GROSS ESTIMATE OF BALLAST WATER DISCHARGES INTO COOK INLET, ALASKA

Prepared for
COOK INLET REGIONAL CITIZEN'S ADVISORY COUNCIL

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Introduction

This report was requested by the Cook Inlet Regional Citizen's Advisory Council (CIRCAC) to assess the volume and source of ballast water being discharged into the waters of Cook Inlet from marine vessels trading at the various ports in Cook Inlet, Alaska. This information may be useful to help determine the potential risk of the introduction of non-indigenous species (NIS) to Cook Inlet and to develop port-based ballast water management plans. Ship's ballast water is the major vector for introducing NIS to coastal ecosystems, where these biological invaders can cause severe impacts, both ecological and economic (Carlton and Geller, 1993). A project recently completed by Ruiz & Hines, for the Prince William Sound Regional Citizens' Advisory Council, reports that a significant amount of planktonic organisms are discharged from tanker ballast water annually into Prince William Sound, and suggests that cold water ecosystems are vulnerable to invasion by a diverse array of marine and estuarine species (Ruiz & Hines 2000).

This project's original scope was to estimate the total amount of ballast water that has been discharged into Cook Inlet each year, going back 15 years. However, because of a lack of reliable data on vessel traffic and ballast water capacity, the scope was modified to examine only the past 5 years. Included in this paper is a bibliography identifying books, papers, and web sites devoted to ballast water issues.

Vessel ballast discharge amounts were estimated based on the most complete data set available at the time of the study. Various estimates were made when information was incomplete for certain years and traffic types. **Due to the lack of a complete, consistent, and reliable data set, the information presented in this paper should only be considered a gross estimate of the ballast water that was discharged into Cook Inlet during the study period.**

Data Sources

Several potential sources of data were considered for this study. The Southwest Pilot's Association was considered as a data source, however they only collect information about ship movements that require their pilots, and their database contains no information about ship cargo or ballast. Also, because they recently installed a new computer system, their records were not readily available to search. The State Pilot Board was also contacted, but their data consists only of quarterly summaries of ship movements.

The individual dock facilities were contacted for information. Tesoro Alaska, which owns the Kenai Pipeline Dock, was very helpful in compiling a complete data set of vessels that had called at their facility. This data set provided comprehensive information on the amount and source of ballast water discharged for each vessel visiting the facility. No other dock facility managers elected to cooperate in this study.

The National Ballast Water Information Clearinghouse (NBIC), a joint project of the United States Coast Guard (USCG) and the Smithsonian Environmental Research Center, was established in 1997 as directed by the National Invasive Species Act of 1996. They maintain a database of ballast discharges reported by ships trading in U.S. ports. Even though the reporting requirement is mandatory, the database is incomplete. However, the database was queried and

used for this study. The NBIC also provided a customized data set containing contain ballast capacity and gross tonnage for ships trading in Alaska. This data set proved useful for determining the correlation between gross tonnage and ballast capacity.

Another source of useful information was the Port State Information Exchange (PSIX) database maintained by the USCG. This database contains information, including the gross tonnage, about many ships trading in U.S. waters.

Finally, the USCG Marine Safety District Office in Kenai, Alaska was asked to provide a data set for this study. The data set does not include information about ballast discharges, but does include ship arrival information (vessel name, date, facility and in some cases the last port of call).

Lloyds Registry of Ships was investigated as a possible source of information. Their database contains the ballast capacity of each ship, which would have been useful for this study. However, the subscription cost for this service is $950 per year, so it was not utilized.

Methods

There is no single reliable source of data for ballast water discharges into Cook Inlet. However, some facts are available from which conclusions can be drawn and an analysis can be attempted.

