunity to rely on traditional sovereignty within its jurisdiction. Involvement of many stakeholders in the process of water transport, lack of full autonomy of the flag state to regulate the activities of the ship outside its jurisdiction requires the development of methodological approaches and practical measures to develop ways and methods of institutional and organizational impact on ships based on international requirements and standards.

The purpose of the article is to analyse the existing and potential institutional resources for the prevention of technogenic threats from shipping and the development of water transport on the basis of eco-focused.

The activity of water transport is slowly growing in its scale and consequences, which requires more attention from government agencies, which should join international initiatives to obtain a positive result from environmental activities and increase the authority of the state.
In addition, the aquatic environment is usually the area of interest of different countries and different stakeholders, being a transboundary area, which should take into account not only the interests and needs of different countries, but also form a single legal basis for economic, environmental and recreational activities within marine and river borders.

**Conclusion.** The paper examines and analyses the existing organizational and legislative precautionary tools to reduce technogenic pollution of the marine and river environment, investigates measures for the treatment of ballast water and developed an algorithm for their management; an analysis of possible precautionary measures against the impact of air pollution, garbage, oil and petroleum products on the quality of the aquatic environment and proposed a number of precautionary measures; conceptual provisions for the formation of a national action plan for ballast water management have been developed. Conceptual provisions for the formation of state organizational and institutional support for the treatment of ballast water by methods of preventive protection on the basis of updated management tools, economic feasibility and environmental orientation; developed scientific and applied substantiation of regulatory and coordination approaches based on economic feasibility, focused on the balanced development of aquatic ecosystems and environmental safety of navigation.

**Keywords:** inland water transport, environmental safety of navigation, pollution of the aquatic environment, ballast water management, eco-oriented development

**Problem statement and its connection with important scientific and practical tasks.** Industrialization and globalization have contributed to the development of international trade, in which the total volume of its maritime part has tripled since 1990. Although water transport causes relatively less pollution than other modes of transport (such as road and air transport), it can significantly harm the environment due to its large industrial scale. Shipping activities can harm the environment in a variety of ways, such as the consumption of natural resources (eg fuel consumption), greenhouse gas emissions (eg CO2) and emissions from ship-generated waste (eg ballast water and oil). Given the growing emphasis on the environment as part of corporate social responsibility, shipping companies have become aware of the importance of "greening" their activities in the service of the world community through their role in supporting international trade. However, the intensification of trends in increasing the volume, volume and tonnage of the world fleet leads to the complexity of ship operations, which has consequences in increasing the risk of such operations and the risk of adverse effects on the marine and riverine environment.

Therefore, the task is to study the existing and potential institutional resources for the prevention of technogenic threats from shipping and the development of water transport on the basis of eco-orientation.

**Analysis of recent publications on the problem.** It is possible to obtain data on the state of territorial waters from the web resources of specialized agencies in Great Britain [1], Australia [2], Denmark [3], Norway [4], Canada [5], EU [6–8], etc., as well as independent experts and insurance agencies [9–11]. However, a meticulous analysis of the problems related to the state and exploitation of marine and river natural resource potential and proposals for their solution is possible only in the works of leading scientists and experts in this field. A wide range of issues in this area has been studied by domestic scientists for many years. For example, the work of Shchipstov O. A. and Shchipstov O. O. [12] focuses on the study of the defining UN document "Revised Roadmap for the United Nations Decade for Ocean Science for Sustainable Development", considered some organizational aspects of the preparatory phase of the Decade; a commentary on the need to form a strategy for the development of ocean science in Ukraine for the long term.

The work of Yarova AO [13] examines the procedure for resolving disputes over marine pollution as a result of an accident, proposed specific ways to solve this problem, namely the adoption of a separate international legal act, which would contain standards and regulations for ships, as well as in relation to how they should be equipped.

