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No. 51

STUDY OF THE TRANSPORTATION OF PACKAGED DANGEROUS GOODS BY SEA IN THE BALTIC SEA AREA AND RELATED ENVIRONMETAL HAZARDS

Report on a study on the transportation patterns
for packaged dangerous goods in the Baltic Sea Area
and related hazards to the marine environment,
carried out under the auspices of the Combatting Committee
of the Helsinki Commission in 1990-1992.

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Baltic Marine Environment Protection Commission
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PREFACE

Within the framework of the Baltic Marine Environment Protection Commission - Helsinki Commission - a study on the transportation of packaged dangerous goods in the Baltic Sea Area and related environmental hazards has been carried out in accordance with a decision by the Helsinki Commission. Finland has acted as Lead Country in compiling and analyzing the information provided by the Contracting Parties and Mr. Börje Stenström from ÅF-Industriteknik AB, Sweden, has acted as consultant in the execution of the work.

The contents of this publication has been considered by the ad hoc Working Group on Combatting Spillages of Harmful Substances Other than Oil (CC CHEM) of the Helsinki Commission under the chairmanship of Mr. Olli Pahkala, Ministry of the Environment, Finland.

The final editing of this publication has been made by the consultant.

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STUDY OF THE TRANSPORTATION OF PACKAGED DANGEROUS GOODS BY SEA IN THE BALTIC SEA AREA AND RELATED ENVIRONMENTAL HAZARDS

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STUDY OF THE TRANSPORTATION OF PACKAGED DANGEROUS GOODS BY SEA IN THE BALTIC SEA AREA AND RELATED ENVIRONMETAL HAZARDS

Abstract

A study has been performed under the auspices of the Combatting Committee of the transportation of packaged dangerous goods in the Baltic Sea area. The study is based on information collected from all ports in the area of loading and unloading of packaged dangerous goods during October and November 1990. Although this limited time period may be too short for producing statistically reliable data, the large amount of information thus collected gives very useful information about the transportation of packaged dangerous goods, previously not available.

The total transportation activity has been found to be about 143000 tons of packaged dangerous goods per month, divided in about 11400 parcels carried in about 4000 shipments, The average size. of a parcel of packaged dangerous goods is thus about 12 tons but very large variations exist, from a large number of very small parcels of consumer goods shipped on ferry routes to a limited number of very large shipments of industrial base materials in conventional cargo vessels. Table 1 gives an overview of how the goods is divided between the main IMDG classes by quantity and number of parcels.

The total transportation activity corresponds to about 25000 shiphours at sea per month or about, as an average, 35 ships carrying dangerous goods being at sea at any one time. The Baltic Sea area has been divided in 13 sea areas in which the shipping activities have been allocated in accordance with reported origin and destination for each parcel. The activities have been summarized per IMDG class. The total shipping pattern is illustrated in Figure 0.1. showing per sea area the quantity and number of parcels shipped per month. As may be expected, the highest shipping intensity is found in the south-west part of the Baltic Sea area and a medium high intensity is found in the rest of the south Baltic Sea, the Danish waters, the Kattegatt, along the Swedish east coast and in the Gulf of Finland.

A total of 795 different substances have been reported as being carried. About half of these are, however, only carried once or twice per month. About 100 substances are carried more than 20 times per month. These 100 substances account for about 75 per cent by number of all parcels being shipped. 25 of these substances by UN numbers are classified as “marine pollutants” or conditional “marine pollutants”. As some of these are carried frequently, the marine pollutants and the conditional marine pollutants account together for about 50 per cent by number of all shipments.

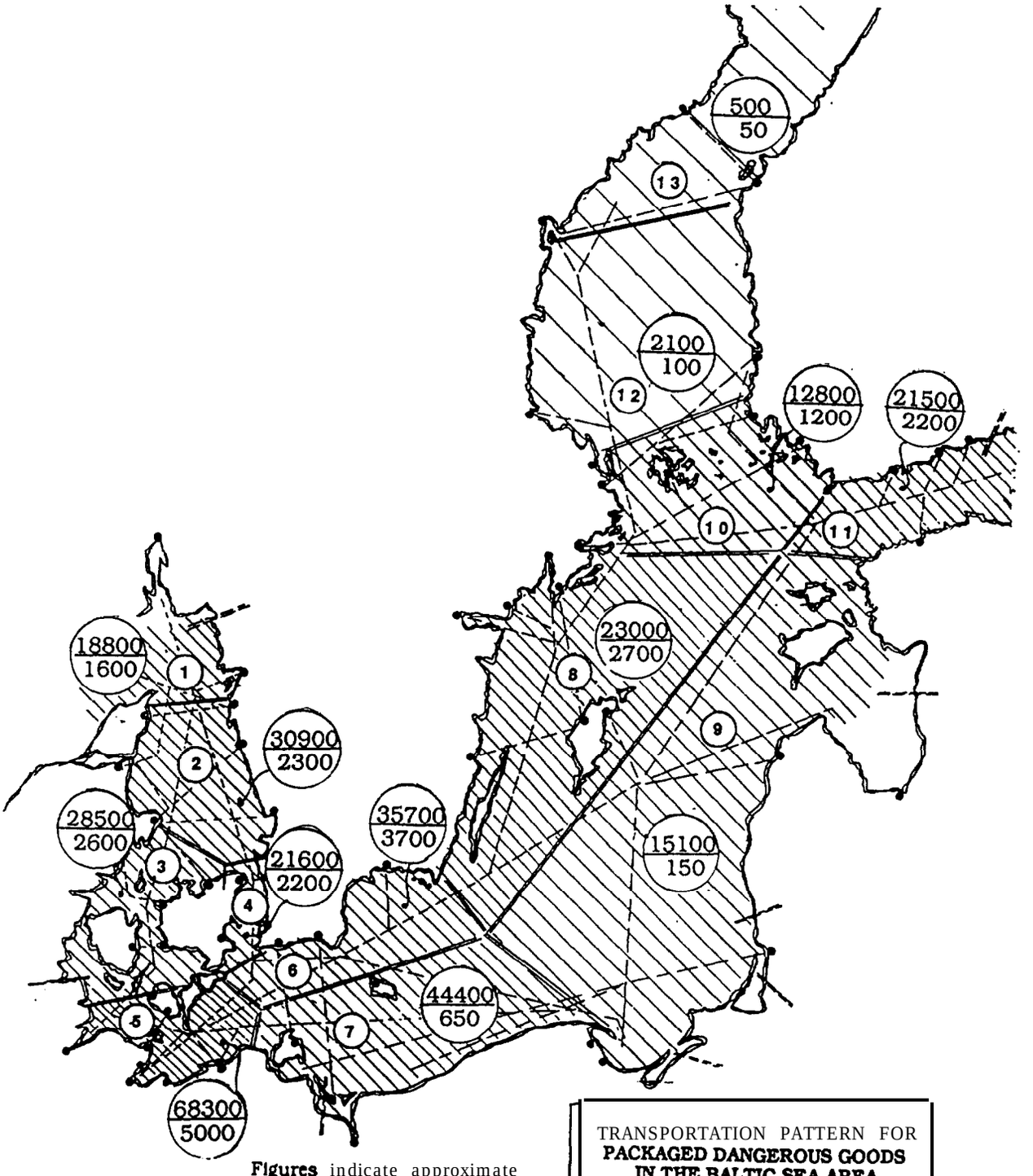
A total of about 130 shipping routes for packaged dangerous goods within the Baltic Sea area have been identified in the reporting. 80 of these carry more than 100 tons each per month. 34 of the routes are regular ferry lines, some general passenger/car/railroad ferry lines and some more pronounced cargo ferry lines. The ferry routes account for about 76000 tons per month or slightly above 50 per cent by weight of all packaged dangerous goods carried. The ferries carry about 75 per cent of all dangerous goods shipments by number of parcels.