Large marine vessels[1] (ships) trade at four ports in Cool Inlet: Anchorage, Nikiski, Homer, and Drift River. Vessels importing cargo to those ports either do not carry ballast or do not normally discharge ballast upon arrival in Cook Inlet waters. Ships that come to load cargo for export from Cook Inlet do carry ballast and usually discharge that ballast in preparation for taking on their cargo. Barges do not normally carry ballast. Therefore, only ships that are coming to Cook Inlet empty to carry away cargo need to be considered when estimating ballast water discharges. Vessels regularly load the following export products from the following facilities in Cook Inlet:

- Logs and wood chips, Homer Deep Water Dock, Homer;
- Urea and ammonia products, Agrium Dock, Nikiski;
- Liquified natural gas, ConocoPhillips Dock, Nikiski;
- Petroleum products, Kenai Pipeline Dock, Nikiski; and
- Crude oil, Cook Inlet Pipeline Dock, Drift River.

A regression analysis was used to explore the relationship between gross tonnage and ballast capacity. Data provided by the NBIC for ships trading in Cook Inlet were utilized to create the tonnage/ballast models.

[1] For the purposes of this study only marine vessels of greater that 500 gross tons were considered.

Ship arrivals for each facility were analyzed using the following methods:

- **Step #1:** If the facility provided a data set containing a record of each ship that visited their dock, including the date of the visit and the amount of ballast discharged, the data set for that facility was considered complete. If not, proceed to Step #2.
- **Step #2:** Utilize the USCG ship arrival data set to determine which ships visited the facility, create a ship record for each arrival, and proceed to Step #3.
- **Step #3:** Look up each arriving ship's record in the NBIC database to determine if the operator voluntarily reported their ballast discharge. If reported, record the discharge and consider the ship record complete, otherwise proceed to Step #4.
- **Step #4:** Look up each remaining ship record in the PSIX database to determine its gross tonnage. If the gross tonnage is available use the appropriate tonnage/ballast model for that facility to estimate the ballast discharge and consider the record complete, otherwise proceed to Step #5.
- **Step #5:** Estimate the remaining ships' ballast discharge based on the average ballast discharge from ships for that facility for the same year for which a discharge was reported or estimated using the tonnage/ballast relationship.

Ballast discharge estimates were then summarized for each year at each facility.

The sources of ballast water were summarized by examination of the "Last Port of Call" information, when available. Ballast water source was characterized by region of origin and the regions were ranked for each facility.

Results

During the five-year period from 1997 to 2001, the USCG ship arrival data set shows that almost 1,000 ships arrived at the five Cook Inlet export docks (Table 1). Eighty-one percent of the ships arrived at the three docks near Nikiski: Kenai Pipeline (36% overall), Agrium (27% overall) and ConocoPhillips (17% overall).

Table 1. Ship arrivals at the five Cook Inlet export facilities.

Facility	1997	1998	1999	2000	2001	Total	
Kenai Pipeline	84	78	69	72	49	352	36%
Agrium	58	67	62	24	52	263	27%
ConocoPhillips	34	35	34	35	30	168	17%
Cook Inlet Pipeline	27	28	9	32	5	101	10%
Homer	29	35	0	8	14	86	9%
Total	232	243	174	171	150	970	

Source: Vslstat2.xls provided by USCG MSD Kenai.

Some facilities trade with many different ships, while other facilities trade with a relatively small number of ships. The number of different ships that visited each facility each year is shown in Table 2.

Table 2. The number of different ships that arrived at the five Cook Inlet export facilities.

Facility	1997	1998	1999	2000	2001
Kenai Pipeline	7	5	23	20	19
Agrium	36	36	36	23	38
ConocoPhillips	2	2	2	2	4
Cook Inlet Pipeline	5	2	2	2	2
Homer	20	11	0	3	6
Total	70	56	63	50	69

Source: Vslstat2.xls provided by USCG MSD Kenai.

Federal law (National Invasive Species Act of 1996, P.L. 104-332) mandates that all ships arriving in U.S. waters complete and submit a ballast water information report to NBIC. NBIC has been receiving ballast water reporting forms from ships that arrive to U.S. ports from overseas since July 1, 1999. During the period from July 1, 1999 through December 31, 2001, 131 ships arriving at the five facilities submitted reports to the NBIC. The USCG MSD Kenai data set contains 378 arrivals during the same timeframe. This indicates that, even though there is mandatory reporting requirement, only 35% of the ship operators complied with the requirement.