A wide range of problems is solved in the works of scientists Pavlenko M. Yu., Orlova I. G. Komorin V. M. [14], but research on preserving the natural potential of the marine and river environment of Ukraine from the impact of shipping is virtually minimized for many reasons. First of all, in the absence of a statistical basis for the analysis of man-made impact adequate to the defined tasks in terms of completeness and dynamics.

Nevertheless, the solution of economic and environmental problems in various areas, including those inherent in the activities of water transport, are now the subject of research by many domestic and foreign scientists – Bur'kinski B. V. [15, 18], Stepanova V. M. [15], Kotenko S. V. [17, 18], Masliy N. D. [16], Rubel O. E. [19], Karpenko O. O., Sacsna N., Larsena T. [20], Trozzi S., Vaccaro R., Nicolo L. [21], Iscason J., Person T. A., Lindgren E. S. [22], Kupper D. A. [23], Slangerpa J. W. [24], Fürstenberg S. [25], Cullenberg G., Lee W. [26], Golash S., David M., Voigt M. and others. [27], Ten A. K.-J. [28] and many other specialists and scientists.
Allocation of previously unsolved parts of the general problem. Despite the large number of scientific papers in the field of our research, today in the Ukrainian research environment there are virtually no scientific developments on the institutional support of preventive and operational measures to protect marine and river environment from technogenic impacts of shipping.

Formulation of research objectives (problem statement). Based on the above, the aim of the article is to study the existing and potential institutional resources for the prevention of man-made threats from shipping and the development of water transport on the basis of environmental orientation.

An outline of the main results and their justification. The existence of marine and river ecosystems, especially in recent years, has received close attention from the world scientific community due to the accumulation of unresolved issues of rapid deterioration of their condition, primarily due to anthropogenic impact. The solution to these problems is to apply new technologies to vehicles, new transportation technologies and traffic management. Creating an environmentally sustainable transport system is a goal of global scale and global significance.

The damage that can be caused by the world's oceans of organic, toxic, mineral, radioactive waste is huge, it is difficult to overestimate, but it is almost impossible to calculate. However, the concept of sustainability implies the ability to meet the needs of the present without compromising the needs of the future. Despite the environmental orientation, this term has clear economic and social aspects.

World Ocean is interconnected complex system in which all processes (carbon, hydrological cycles, atmospheric and biosphere systems) interact with each other. Today's critical rise in global temperature is determined not only by the amount of carbon dioxide in the atmosphere during the combustion of fossil fuels, but also as a result of how systems interact with each other. All of these interactions are regulated by feedback mechanisms that either absorb and alleviate stress / pressure (negative feedback) or self-reinforce change (positive feedback), thereby determining the desired or undesirable outcome for people.

Trends in global climate change indicate that the carrying capacity of the atmosphere has been exceeded, there have been changes in the overall thermal balance of the Earth, changes in climatic and meteorological parameters. The most dangerous of all violations are those related to the oceans. Due to the huge amount of water in the oceans and active exchange with other natural areas, the resilience of the ocean is enormous. However, for the same reasons, it is very difficult to establish the disturbed balance. The world's oceans form the final link in large-scale flows of various substances and their transformations, and the oceanic part of the biogeochemical cycles of vital elements plays a major role in the existence of all living things on the planet. Therefore, the aquatic environment of the planet is experiencing a strong enough anthropogenic impact, which leads to negative geophysical and environmental consequences. The dynamics of marine ecosystems, their biological processes and biogeochemical cycles are directly related to global climate change and are global environmental issues [29, 30].

According to statistics, shipping, which transports about 90% of world trade, is the least harmful mode of transport, taking into account its production value. Despite the fact that, in contrast to the terrestrial industry, shipping in general makes a relatively small contribution to marine and river pollution from human activities, many efforts of international organizations are focused on developing preventive measures to worsen the environmental situation in world waters.