Certain substances are carried in large quantities. This includes some bulk materials, essentially fertflizers. Paints and laquers account for the largest number of parcels per month and also for the second largest quantity, following the fertilizer type of substances. Some of the substances, 17 in total, have been identifies as being highly hazardous due to their physical properties.

The study identifies the risk for accidents with vessels carrying packaged dangerous goods in various parts of the Baltic Sea area. The total risk for a serious accident to a ship carrying dangerous goods is estimated to be one per year. Damage to dangerous cargo carried onboard as a result of accidents or incidents involving lost or damaged containers or other packagings is estimated to about 6 times per year, in most cases resulting in the cargo being released into the sea.

Table 1
TOTAL QUANTITY AND NUMBER OF PARCELS PER CLASS
Approximate values for one month

Class	Class properties	Quantity, tons	Number of parcels	Average size of parcel, tons
1	Explosives	2700	370	7,3
2	Gases	10900	1100	9,9
3	Inflamable liquids	32450	4700	6,9
4	Inflamable solids	18500	540	34,3
5	Oxidizing substances	25000	510	49,0
6	Poisonous substances	12800	1100	11,6
7	Radioactive materials	1300	30	43,3
8	Corrosives	29600	2400	12,3
9	Others	9500	640	14,8
Total		142750	11390	12,5



Figures indicate approximate **shipments** per month,
Quantity (tons)
Number (of parcels)

TRANSPORTATION PATTERN FOR
PACKAGED DANGEROUS GOODS IN THE BALTIC SEA AREA

IMDG CLASSES 1-9 (TOTAL)

FIGURE 0.1

STUDY OF THE TRANSPORTATION OF PACKAGED DANGEROUS GOODS BY SEA IN THE BALTIC SEA AREA AND RELATED ENVIRONMENTAL HAZARDS

1. Background.

The study presented in this report has been conducted in order to identify the transportation pattern for packaged dangerous goods in the Baltic Sea area, including various pertinent transportation parameters and to illustrate the related risk for accidents and environmental hazards.

This study has been performed under the auspices of the Combatting Committee of the Helsinki Commission in close cooperation between all the Baltic Sea States and forms a part of a joint work in the development of necessary response capacities to deal with potential incidents and spills of packaged dangerous goods in the Baltic Sea area.

A collection of information about loading and unloading of packaged dangerous goods was made by the Baltic Sea States covering all ports in the area during the period of October and November 1990. It should be realized that a two months sampling of the transportation activities may be inadequate for obtaining a statistically corrects information about the transportation pattern but due to the large amount of detailed information involved and the large work load in collecting this information it was determined that a two months sampling period should suffice. A more extensive reporting and analysis may be instituted at a later opportunity when computerized information handling in ports has become more generally adopted.

The results from the current work should be taken as indicative for the transportation pattern of packaged dangerous goods and is believed to contain valuable information, not hitherto available. This includes information about quantities and number of shipments of substances of various classes transported in different parts of the Baltic Sea area, information about typical and frequent substances and identification of those presenting higher hazards, range of sizes of individual shipments, common types of containment of packages and types of ships engaged in the transportation.

Packaged dangerous goods is carried in a large variety of shipments, from small parcels of consumers goods to shipments in large quantities, being comparable to bulk shipments. The properties of the substances vary considerably and includes solid substances as well as liquids and compressed or liquified gases. The necessary containment varies likewise greatly in accordance with the properties of the substances and the relevant protection requirement.

The transportation of certain packaged dangerous goods, identified as “harmful substances” from the marine pollution point of view, is regulated by Annex III of MARPOL 73/78. Handling of dangerous goods from the safefy point of view is regulated by the International Maritime Dangerous Goods Code (the IMDG Code) and related supplements, now having been made mandatory by connection to the SOLAS Convention. The IMDG Code gives, for each substance, advice on terminology, packaging, labelling, stowage, segregation, handling and emergency response actions. This also includes Emergency Procedures (EmS) and the Medical First Aid Guide (MFAG). Substances in the IMDG Code, which come under the regulations of Annex III of MARPOL as “harmful substances”, are identified in the Code as “marine pollutants” or “severe marine pollutants”.

All substances being known to be traded or handled universally have been given a UN identification number. This UN number is used generally to identify a substance in order to avoid ambiguities and uncertanties in the proper identification of a substance.

In the IMDG Code substances have been grouped in nine classes based on their hazardous properties. Some of the classes are additionally divided in subclasses. A given substance may have such properties that it belongs to more than one class. The system contains the

following main classes:

1. Explosives
2. Gases
3. Inflamable liquids
4. Inflamable solids
5. Oxidizing substances
6. Poisonous substances
7. Radioactive materials
8. Corrosives
9. Miscellaneous dangerous substances.

2. Treatment of Data.

Each reported shipment of packaged dangerous goods, identified by date, port of origin and destination, UN number, class and quantity has been fed into a database. Additional information about ship type, type of package and stowage has been included where available. Only shipment in larger quantities than 100 kilograms have been taken into account in the study. To enable identification of any duplication of data from two ports, related to the same shipment, all shipments have initially been added up and screened for duplications on each identified route between two ports or one port and the relevant inlet/outlet from the Baltic Sea.

The reported information generally reflects a workable information handling system in the ports but information about incoming cargo sometimes seem to be less complete than that about outbound cargo.

Some inconsistencies in the reporting have been observed in as much as the two reports related to each end of a given shipment sometimes deviate. Reasons for variations in the reports from the two ends of a transportation leg may be mix-up of information about the destination of the vessel and the destination of the particular parcel of cargo. When the information from two ports related to the same shipment have been compared, the most likely estimate of the actual shipping activity has been made and used in the further analysis work.

A further source of deviations lies in the identification of weight. The majority of the weight information is related to gross weight of the parcel, including its containment. In some cases this involves large errors such as when a container or railroad car is included in the weight information. This uncertainty has in particular been large on the railroad ferry routes. Such information has been adjusted based on judgement and best information available.

The prime identification of shipments has been by IMDG main class number. It has not been practicable to use the IMDG sub-classes as the basis for analysis due to inconsistent reporting in this regard. It has also been observed that shipments under IMDG class 9 have not always been delt with as dangerous goods, in particular not in railroad transportation, and some information regarding this class may therefore be missing.

Information for each transportation route, adjusted as far as possible for duplications and any deviation of the length of the reporting period and added up on a class basis has been allocated to relevant sea areas as described in section 3 below and used as basis for the analysis of the transportation activity in the sea areas. Shipments have been identified to their sailing routes without regard to the direction of the movement of the cargo. i.e. no differentiation has been made between inbound and outbound shipments following an identified route.

Available information about the type of containments and packagings used has been of varying standard. The information from some ports has, however, been detailed enough to give a general picture of the frequency of various types of packaging used. The type of ships engaged in the transportation have been identified in general categories. It has.

however, not been possible to analyse in any detail how the dangerous cargo has been stowed onboard the vessels.

Although complete information has not been available on all shipments and no means have been available for checking to which extent reporting has been missing, the large volume of usable data supports a picture of the transportation pattern that may be regarded as highly representative.

Some UN-numbers apply to a group of products, e.g. paints. Such group UN numbers may include substances which are marine pollutants as well some which are not. The "P" symbol used in various tables to indicate marine pollutants has been placed in parenthesis in case of substances which are not in all cases marine pollutants.