NBIC records for ships that did report indicate that 93% of the vessels reporting did discharge ballast and most ships discharged almost all of their ballast capacity. The NBIC data set also indicates that 65% of the reporting vessels did not treat their ballast in any manner.

Based on the comparison of the NBIC records with the USCG records, it was decided that where no report was submitted to NBIC for a ship entry, the best estimate of the ballast capacity of the vessel would be used to estimate total ballast discharges. Thus, the estimates presented below represent the maximum ballast discharges for the vessels covered in the study.

Gross Tonnage/Ballast Capacity Relationship

Because there is no ballast discharge information available on most of the ship arrivals covered under this study, the ballast capacity of the vessel was estimated based on the ship's gross tonnage. The NBIC provided a custom data set for this purpose. The data set was from ships that arrived at one of the five Cook Inlet export facilities and reported both their gross tonnage and their total ballast capacity. The data set contained 28 ships: 5 freight ships going to Homer, 10 freight ships going to Agrium and 13 tankers going to Kenai Pipeline, Cook Inlet Pipeline or ConocoPhillips. Figure 1 contains a scatter diagram of the gross tonnage of the vessels versus their ballast capacity. A linear regression analysis of the entire data set results in a correlation coefficient of 0.89.

Close examination of the scatter diagram reveals that the freight vessels going to Agrium and Homer are clustered based on their destination. This may be because different classes of vessels are used for different types of trade. The data set was segregated into three categories: tank vessels, Homer-bound vessels, and Agrium-bound vessels. The linear regression analysis was repeated and the results are reported in Table 3.

Table 3. Relationship between gross tonnage and ballast capacity for a selected set of ships arriving at Cook Inlet export facilities.

Vessel Category	n	slope	intercept	correlation coefficient
Homer Freight Vessel	5	1.81	-42312	.90
Agrium Freight Vessel	10	1.83	-19199	.93
Tank Vessel	13	0.58	2052	.92

Source: Data provided by NBIC

For the purpose of this study, when the ballast discharge for an arriving ship is not known but the gross tonnage is know, the ballast discharge/capacity is estimated using the following formula with the values for slope and intercept from Table 3:

$$BW=GT \times slope + intercept$$

Where:

- BW is estimated ballast water capacity in metric tons,
- GT is the gross tonnage of the vessel in metric tons,
- *Slope* is the slope from the regression analysis for the category of vessel, and
- I*ntercept* is the intercept from the regression analysis for the category of vessel.

In a few cases, the above ballast estimation process for small ships arriving at Homer resulted in a negative number. In those cases, the linear regression slope and intercept for the un-segregated all-vessels model was used to estimate the ballast capacity.[2]

[2] The negative number likely resulted because the small class of ship, less than 20,000 gross tons, was not represented in the NBIC tonnage/ballast data set, which ranged from 34,000 to 36,000 gross tons for Homer Ships. The special case slope = 0.69 and intercept = 73.