In recent decades, the volume of transported goods, the most dangerous in the environmental sense, has been gradually increasing in international trade. In this context, there are certain features that have implications for the formation of a number of preliminary and ongoing responses. For unforeseen accidents of water pollution that occur during shipping operations, the aim is to completely prevent their occurrence. According to the IMO rules, they are defined as ALARP – their levelling is as high as possible. For operational cases – the establishment of optimal emissions of pollutants. Accordingly, the institutional instruments for the regulation of environmental measures in accordance with the requirements of the IMO should be divided into three categories: - technical and technological rationing with the establishment of certain standards for equipment, cargo handling technologies, equipment of reloading places, etc; - standardization of operational processes regarding packaging, labelling, availability of documentation, placement and notification of harmful substances on board, etc.

For a more meticulous and accurate determination of the degree of accidents in world shipping, it is necessary to conduct estimates based on relative indicators, taking into account the dynamics of changes in the number and tonnage of the world fleet. Based on data from UNCTAD [31] and EQUASIS [32], maritime traffic increased almost 3.7 times between 1970 and 2012, from 2,605 to 9,548 million tons (Figs. 1, 2).

The graphs show a practical increase in world tonnage almost twice, and the number of fleet vessels by 40%.

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However, the number of accidents in maritime transport, according to Allianz Global Corporate & Specialty [33], for the period 2006–2015, the world fleet lost 1,231 ships (1.4 % of the total), which is evidence of the scale of the impact on the marine environment (Fig. 3).

From the graph of Fig. 3 there is a dynamic of reducing the number of accidents (2005 – 0.25 % and 2015 – 0.1 % of the world fleet), but this is not indicative, as the dynamics of pollution is supported by increasing trends in tonnage and world fleet.

Combining all possible types of pollutants in water bodies, the appearance of which occurs as a result of emergencies or by operation, we will make a list of the most common of them: - Discharges from cargo residues; - Discharge of bilge water; - Exhaust gases from the engine; - Waste incineration; - Freon and gallon gases; - Sewage; - Waste; - Oil spills and engine room discharges; - Ballast water discharges; - Heavy metals from the anodes; - Antifouling biocides.

Due to the use of ships, large volumes of world trade are carried out, at the same time about 10 billion tons of ballast water are moved every year (in total on ships of international trade) (Table 1).

One cubic meter of ballast water can contain up to 50,000 samples of zooplankton [34–37] and / or 10 million phytoplankton cells [38].

In order to develop ballast water management plans nationwide, it is advisable to have a national information and analytical system that will accumulate data on entry and exit routes of vessels with different types of cargo. Based on this knowledge, as well as information on the cities of ships origin and the conditions of donor ports of importing countries, the exporting country will be able to: - compare the environmental characteristics of the port importing goods with the characteristics of ports of destination if the port is similar, the degree of risk is significantly increased); - determine the frequency of discharges from a particular donor port (noting that the more often specific species are introduced, the higher the risk of their consolidation and conversion into invasive – it is also established that there is a corresponding characteristic of species, it is known as reproductive pressure); - identify priority species among those that may be in
transportable ballast water that have a high potential to become invasive, and include them in early detection, monitoring and response programs.

Minimizing the risk of introducing invasive alien species with ballast water requires a combination of many approaches and well-founded strategies.