3. General Transportation Pattern.

The total quantity of packaged dangerous goods handled in Baltic Sea area ports per month is, from the data collection available, about 143,000 tons. The number of individual parcels is about 11,400. This does not include the large number of shipments of consumer goods in parcels of less than 100 kilogram size. The total number of ship voyages on which these shipments have been carried is about 4000 per month. This indicates that the average size of a shipped parcel is around 12 tons and the average quantity of dangerous packaged goods onboard a vessel is around 36 tons, comprising 3 different parcels. Very large variations in this pattern do, however, exist as is illustrated in section 4 below.

The transportation pattern includes shipments of varying lengths, from a very large number of short distance shipments on the ferry routes in the south-west part of the Baltic Sea to shipments with a length of about 48 hours from the North Sea inlets to the Baltic Sea area to the ports in southern Finland and eastern Sweden. The duration of shipments has been estimated on an area by area basis and been found to be about 25000 shiphours per month, corresponding to about 35 ships in continuous operation at sea with packaged dangerous goods onboard.

The distribution of the total quantity and number of shipments on a one month basis, divided in the nine IMDG classes, is illustrated by Table 1. As can be seen, inflamable substances in class 3 make up the largest single class of substances, followed by corrosive substances in class 8 and oxidizing substances in class 5. The average size of parcels varies and is larger in case of classes 4 and 5. The average size is also large in case of class 7. radioactive substances, probably due to the weight information including a considerable containment weight. Class 3 also contributes with the largest number of shipments. A clear difference may be seen between classes containing a large portion of "consumer goods" in a distribution network, essentially classes 1 and 3, and classes containing essentially industrial base materials such as classes 4. 5 and 8.

Table 1
TOTAL QUANTITY AND NUMBER OF PARCELS PER CLASS
Approximate values for one month

Class	Class properties	Quantity, tons	Number of parcels	Average size of parcel, tons
1	Explosives	2700	370	7,3
2	Gases	10900	1100	9,9
3	Inflamable liquids	32450	4700	6,9
4	Inflamable solids	18500	540	34,3
5	Oxidizing substances	25000	510	49,0
6	Poisonous substances	12800	1100	11,6
7	Radioactive materials	1300	30	43,3
8	Corrosives	29600	2400	12,3
9	Others	9500	640	14,8
Total		142750	11390	12,5

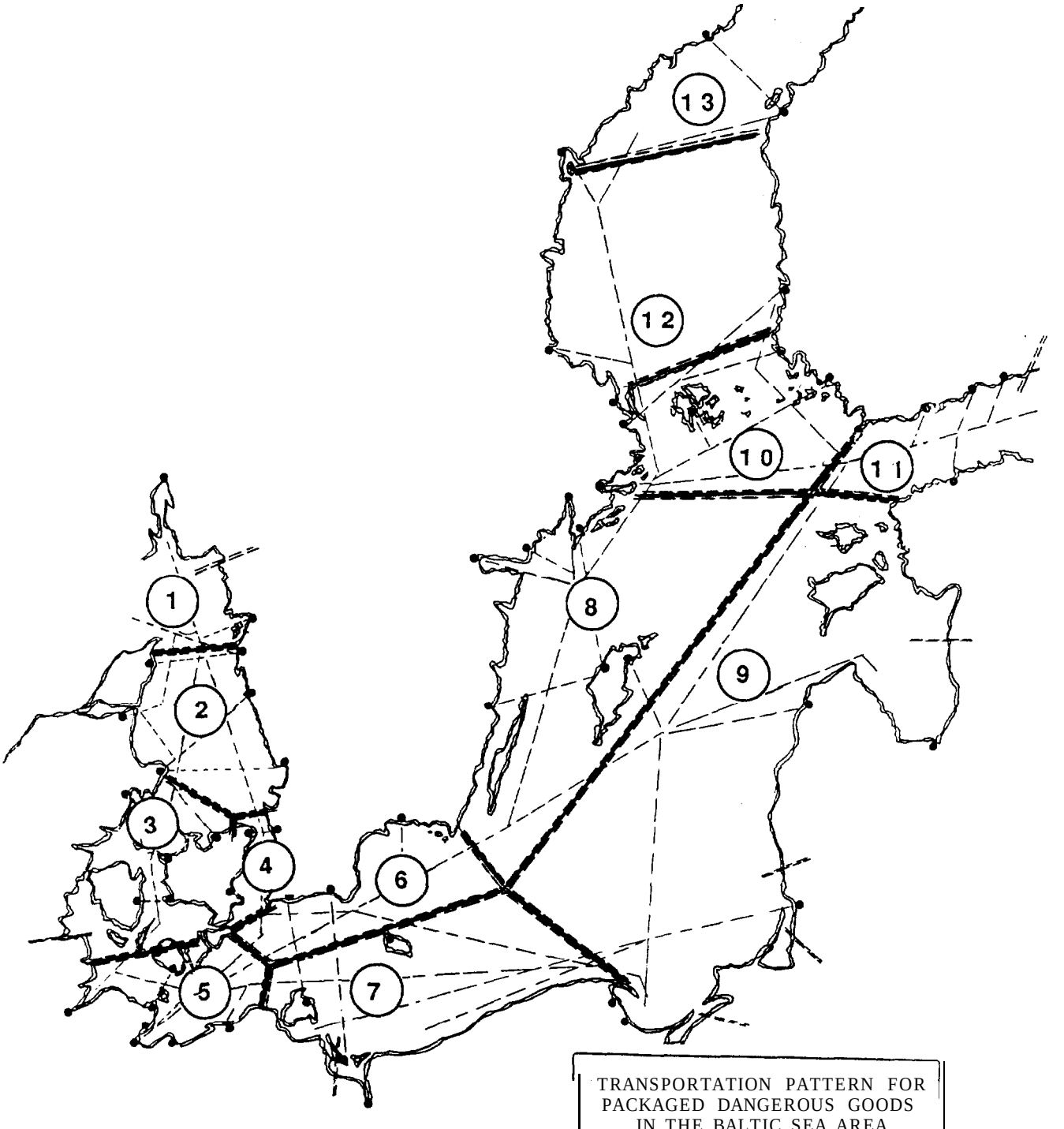
A total of about 130 shipment routes between named origins and destinations have been identified. This includes 45 routes "terminating", for the purpose of this overview, in the the inlets/outlets of the Baltic Sea area. About 35 of the routes inside the Baltic Sea area are regular ferry routes.

The Baltic Sea area has been divided in 13 sea areas as shown in Figure 1. Each port to port shipping route has been assigned to the most likely sailing route, traversing one or several of the sea areas. Some uncertainty exist in the allocation of sailing routes between the southern Baltic and the Gulf of Finland to sea areas as these passages may take place east or west of the island of Gotland depending on weather and other circumstances. Generally it has been assumed in this case that traffic moving along the Swedish south coast will continue along the western side of the Baltic Sea whereas shipments entering the Baltic Sea via the Kiel canal or starting from ports along the south coast of the Baltic Sea and being bound for the Gulf of Finland ports will proceed along the eastern part of the Baltic Sea.

Approximate monthly quantities and numbers of parcels per sea area and class are shown in Table 2. The largest total shipping activity, both by quantity and number of parcels, is found in sea area number 5, the Kiel Canal approach and surrounding waters. The shipping density is also relatively high in the rest of the south Baltic, gradually reducing further north to low values. The intensities along the Swedish west coast, Danish waters and Öresund are all of medium level. The transportation activity is generally low in the Gulf of Bothnia. Shipments from ports along the south and south-east coast of the Baltic Sea deviate from the general pattern as the average quantities are larger. This includes shipments in sacks and drums of large quantities of base substances which may be comparable to bulk shipments.