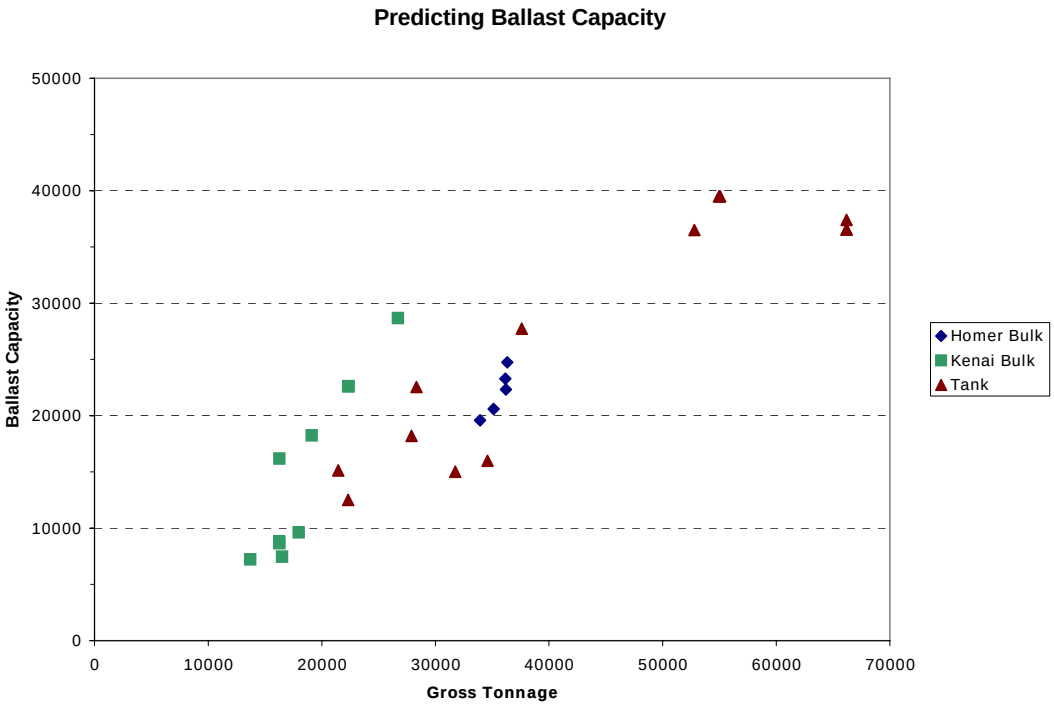

Figure 1. Scatter diagram of NMIC data set showing three categories of vessels visiting Cook Inlet ports, comparing ballast water capacity vs. gross tonnage.

Agrium Dock

The Agrium facility received the second highest number of ship visits over the five-year period and the highest number of different ships each year. The ships serving this facility vary considerably and have a poor reporting record with the NBIC. The ballast estimates are almost all based on estimates derived from gross tonnage, therefore the confidence in these ballast estimates is low. The ballast water discharge estimates for this facility are presented in Table 4. The USCG data set did not identify the last port of call for any of the vessels visiting this facility, so the source of the ballast is unknown.

Table 4. Ballast water discharge estimates (metric tons) for vessels calling at Agrium dock.

Ballast Source	1997	1998	1999	2000	2001	Total	
Unknown	1,053,799	843,210	860,074	376,840	925,082	4,059,006	100%
Total	1,053,799	843,210	860,074	376,840	925,082	4,059,006	

Source: USCG data set, NBIC database, PSIX database.

ConocoPhillips Dock

The ConocoPhillips facility received the third highest number of ship visits over the five-year period, with the lowest number of different ships each year. This is because two ships operated by ConocoPhillips usually serve the facility. These two ships have a very high compliance record with the NBIC, therefore the confidence in the ballast estimations are very high. The ballast water discharge estimates for this facility are presented in Table 5. Because the facility is in a dedicated trade with Japan, the source of the ballast is known.

Table 5. Ballast water discharge estimates (metric tons) for vessels calling at ConocoPhillips dock.

Ballast Source	1997	1998	1999	2000	2001	Total	
Japan	955,009	981,412	955,009	984,783	805,641	4,681,854	100%
Total	955,009	981,412	955,009	984,783	805,641	4,681,854	

Source: USCG data set, NBIC database, PSIX database.

Cook Inlet Pipeline Dock

The Cook Inlet Pipeline facility received the fourth highest number of ship visits over the five-year period, with a low number of different ships each year. Tesoro Alaska buys all of the crude oil produced through the Cook Inlet Pipeline facility and brings it to the Kenai Pipeline facility with their time-chartered vessels. The ballast water discharge estimates for this facility are presented in Table 6.

The USCG data set did not identify the last port of call for any of the vessels visiting this facility, so the source of the ballast is unknown from that data set. However, Tesoro's usual operating practice is to send a vessel that has just offloaded at Kenai Pipeline to Cook Inlet Pipeline to pick up crude oil. In theses cases, the ship either does not ballast or takes on Cook Inlet ballast water. Therefore, this ballast discharge is probably high and very little ballast discharge by vessels visiting this facility came from outside Cook Inlet.