<table>
<thead>
<tr>
<th>Vessel type</th>
<th>deadweight (tons)</th>
<th>Normal ballast (tons)</th>
<th>% of deadweight</th>
<th>Full ballast (tons)</th>
<th>% of dwt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balker</td>
<td>250,000</td>
<td>75,000</td>
<td>30</td>
<td>113,000</td>
<td>45</td>
</tr>
<tr>
<td>Balker</td>
<td>150,000</td>
<td>45,000</td>
<td>30</td>
<td>67,000</td>
<td>45</td>
</tr>
<tr>
<td>Balker</td>
<td>70,000</td>
<td>25,000</td>
<td>36</td>
<td>40,000</td>
<td>57</td>
</tr>
<tr>
<td>Balker</td>
<td>35,000</td>
<td>10,000</td>
<td>30</td>
<td>17,000</td>
<td>49</td>
</tr>
<tr>
<td>Tanker</td>
<td>100,000</td>
<td>40,000</td>
<td>40</td>
<td>45,000</td>
<td>45</td>
</tr>
<tr>
<td>Tanker</td>
<td>40,000</td>
<td>12,000</td>
<td>30</td>
<td>15,000</td>
<td>38</td>
</tr>
<tr>
<td>Container carrier</td>
<td>40,000</td>
<td>12,000</td>
<td>30</td>
<td>15,000</td>
<td>38</td>
</tr>
<tr>
<td>Container carrier</td>
<td>15,000</td>
<td>5,000</td>
<td>30</td>
<td>Out-of-date</td>
<td></td>
</tr>
<tr>
<td>Dry cargo vessel</td>
<td>17,000</td>
<td>6,000</td>
<td>35</td>
<td>Out-of-date</td>
<td>Out-of-date</td>
</tr>
<tr>
<td>Dry cargo vessel</td>
<td>8,000</td>
<td>3,000</td>
<td>38</td>
<td>Out-of-date</td>
<td>Out-of-date</td>
</tr>
<tr>
<td>Passenger/Ro-Ro</td>
<td>3,000</td>
<td>1,000</td>
<td>33</td>
<td>Out-of-date</td>
<td>Out-of-date</td>
</tr>
</tbody>
</table>


This includes operational procedures for ships and ports, monitoring, inspection and certification, training and education of staff, clear division of roles, responsibilities and powers. Thus, there is a need to develop certain tools for the development of specific policies, strategies, legal frameworks and organizational measures that are adequate and harmonious at both national and international levels for regulation and management. In order to form a system of risk reduction measures, we recommend developing a number of strategies that should include one or more complementary methods: - minimizing the intake of organisms in ballast tanks. Ballast water should be avoided in areas of shallow and muddy water, such as where propellers can lift sediment, and at night, when many organisms migrate vertically for food, this will reduce the number of organisms entering ballast tanks; - removal of ballast water deposits.

Routine cleaning of tanks and ballast water, as well as removal of sediment in the open ocean or their transfer to special receiving equipment provided by the port, will reduce the number of organisms that are transported with ballast water; - prevention of ballast water discharge unnecessarily – if cargo handling requires the reception and discharge of ballast water within the port, the water received in another area should not be discharged, if possible; - ballast water replacement - ballast water can be replaced between ports, in the open ocean and at depth, where the risk that organisms transported with ballast water will find an acceptable habitat after being discharged into the water will be minimized; - ballast water treatment – among the methodologies aimed at removing or reducing the number of harmful organisms in ballast water during its stay in ship tanks; - discharges of ballast water to receiving devices – this prevents the discharge into the natural environment of foreign organisms transported in ballast water.

In King, Dennis M. [39], the author takes as a starting point the future implementation of ballast water management rules and analyses its potential financial impact on shipping companies' costs, import prices and world trade. Based on the calculation of compliance costs for affected shipowners and taking into account the special status of the global shipping industry in world trade (e.g., high inelasticity of shipping demand), he concludes that the overall impact of ballast water rules on global shipping, industry and others the parties are likely to be insignificant, as the industry may slightly increase freight rates to shift its compliance costs to shippers and importers. According to [39], the annual costs of complying with the requirements of the global
shipping industry are low compared to its annual revenues (costs of about $12 billion per year against revenues of $380 billion).

In addition, the author concludes that although the figures for individual countries will differ, the economic value of world trade is so high that the overall economic impact of ballast water regulation on world trade, international markets and global economic prosperity is probably not statistically different from zero. (i.e., the average price paid by households for goods and services may increase by about 0.005%).

Despite the problems of ballast water pollution, the protection of water bodies from pollution, oil and chemical spills, the indirect effects of air pollutants, the preservation and maintenance of the quality of sea basins and the long-term need attention.

According to a study by the International Maritime Organization (IMO), the maritime sector was responsible for almost 3.3% of global greenhouse gas (GHG) emissions during 2007. International shipping was responsible for about 2.7% of global CO₂ emissions in 2007. In the absence of appropriate action, emissions from the maritime sector alone could increase by 150–250% by 2050 compared to 2007.