Table 2
TRANSPORTATION OF PACKAGED DANGEROUS GOODS PER CLASS AND SEA AREA
Approximate values for one month, tons and number of parcels

Class	Class properties		Sea areas 1 Skage-rack	2 Kalte-gatt	3 Danish waters	4 Öre-sund	5 Kieler Bight	6 Swedish south	7 Baltic south	8 Baltic west	9 Baltic east	10 Åland sea	11 Gull of Finland	12 Gull of Bothnia	13 Gull of Bothnia
1	Explosives	quantity	1220	1380	530	520	850	670	300	380	50	200	120	1	0
		number	70	120	70	90	180	120	20	70	10	40	40	1	0
2	Gases	quantity	490	1490	4420	1040	2900	3810	2950	880	1	570	260	0	0
		number	100	170	380	220	350	310	110	220	2	40	130	0	0
3	Inflamable liquids	quantity	3590	5340	7150	7180	13400	9730	3480	5560	960	3200	4770	270	100
		number	540	810	1160	960	2110	1520	160	1170	30	450	980	30	5
4	Inflamable solids	quantity	2180	2650	1410	1060	11000	3090	12400	780	1900	420	770	20	0
		number	100	150	70	80	220	200	120	80	25	40	60	2	0
5	Oxidizing substances	quantity	3870	6010	1340	3040	14470	6770	11240	7180	3860	2580	3560	1100	10
		number	80	150	60	120	280	250	70	150	30	70	120	10	1
6	Poisonous substances	quantity	1900	2660	1720	2830	7930	3270	2260	2730	1670	1110	2950	340	10
		number	140	230	220	210	670	420	50	320	20	100	290	20	5
7	Radioactive materials	quantity	840	1000	5	290	20	230	1	320	1	350	30	0	0
		number	150	10	5	5	5	1	1	5	1	5	1	0	0
8	Corrosives	quantity	4150	5690	7710	4800	11030	6290	7270	3420	2150	2800	3950	250	190
		number	410	570	580	400	920	680	110	500	25	330	370	20	20
9	Others	quantity	570	4690	4170	860	6770	1880	4500	1710	4500	1560	5290	110	200
		number	90	130	50	140	320	230	15	200	10	150	160	5	10
Total		quantity	18800	30900	28500	21600	68300	35700	44400	23000	15100	12800	21500	2100	500
		number	1600	2300	2600	2200	5000	3700	650	2700	150	1200	2200	100	50
		ave. tons	11,7	13.4	11.0	9.8	13.7	9.6	68.3	8.5	100.7	10.7	9,8	21.0	10.0

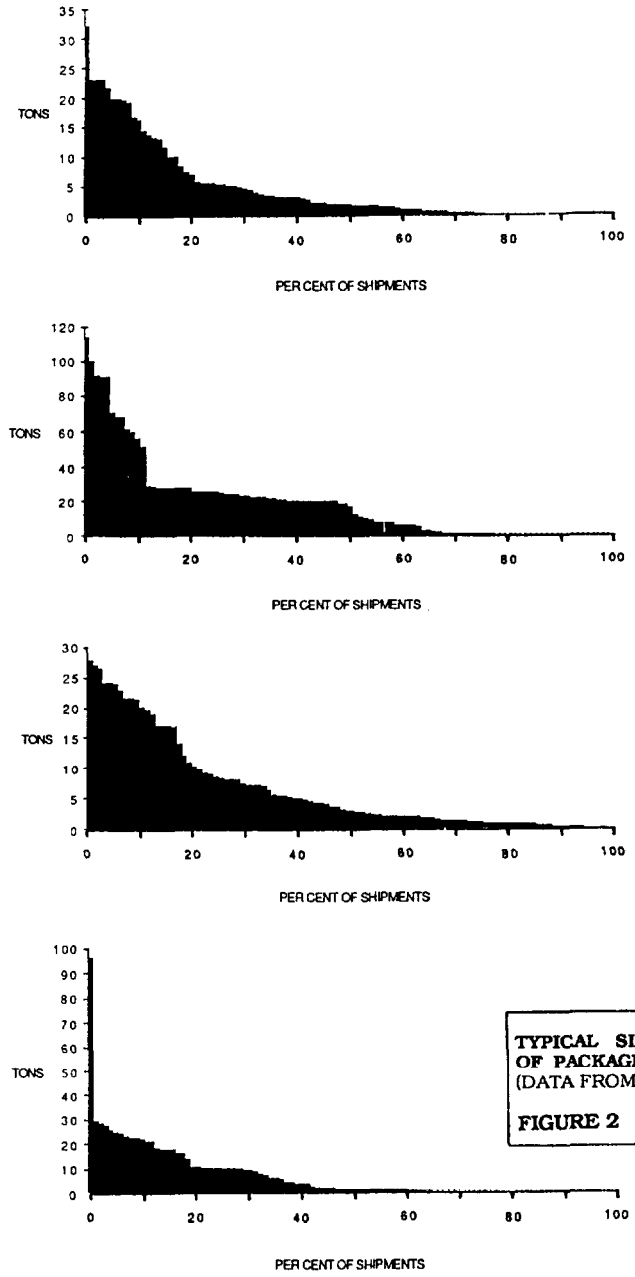


TRANSPORTATION PATTERN FOR PACKAGED DANGEROUS GOODS IN THE BALTIC SEA AREA

IDENTIFICATION OF SEA AREAS

FIGURE 1

The size of individual shipments varies considerably, from bulk shipments of several thousand tons to a large number of small size shipments on the ferry routes. The size distribution of individual parcels is illustrated in Figure 2. showing the size distribution of parcels to/from four selected ports. Despite the type of shipping activities varies from ferries to liner service and random shipments, the average size and size distribution does not vary very much. The average spectrum includes shipments in the range up to about 100 tons and with an average size between 10 and 20 tons, Shipments in the largest quantities are not included in this illustration. Shipments of less than 100 kilograms, which are very frequent on the ferry lines, are also excluded from this illustration and calculation of average sizes.



TYPICAL SIZE DISTRIBUTION OF PACKAGED DANGEROUS GOODS
(DATA FROM FOUR SELECTED PORTS)

FIGURE 2

4. Detailed Shipping Pattern

The approximate quantities and number of parcels per sea area for a one month period is shown in the charts in Figures 3.1 to 3.10, one for the total shipping activity and one for each IMDG class. Major sailing routes are also indicated in the charts in a schematic way. The shadow pattern in the charts illustrates the approximate shipping density with packaged dangerous goods in each sea area. The concentration of the shipping activities towards the south-west part of the area is evident except for IMGD classes 1 and 7.

The most important substances carried in each sea area are listed in Table 3. The table lists for each sea area the six individual substances which have been found to be carried in the largest quantities. The table also indicates the relative magnitude of these shipments, expressed as the percentage fraction of the total transportation of packaged dangerous goods in the area, represented by each one of these large quantity substances.

The total number of different substances which have been reported as being shipped during the period is 795. Only 350 of these are, however, shipped more than once or twice per month and may be considered as being shipped regularily. They represent together more than 90% of the total number of parcels being shipped. Table 4 shows a listing of these 350 substances by UN number and IMDG class.

About 100 of the substances are reported as shipped in 20 parcels or more per month. This group of substances, accounting for about 75 % by number of all parcels being shipped, are listed in Table 5. The table identifies these shipments by UN-number, class, nomenclature, shipping frequency and identification of marine pollutant characteristics. The parcels of substances, which are classified as marine pollutants or potential marine pollutants, account for almost 50% by number of all the parcels being shipped regularly.