Table 6. Ballast water discharge estimates (metric tons) for vessels calling at ConocoPhillips dock.

Ballast Source	1997	1998	1999	2000	2001	Total	
Unknown	465,267	509,692	163,829	596,930	101,370	1,837,088	100%
Total	465,267	509,692	163,829	596,930	101,370	1,837,088	

Source: USCG data set, NBIC database, PSIX database.

Homer Deep Water Dock

The Homer Deep Water Dock facility received the least number of ship visits over the five-year period, with a proportionally high number of different ships calling at the facility. No vessels are listed as calling at the facility in 1999, however the USCG data set may be erroneous in this case, as the Homer harbormaster reported that freighters did call at the facility in 1999. The ships serving this facility have a poor ballast reporting record with the NBIC. The ballast estimates are almost all based on estimates derived from gross tonnage, therefore the confidence in these ballast estimates is low. The ballast water discharge estimates for this facility are presented in Table 7.

Table 7. Ballast water discharge estimates (metric tons) for vessels calling at Homer Deep Water dock.

Ballast Source	1997	1998	1999	2000	2001	Total	
Unknown	483,836	448,301	0	85,688	89,028	1,106,853	100%
Total	483,836	448,301	0	85,688	89,028	1,106,853	

Source: USCG data set, NBIC database, PSIX database.

Kenai Pipeline Dock

The Kenai Pipeline Dock facility received the highest number of ship visits over the five-year period, with a proportionally low number of different ships calling at the facility. Many of the ships calling at the Kenai Pipeline Dock bring crude oil feed-stock to the Tesoro refinery and do not carry ballast. Therefore, it would not be possible to derive any reliable estimate of ballast discharges from the USCG data set. However, Tesoro Alaska did provide a data set containing details of every ship arrival during the study period, including ballast discharges. The ballast water discharge reports for this facility are presented in Table 7. These numbers are based on actual reports and therefore have the highest degree of confidence of any of the discharges covered in this study.

The majority of ballast water discharged by vessels calling at Kenai Pipeline consisted of Cook Inlet water. As discussed above, many of the ship arrivals at the Kenai Pipeline facility were from the Cook Inlet Pipeline facility. The vast majority of ballast discharges from outside the region came from the west coast of the U.S.

Table 8. Ballast water discharges (metric tons) for vessels calling at Kenai Pipeline dock.

Ballast Source	1997	1998	1999	2000	2001	Total	
Cook Inlet	163,460	438,033	459,482	412,901	587,952	2,061,827	65%
US West Coast	36,407	156,572	200,238	281,231	353,324	1,027,772	32%
Korea					41,666	41,666	1%
Russia	11,888	17,832				29,719	1%
Mexico West Coast			27,433			27,433	1%
Total	211,754	612,436	687,154	694,132	982,942	3,188,418	

Source: Tesoro data set.

Summary by Facility

When summarized by facility, the total ballast water discharged into Cook Inlet totaled 14.8 million metric tons during the five-year study period (Table 9). The average yearly discharge was about 3 million metric tons. The yearly average did not vary greatly during the study period.[3]

Table 9. Summary of ballast water discharge estimates (metric tons) by facility.

Facility	1997	1998	1999	2000	2001	Total	
ConocoPhilips	955,009	981,412	955,009	984,783	805,641	4,681,854	31%
Agruim	1,053,799	843,210	860,074	376,840	925,082	4,059,006	27%
Kenai Pipeline	211,754	612,436	687,154	694,132	982,942	3,188,418	21%
Cook Inlet Pipeline	465,267	509,692	163,829	596,930	101,370	1,837,088	12%
Homer Deep Water	483,836	448,301	0	85,688	89,028	1,106,853	7%
Total	3,169,667	3,395,052	2,666,065	2,738,372	2,904,063	14,873,219	

As discussed above, the amount of ballast water allocated to the Cook Inlet Pipeline facility has probably been greatly overestimated. Discounting the Cook Inlet Pipeline facility estimates completely yields a more realistic ballast water discharge estimate of 13.0 million metric tons or 2.6 million metric tons per year.