It should be noted that air pollution from ships is operational pollution, so the place, time and amount of emissions are predictable and controlled. Thus, the basic conditions for the use of economic tools to control this pollution are obvious. When adopting regulations on the state of the marine and river environment, the state body must make two types of decisions: use administrative control tools, or refer to the market. The first decision concerns the degree of such pollution control or its purpose. To implement these approaches, a goal must be defined, although it may be explicit or implicit. In the case of accidental pollution, the goal may be to reduce the degree of risk, while exploitative (operational) pollution often has clear goals. The second type of decision is how to achieve the goal or what tools to use. Here it is possible to offer two approaches, regulatory and economic, which are fundamentally different from each other. While in the case of the latter the question of “how to control” remains to be considered by the market, and it is obvious that the availability of alternative technologies to control the use of market instruments will provide greater economic efficiency.

With regard to the prevention of pollution from ships, the difference in the cost of combating pollution is largely due to the different control technologies used by different ships. Therefore, the difference in control costs can be widely represented and reflected by technological differences. The different technologies available to control emissions from ships lead to large differences in cost. For example, the difference in cost between the various measures taken to reduce SO₂ emissions from ships by more than eight times ranges from 0.3 to 2.5 Euro / kg, and to reduce NOₓ emissions from ships by 60 times, from 0.1 to 6 Euro / kg [40]. It is believed that such huge diversity in control costs is due to the fact that air pollution control was introduced at an early stage in shipping compared to other sectors, so a range of different control measures is formed and available, while in terrestrial sectors only the most cost-effective technologies. According to [41], the use of various technologies in ship design, such as new design concepts, better hulls and superstructures, better power systems, renewable energy, low-carbon fuel, exhaust abatement technologies, etc. reduces CO₂ emissions by 10–50%. This, combined with other methods of reducing emissions by 10–50% by improving the performance of ships, can reduce overall CO₂ emissions from ships by 20–75% by 2050.

As noted, the method of administrative control has advantages in simplicity, efficiency and political attractiveness, although it is less cost-effective. In a sense, all the strengths of the method of administrative control can be considered as weaknesses of market methods, but the most important instruments of administrative restrictions and trade, emission tax instruments depend on the effectiveness of their application and the level of market fluctuations.

As for the effectiveness of the application, in contrast to the technical standard, which can be clearly defined and relatively easily controlled, it is difficult to impose strict, general implementation of such restrictions in emission limits and rules. However, without the same requirements for all signatories to the Convention, this tool will not be effective. The Kyoto Protocol has exceptions for developing countries, as well as many “special” sectors that are outside the scope of this instrument. If such a system of emissions trading for international shipping is established, not all countries will join it [42]. Because emissions taxation usually depends on the country’s fiscal regime, it can only be effectively implemented at the national level, although shipping pollution is an international problem without borders and requires an international tax regime. Unfortunately, such a scenario is almost impossible to implement. However, international transport may be an exception in this case. All taxable emissions from ships operate in international waters, so the IMO insists that the tax on pollution caused by emissions from ships should be paid by all ships, regardless of their nationality.
Another problem resulting from market fluctuations is the situation with emissions trading, which is different from the situation with the emission tax. First, the link with carbon market price fluctuations (for example, back in 2008, when a sharp fall in prices was not expected, the price fell to 10 Euro / tonne compared to 30 Euro / tonne in 2005) [43]. The formation of such a low price is not an incentive to carry out pollution control procedures, as it is much lower than the marginal cost of financing such measures. Also, strong fluctuations in carbon prices do not help to attract long-term investment in new control technologies. Another problem with fluctuations in carbon prices, from the practice of other areas of activity, is the intensification of speculative schemes for the purchase and sale of large volumes of permits and the possibility of market manipulation.