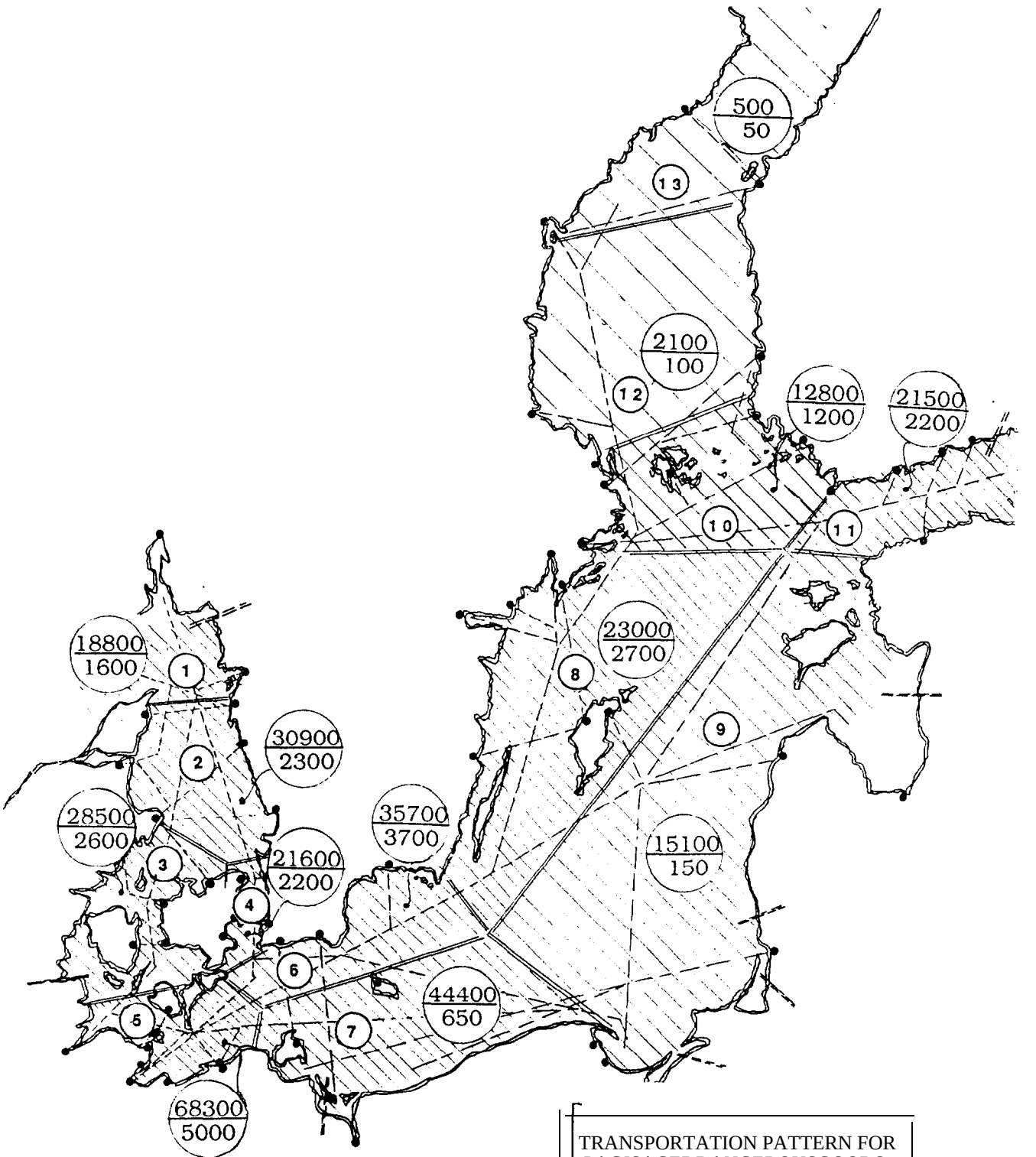
About 80 of the 130 shipping routes, which have been defined as carrying packaged dangerous goods, carry more than 100 tons per month. These routes are identified in Table 6, indicating for each route the approximate quantity and number of parcels per month and predominant IMDG classes which are being shipped on the route.

Substances carried in large quantities are listed in Table 7. As shown by the table bulk substances such as ammonium nitrate and calcium carbide represent the largest quantities, although carried in a relatively small number of shipments. Substances in class 3, greatly consisting of consumer goods, represent the second largest category by quantity and account for the largest number of parcels. The table also indicates the sea areas, in which the shipments predominantly take place.

Typical individual large shipments are listed in Table 8, arranged in class order. Again, it is shown that some substances in classes 4. 5 and 8 are those carried in the largest individual parcels. Generally these large individual parcels make up the large quantities reported for some substances in Table 7.

5. Ferry Routes.

34 of the identified shipping routes have been considered as regular ferry routes, served by dedicated passenger/car/freight ferries making regular and frequent passages. Liner services which make regular calls in identified ports have not been regarded as ferries but the dividing line between the two categories may in some cases be vague. Table 9 includes a summary of these ferry lines, including the approximate quantity och dangerous good carried per month and the number of parcels. The table also lists the calculated average quantity of dangerous goods per voyage and the average number of such parcels per voyage. This information is based on the estimated total number of ferry voyages, including those carrying no dangerous goods. The quantity shipped on each passage varies however considerably, partly in a controlled manner due to restrictions to carry dangerous goods on passenger ferries. Some of the ferry lines are pronounced cargo ferries or railroad ferries and carry the bulk of the shipments.