Summary by Source

A summary of the ballast water discharges by source is presented in Table 10. The source of almost half of the ballast water discharged into Cook Inlet is unknown because of poor compliance with ballast water reporting requirements. Of the known sources, Japan was the greatest source, followed by Cook Inlet and the west coast of the U.S.

[3] The standard deviation is 0.3 million metric tons.

Table 10. Summary of ballast water discharge estimates (metric tons) by source.

Ballast Source	1997	1998	1999	2000	2001	Total	
Unknown	2,002,903	1,801,203	1,023,903	1,059,457	1,115,480	7,002,947	47%
Japan	955,009	981,412	955,009	984,783	805,641	4,681,854	31%
Cook Inlet	163,460	438,033	459,482	412,901	587,952	2,061,827	14%
US West Coast	36,407	156,572	200,238	281,231	353,324	1,027,772	7%
Korea	0	0	0	0	41,666	41,666	0%
Russia	11,888	17,832	0	0	0	29,719	0%
Mexico West Coast	0	0	27,433	0	0	27,433	0%
Total	3,169,667	3,395,052	2,666,065	2,738,372	2,904,063	14,873,219	

Removing the ballast discharges originating from Cook Inlet sources and discounting the Cook Inlet Pipeline estimates resulted in an estimated total of 10.9 million metric tons over the 5-year period, or 2.2 million metric tons per year of non-indigenous ballast water being discharge into Cook Inlet.

Discussion

At present, it is difficult to accurately determine the amount and source of non-indigenous ballast water being discharged into Cook Inlet, because the ballast water reporting requirements are not consistently complied with nor enforced. The USCG should implement and enforce a requirement to submit ballast water reports upon arrival at a port, or they should compare reports received by NBIC with USCG port arrival data and take enforcement actions on ship operators failing to report ballast water discharges. Until compliance is ensured, the NBIC database is of little value in determining total discharge amounts and sources.

The circuitous methods used in this study to estimate ballast discharges are the best methods available at this time. The resulting estimate of 2.2 million metric tons of non-indigenous ballast water discharges per year provides a gross estimate of the size of the inoculation of non-indigenous species into Cook Inlet ecosystems. There is no evidence that the total amount of ballast water discharges significantly increased or decreased over the study period. A significant portion of these discharges originated in Japan and the west coast of the United States. However, the origin of most of the discharges remains unknown.

Web sites

Global Directories & Databases

The IMO Ballast Water Treatment R&D Directory (http://globallast.imo.org/research)

Scope and Focus: Global Ballast water treatment R&D.

One of the many functions of the GloBallast PCU is to establish and maintain an information resource centre and clearing house mechanism, in order to improve the global communication and dissemination of information relating to this issue, and thus facilitate increased coordination and cooperation between the many parties involved. This Ballast Water Treatment R&D Directory has been developed as part of this effort.

This directory lists research and development projects that are focussed specifically on the physical, mechanical or chemical treatment of ballast water to prevent/reduce the transfer of aquatic organisms. It does not list broader research projects relating to ballast water or marine bio-invasion issues in general.

The Aquatic Invasions Research Directory (AIRD) (http://invasions.si.edu/aird.htm)

Scope and Focus: Global. Research relating to all aspects of aquatic bio-invasions.

Over the past two decades, research in the field of aquatic (marine and freshwater) invasions has expanded rapidly, reflecting an increased awareness of the impacts of invading species on the economics and ecology of invaded environments. As an inevitable consequence of the publication process, the dissemination of information amongst the scientific and wider community has at times been unable to keep pace with advances in the field. This shortfall has prevented researchers and policy makers from benefiting from findings of contemporary research or experience gained outside their own networks; it may also lead to the proliferation of uncoordinated studies and unnecessary duplication of effort.
The Aquatic Invasions Research Directory (AIRD) was conceived as a means to address this shortfall. The Directory is an Internet-based, searchable database containing up to the minute information on people, research, technology, policy, and management issues relevant to aquatic invasions. The scope of the Directory falls into four broad areas:

1. The ecology of aquatic invasions: vectors, impacts, risk assessment and response
2. The ecology of ballast water
3. Prevention and treatment technologies
4. Policy and management

AIRD is being developed at the Smithsonian Environmental Research Center (SERC) in Maryland, USA in collaboration with researchers in other parts of the world.