The problem of market fluctuations in the pollution tax is different. In international shipping, freight markets develop cyclically, when freight prices can fluctuate over a short period of time, especially in dry cargo markets, which are highly volatile. The pollution tax, which is defined as a fixed amount per tonne of oil spilled, should be relatively stable. Thus, it will represent a variable percentage of the marginal benefit of the vessel. When the market is "high", the shipowner will without hesitation pollute more, even if it involves paying more tax. Therefore, in the short term, when the freight market is developing, the amount of pollution may well exceed the expected level. For example, during the increased activity of the shipping market in 2003-mid-2008, the disposal of old ships was postponed, and all ships worked at maximum intensity, especially when the price of oil reached $ 140 per barrel. To solve such problems, it is necessary to introduce a system with variable tax rates.

Given the lack of tools based on the proposed examples, it is advisable to consider an integrated approach that involves two levels of integration:

- using only market methods – in this case, a hybrid system could give better results than using only emissions trading or emissions tax. This is due to the fact that the combined system can prevent fluctuations in trade prices, setting the emission tax as the minimum amount that the ship must pay. At the same time, it is advisable to monitor and implement a mechanism of work based on the sale of additional permits at the maximum price, when the prices of emission permits reach maximum values.
- the use of a hybrid system that could be an effective tool to contain pollution during periods of increased market activity and introduce a "limit" as the maximum allowable emissions. Such integration is a combination of traditional regulatory and relatively new economic approaches, or the application of pollution standards complemented by market-based instruments. In a complex sector such as international shipping, an integrated policy could increase the overall effectiveness of pollution control and thus be more likely to achieve ambitious environmental goals.

A separate problem is the pollution of water bodies with oil, petroleum products and chemical compounds, which can be segmented into two directions - preventing their emergency leaks and minimizing the operational volume of pollutants.

A separate problem is the pollution of water bodies with oil, petroleum products and chemical compounds, which can be segmented into two directions - preventing their emergency leaks and minimizing the operational volume of pollutants.

The economic costs of oil spills are also determined by several factors - the type and volume of oil and oil products, geographical location of the spill, weather conditions and water flows in the affected area, seasonality, and the cost of repairing and overcoming the consequences, which generally affects the final cost. emissions [64].

The amount of oil spilled undoubtedly affects the cost of solving the problem, although the effect is not linear [47], because although the cost of cleaning measures increases with increasing spill volume, which leads, of course, to higher costs, but smaller spill volumes always have a higher share. the weight of the cost per tonne of emissions, as this involves significant response costs to cleaning, equipment mobilization and personal experience [48, 49].

The total cost of overcoming the oil spill can be grouped into three categories:
- costs of cleaning the marine environment;
- socio-economic costs; and
- environmental costs.

The direct costs of overcoming the accident are mainly related to the purification, recovery and storage of spilled oil, as well as the disposal of collected waste [50, 51]. For example, in the case of the fuel oil spill from the single-hull bulk carrier «Prestige» in 2002 in the amount of 64,000 tons, the total damage amounted to 4 billion euros, 2.5 million euros were spent to eliminate the consequences of the accident [51].
Table 2  
IMO Convention on the Control of Emissions of Pollutants from the Marine Environment

<table>
<thead>
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¹ Annex I-VI is a supplement to MARPOL 73/78  
Source: systematized by the authors

The most common marine pollutant among garbage is plastic [52]. Plastic bedding is very strong, mobile, able to adsorb and accumulate toxic compounds that are present in the sea. It can also have a significant impact not only on the marine environment, human health, the state of coastal areas, but also as a threatening factor in the dangerous conduct of ship operations.

The overall economic consequences of the impact of marine litter include the cost of cleaning beaches and harbors, declining tourism revenues and damaging ships and fishing gear. According to [53], the shipping sector’s losses from marine litter were found on the example of the Scottish fishing fleet, which received smaller and more polluted catches, damaged nets, contaminated propellers and blocked intake pipes, resulting in annual costs of approximately € 12 million. Disposal of ship-generated debris is governed by the rules of Annex V of MARPOL 73/78 on the prevention of ship-source debris. At European regional level, on 27 November 2000, EU Directive 2000/59 / EC of the European Parliament and of the Council was adopted. This legislation regulates the requirements for reception facilities for ship-generated waste and cargo residues.