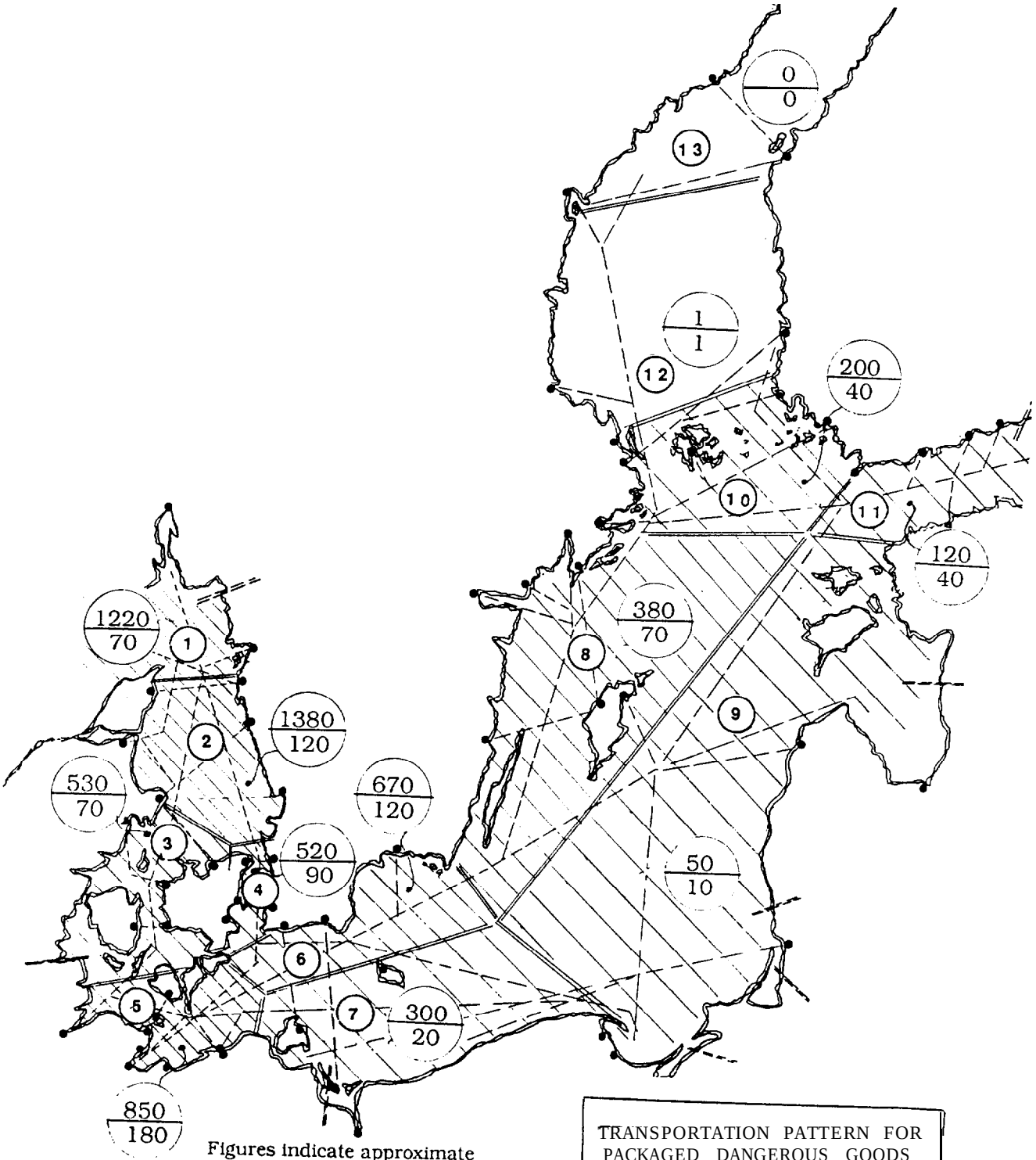


Figures indicate approximate shipments per month,
Quantity (tons)
Number (of parcels)

TRANSPORTATION PATTERN FOR PACJSAGEDDANGEROUSGOODS IN THE BALTIC SEA AREA

IMDG CLASSES 1-9 (TOTAL)

FIGURE 3.1

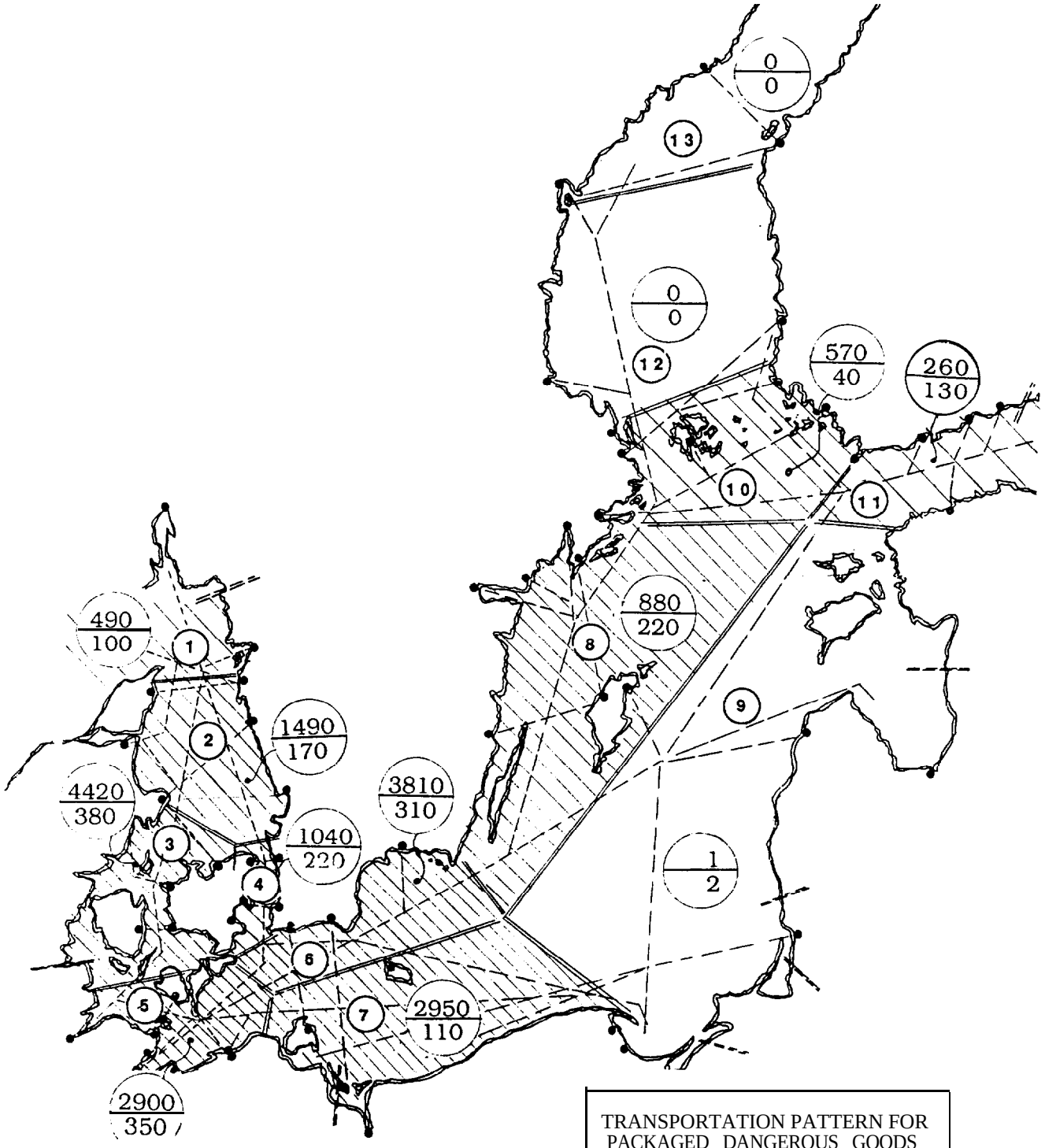


Figures indicate approximate shipments per month.
Quantity (tons)
Number (of parcels)

TRANSPORTATION PATTERN FOR PACKAGED DANGEROUS GOODS IN THE BALTIC SEA AREA

IMDG CLASS 1
(EXPLOSIVES)