The Global Invasive Species Database(http://www.issg.org/database/)

Scope and Focus: Global. All aspects of bio-invasions.

This database is being developed by the IUCN Invasive Species Specialist Group (ISSG) as a contribution to the Global Invasive Species Programme (GISP). It has very broad scope with a greater focus on terrestrial invasive species than aquatic invasive species, although it does have a specific aquatic component which when fully developed will prove especially useful for management purposes, including predictive modeling.

The FAO Database on Introductions of Aquatic Species (DIAS) (http://www.fao.org/waicent/faoinfo/fishery/statist/fisoft/dias/index.htm)

Scope and Focus: Global. Originally only intentional introductions for fisheries purposes. Scope is being expanded.

R. Welcomme initiated the FAO database on introductions of aquatic species in the early 1980's. It considered primarily only freshwater species of fish and formed the basis for the 1988 FAO Fisheries Technical Paper no. 294. The database has been expanded to include additional taxa, such as molluscs and crustaceans, and marine species. In the mid **1990**'s a questionnaire was sent to national experts to gather additional information on introductions and transfers of aquatic species in their countries.

The database, which contains now about 3,150 records, can be queried through the Search Form. Users aware of other introductions of aquatic species not already included in the database or that have additional information on the records in the database are requested to fill in the Input Form. Periodically this information will be validated and added to the database.

The database includes records of species introduced or transferred from one country to another and does not consider movements of species inside the same country (see the Glossary for more explanations about these terms). Coverage of accidental introductions of organisms (e.g., through ship ballast waters) is not complete and records on this topic have been generally entered only when important impacts on fisheries or on the environment have been caused.

Regional Directories & Databases

The Baltic Sea Alien Species Database

(http://www.ku.lt/nemo/read_first.htm)

Scope and Focus: Baltic Sea. Known invasive marine species.

The Baltic Sea Alien Species Database is an interactive tool, which includes the following information retrieval options:

- Database Search,
- Baltic Sub-regions and Species Directory.

The information comprised in the Database comes from:

- members of the Baltic Marine Biologists Working Group on Non-indigenous Estuarine and Marine Organisms and other researchers involved in invasive biology studies;
- published papers, environmental reports, "grey literature" and internet sites;
- the Database Questionnaire.

The CIESM Atlas - New Exotic Species in the Mediterranean Sea (http://www.ciesm.org/atlas/index.html)

Scope and Focus: Mediterranean Sea. Known invasive marine species.

The CIESM Atlas - New Exotic Species is the first attempt to provide a comprehensive, group by group, survey of recent marine 'immigrants' in the Mediterranean, which is undergoing drastic and rapid changes to its biota. Many of these new species are of Indo-Pacific origin having reached the Mediterranean Sea through the Suez Canal : these so called 'Lessepsian' migrants now contribute significantly to the biodiversity of the Eastern basin. With increasing attention paid to this phenomenon, invaders of other origin-notably from the tropical Atlantic realm- are now more frequently recognized as well, a result of a natural invasion through the Gibraltar straits or of introduction (accidental or intential) by man.

The Atlas is a guide for researchers, environmental planners and non-specialists who are interested in or likely to encounter marine species that are not native to the basin. Because of observations and records of these new and often rare species the Atlas will expand as our knowledge on the distribution and ecology increases. We believe the best way to inform you about the changing seascape is through a digital interactive format, which will enable us to quickly update information and allow instant feedback.

The Atlas will consist of about six volumes, each written by a group of specialists in their respective field. Individual species pages are designed to stand alone as information sheets with illustrations, diagnostic features, biological information, references and a distribution map for each exotic species. The CIESM task force experts will continuously review reliable evidence of new or confirmed records thus updating and expanding the Atlas. The first three printed volumes will be published in early **2002**.