Approximately 6.4 million tons of garbage enters the oceans each year [54], with approximately 20% of marine litter originating from shipping and fishing. The main sources of marine litter are merchant, passenger and fishing vessels, the navy, research and pleasure vessels, offshore oil and gas platforms and fishing facilities [54].

The institutionalization of solutions to these problems can be represented by two major blocks - administrative measures and economic instruments.

As for economic instruments, their implementation in the daily practice of sea and river shipping is extremely difficult. Of the available economic instruments, the introduction of a tax on emissions of harmful substances (both operational and emergency) and the introduction of emissions trading schemes for ships are optimal. The use of pollution charges or emission permits encourages shipowners to invest in new pollution prevention technologies from their ships, which minimizes government involvement and burdens on government budgets to address these issues. However, this approach has a number of disadvantages: - the difficulty and cost of establishing an adequate level of fees, pollution control and compliance with all conditions of environmental policy; - the nature of such a tax is fiscal, so it is a burden, the universality of which is difficult to apply, which may lead to a lack of parity between the payers of this tax; - in the stage of
market growth at the stage of its fluctuations in the short term, shipowners may prefer higher profits to the
detriment of environmental measures.

Another instrument may be the issuance of emission permits, when the state responsible body does not
decide on pollution standards, but determines the total amount of permissible emissions, which corresponds
to the total amount of permissible pollution, thus supporting the formation of pollution rights market. The
peculiarity is that the state distributes the original rights/permits for pollution among the polluters, and gives
them the opportunity to freely trade these permits. However, certain conditions must be met: - polluting
vessels (tankers, gas carriers, etc.) have a legal right in the form of permits to pollute the environment; -
public institutions should determine only the total amount of permits and distribute (trade) primary permits
among potential polluters; - there must be a strict definition of rights, the excess of which is subject to
penalty; - free trade in permits must be ensured and a rights market formed, which will allow investing in
new environmental ship technologies. However, to date, economic market-based methods of solving
environmental problems are not used in maritime and river shipping. Preference is given to administrative
measures that: - are simple, with quantified standards for pollutants and their emissions, - with the possibility
of influencing the use of pollutants at the stage of trade with them, - compliance with the principles of parity
between private and public sectors, as certain obligations are imposed not only on the private sector but also
on the relevant sector. However, one of the main complications in the use of administrative control methods
is the existing and obvious difference between the technological structures of countries, the technical and
technological level of manufacturers of the shipping industry and environmental measures, which is almost
hypothetical.

Today, Ukraine has certain instruments to influence the degree of pollution of its water environment,
primarily institutional. One of the most significant and promising in terms of its importance for maintaining the
status and keeping the quality of inland water basins of Ukraine are measures for the treatment of ballast water
from ships. Based on the Ballast Water Convention [55], the IMO Committee has developed 14 additional
manuals to help governments, ship captains, operators and shipowners, port authorities to minimize the risks of
alien species and pathogens from ship ballast water and its sediments, port, and ensure the safety of the vessel.

In order to effectively manage the risks of ballast water operation, a policy based on scientific and
technical information should be established. As the National Ballast Water Management Strategy is a
comprehensive event involving a large number of agencies and specialists, the IMO's recommendation [55]
that the most successful approach to involving many countries in this process is the establishment of a
Government-designated National Authority and Task Force.

The algorithm for developing the National Strategy for Ballast Water Management, the tasks and
responsibilities of its developers are crucial, as they are the basis for the introduction of mechanisms for
optimal management of processes to create safe conditions for the technical sphere, environment and
population. Below is an algorithm (based on IMO recommendations [55]) for the development of a National
Strategy for Ballast Water Management after the relevant policy decision is made by the government (Fig.
4).