FIGURE 3.2

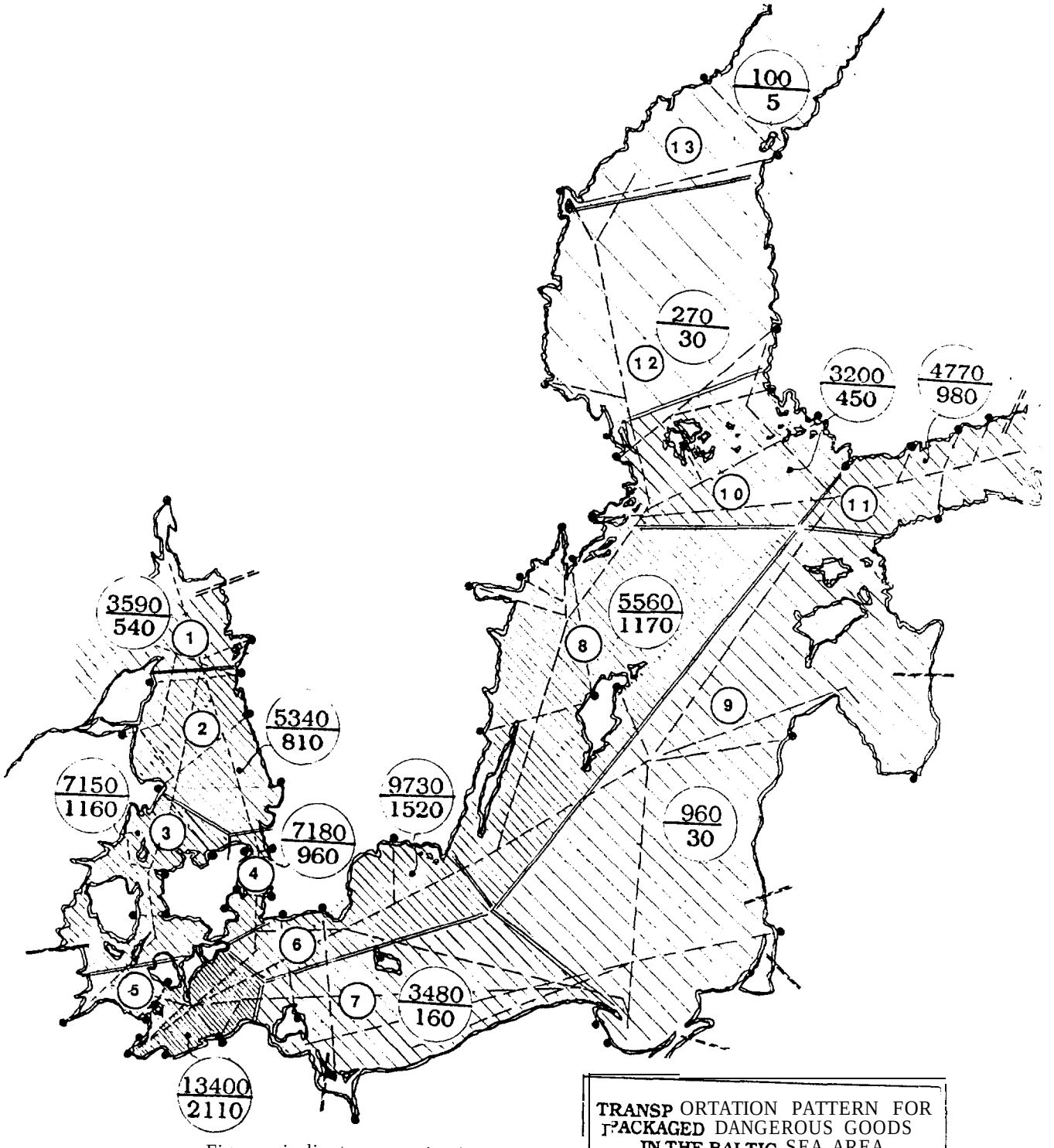


Figures indicate approximate shipments per month.
Quantity (tons)
Number (of parcels]

TRANSPORTATION PATTERN FOR PACKAGED DANGEROUS GOODS IN THE BALTIC SEA AREA

IMDG CLASS 2 (GASES)

FIGURE 3.3

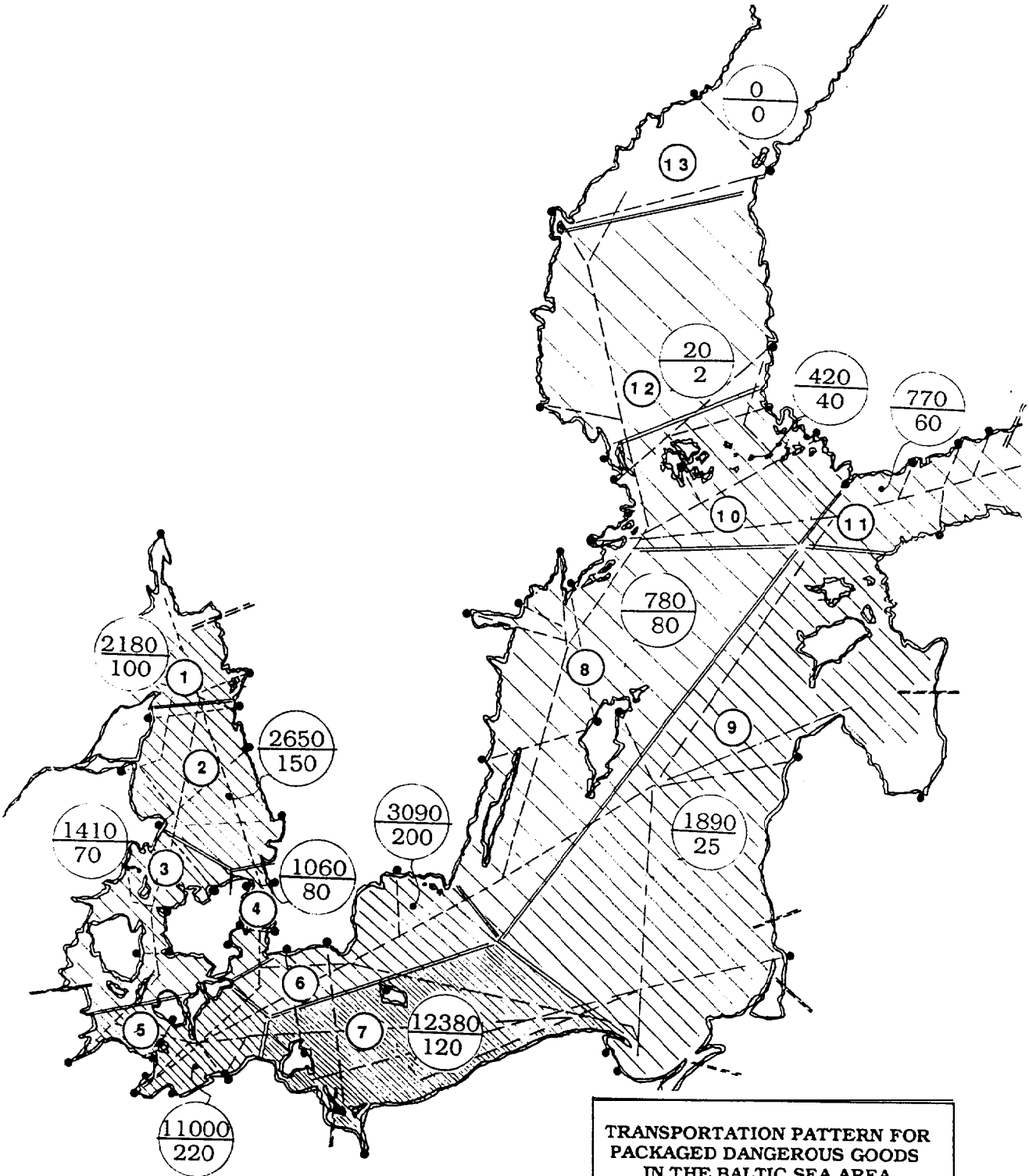


Figures indicate approximate shipments per month.
Quantity (tons)
Number (of parcels)

TRANSPORTATION PATTERN FOR PACKAGED DANGEROUS GOODS IN THE BALTIC SEA AREA

IMDG CLASS 3
(INFLAMABLE LIQUIDS)