National Directories & Databases

UK - Directory of non-native marine species in British waters (http://www.jncc.gov.uk/marine/dns/default.htm)

Scope and Focus: UK waters. Known invasive marine species.

The Directory of non-native marine species in British waters is an inventory-style directory organised according to Phyla. It provides information on known non-native marine species in British waters according to the following categories; Division, Class, Order, Species name, Synonyms, Common name, Date of introduction and origin, Method of introduction, Reasons for success, Rate of spread and methods involved, Distribution, Factors likely to influence spread and distribution, Effects on the environment, Effects on commercial interests, Control methods used and effectiveness, Beneficial effects, Comments and References.

US - National Ballast Water Information Clearing House (http://invasions.si.edu/ballast.htm)

Scope and Focus: US waters. Ballast water management practices and patterns.

The US National Invasive Species Act of **1996** (NISA) directed the United States Coast Guard in conjunction with the Smithsonian Environmental Research Center (SERC) to develop a clearinghouse for the synthesis, analysis, and interpretation of national data concerning ballast water management and ballast-mediated invasions throughout the USA. As a result, the National Ballast Water Information Clearinghouse (hereafter Clearinghouse) was established in **1997** at SERC.

NISA calls for a variety of measures to reduce the risk of exotic species invasions associated with release of ballast water by ships. Among these, NISA requests that all ships arriving to U.S. ports from outside the Exclusive Economic Zone (EEZ) follow voluntary guidelines for open-ocean exchange of ballast tanks that are to be discharged in U.S. waters. This management practice is intended to minimize the transfer of nonindigenous species.

A key element of this legislation is tracking the effectiveness of voluntary guidelines for ballast water management. This assessment includes measuring: (a) the level of compliance, (b) changes in the rate and patterns of ballast water delivery, and (c) reduction in the rate of ballast-mediated invasions. The Clearinghouse was created to provide synthesis and analysis of these measures on a national scale. More generally, the Clearinghouse will function as a central source of information on ballast water and ballast-mediated invasion, including:

- Spatial and temporal patterns of ballast water delivery and management;
- Patterns and rates of marine and estuarine invasions;
- Directory of ongoing and past research on ballast water and ballast-mediated invasions;
- General information on a broad range of topics relevant to this issue.

Together, these elements will provide a valuable resource, which is now lacking for ballast water management and ballast-mediated invasions. The Clearinghouse will produce reports on national patterns of ballast water management and invasion, as well as databases, that are available via the Internet. This approach is intended to provide access to a rich source of information for education, management, policy, and research.

US - National Marine and Estuarine Invasions Database (http://invasions.si.edu/nis.htm)

Scope and Focus: US waters. Known invasive marine and estuarine species.

This database focuses on marine and estuarine alien species in U.S. waters, including organisms that occur in tidal waters of all salinities (i.e., freshwater to full marine salinities). The primary goal of this database is to describe the patterns and effects of alien species invasions in coastal communities on multiple spatial and temporal scales. Although the database is used to synthesize available information on a species-by-species basis, it has been explicitly designed as a research and management tool to test hypotheses about invasion patterns and processes. Specifically, for each species, detailed information is included about :

- taxonomy (including synonym and common names),
- invasion history (e.g., mechanism and date of introduction, source region, history of spread, etc.),
- population biology (including life-history characteristics and abundance),
- community ecology (e.g., habitat utilization, environmental tolerances, ecological interactions),
- economic impacts,
- references for each topic area.

US scientists are querying this database to examine patterns and impacts of invasion by taxa, region, habitat, date of invasion, mechanism of introduction, source region, etc. The database is complete for Chesapeake Bay, and analyses of invasion patterns and effects in Chesapeake Bay are at various stages of completion. Concurrent with these analyses, SERC is expanding the scope of the database to include other coastal sites and regions throughout the U.S. to (1) characterize invasion patterns on a national scale and (2) measure spatial variation in the extent and consequences of invasions. The database (and resulting analyses) will continue to develop and expand over many years, as part of the US National Ballast Water Information Clearinghouse, and will provide a national information source on marine invasions through SERC's website.

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The Ballast Issue

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