However, when formulating the strategy it is necessary to: - determine the degree of risks and threats to the
invasion of aquatic organisms and pathogens for Ukraine (Black, Azov Sea, estuaries and rivers); - establish
current international and regional obligations of Ukraine; - to form a system of supervision over the
implementation of the emergency and the effectiveness of its provisions, ways of economic management of
the problem; - identify the leading institution in the Working Group on Strategy Development (primarily
members of the Head Office); - to form a working group with redistribution of competence between its
members depending on the professional, experience and expert level of the participants; - identify,
consolidate and organize the work of those responsible for individual components of the strategy.

Conclusions and perspectives of further research. At the present stage of economic development,
transport plays a leading role, as it is an important part of industry, service sector, agriculture. As noted,
water transport accounts for the vast majority of international traffic, resulting in negative consequences of
its work. It is known that any of the modes of transport, including sea and river, is one of the biggest
polluters of the environment, but the vital needs of mankind should not be met by future generations.

Solving the protection of the marine and riverine environment is a relatively new direction in the
science of management, however, in recent decades many countries have joined this practice, focusing on
scientific support of programs and plans to combat global change, which affect not only marine biocenoses,
but also have consequences in the form of a shift in the ecosystem framework of the entire planet.
Implementation of strategy and action plan

Monitoring and evaluation of the system

Collection of relevant information on international and national institutional conditions, powers of national authorities and professional institutions on ballast water management, formation of a list of powers, priorities, principles taking into account international requirements and instruments, information on the current state of the environment and biological and environmental indicators status, information on the status and direction of invasive forms

Establishment of a working group, preparation of the NSMBW, its editing in accordance with the directions of national policy

Stakeholder consultations. Definition of organizational powers, establishment of the level of competencies of the working group members, identification of expert knowledge, determination of the process and procedures of emergency development

Establishing legal requirements for the implementation of emergencies, entry into force and ensuring compliance with the flag of Ukraine by the provisions of the Convention [55]. Establishment of rules of the port state control, including inspection of ships in ports of call. Focusing on training specialists, forming training programs, training inspectors, managers, conducting educational activities. Integration of emergency provisions with other relevant documents, as well as with national and municipal activities (management of invasive species, coastal management, etc.). Establishing international relations and cooperation, their stimulation. Monitoring and reviewing organizational measures before their widespread implementation. Conducting research on effective technologies and practices that should be the basis for reviewing and correcting existing regulations.

Ratification and implementation of the IMO Ballast Water Convention

Collection of information and development of strategy, action plan

Preparation, adoption and implementation of relevant legislation and effective organizational reform

Monitoring and evaluation of the system

Implementation of strategy and action plan

Fig. 4. Stages of the National Strategy for Ballast Water Management development

Source: systematized by the authors on the basis of [15, 36, 37, 39, 55]
Maritime and river activities are slowly growing in their scale and consequences, and this requires more attention from government agencies, which should join international initiatives to obtain a positive result from environmental activities and increase the authority of the state.

In addition, the marine environment is usually an area of interest for different countries and stakeholders, being a cross-border area where not only the interests and needs of different countries should be taken into account, but also a single legal basis for economic, environmental and recreational activities within maritime borders.

Based on these approaches, the existing organizational and legislative precautionary instruments to reduce technogenic pollution of the water environment are investigated and analysed, measures for ballast water management are investigated and an algorithm for their management is developed; an analysis of possible precautionary measures against the impact of harmful pollution, garbage, oil and petroleum products on the quality of the aquatic environment and proposed a number of precautionary measures; conceptual provisions for the formation of a National action plan for ballast water management have been developed.

The main scientific and applied conclusions are as follows:

- Conceptual provisions for the state organizational and institutional support formation for the treatment of ballast water by methods of preventive protection on the basis of updated management tools, economic feasibility and environmental orientation.
- Scientific and applied substantiation of regulatory and coordination approaches based on economic feasibility, focused on balanced development of water ecosystems and ecological safety of navigation has been established.

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