FIGURE 3.4

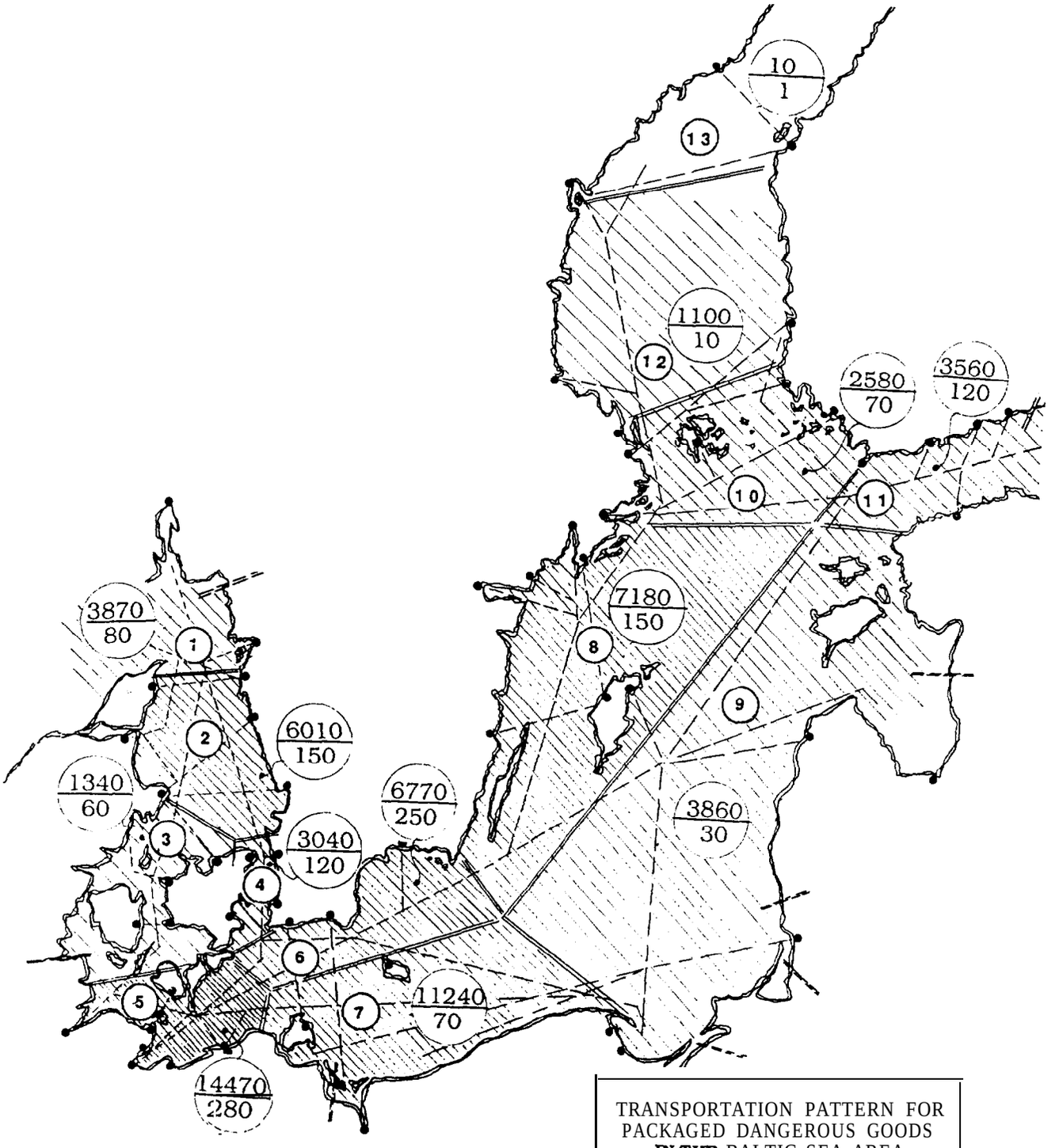


Figures indicate approximate shipments per month.
Quantity (tons)
Number (of parcels)

TRANSPORTATION PATTERN FOR PACKAGED DANGEROUS GOODS IN THE BALTIC SEA AREA

IMDG CLASS 4 (INFLAMABLE SOLIDS)

FIGURE 3.5

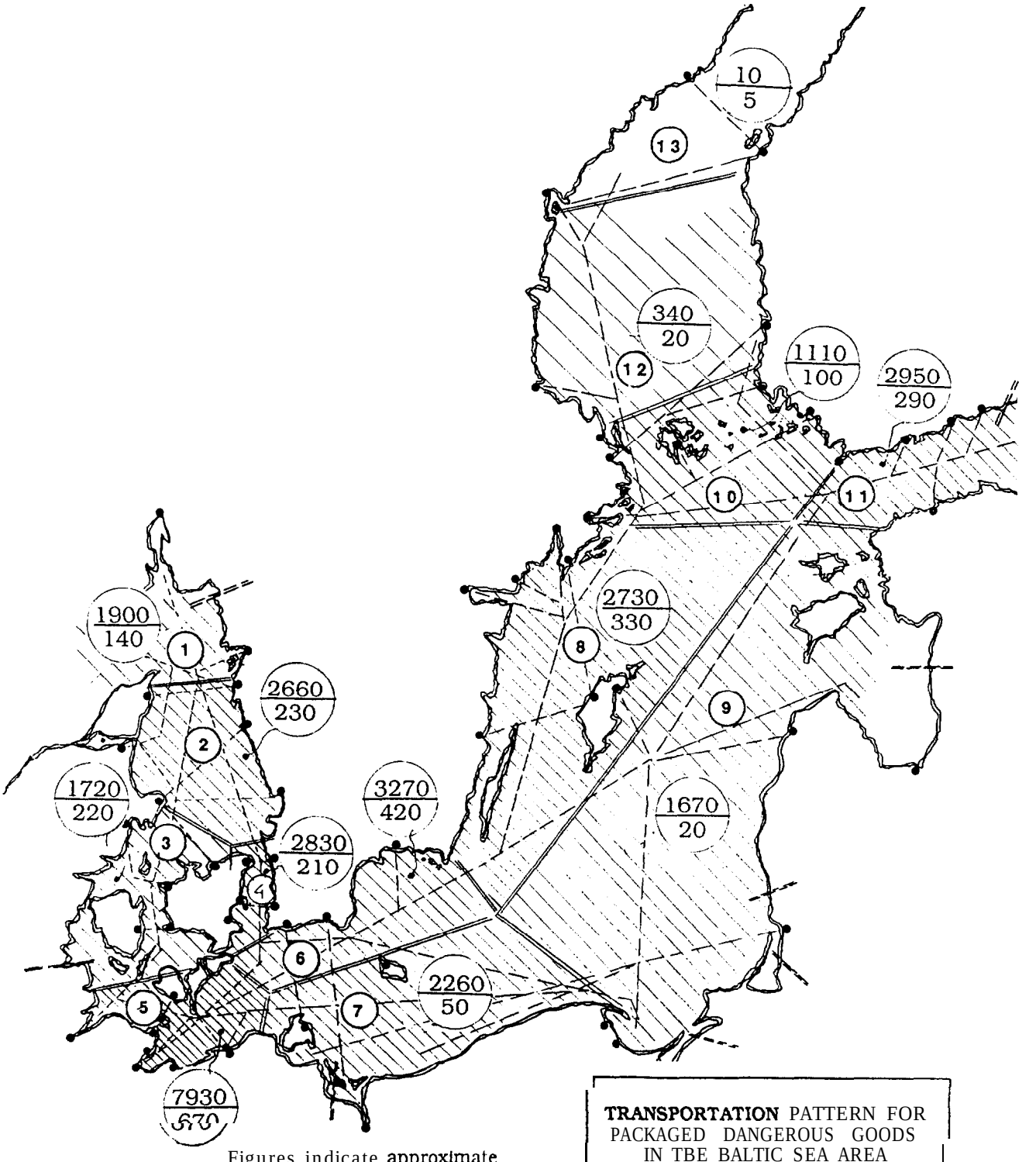


Figures indicate approximate shipments per month,
Quantity (tons)
Number (of parcels)

TRANSPORTATION PATTERN FOR PACKAGED DANGEROUS GOODS IN THE BALTIC SEA AREA

IMDG CLASS 5
(OXIDIZING SUBSTANCES)

FIGURE 3.6

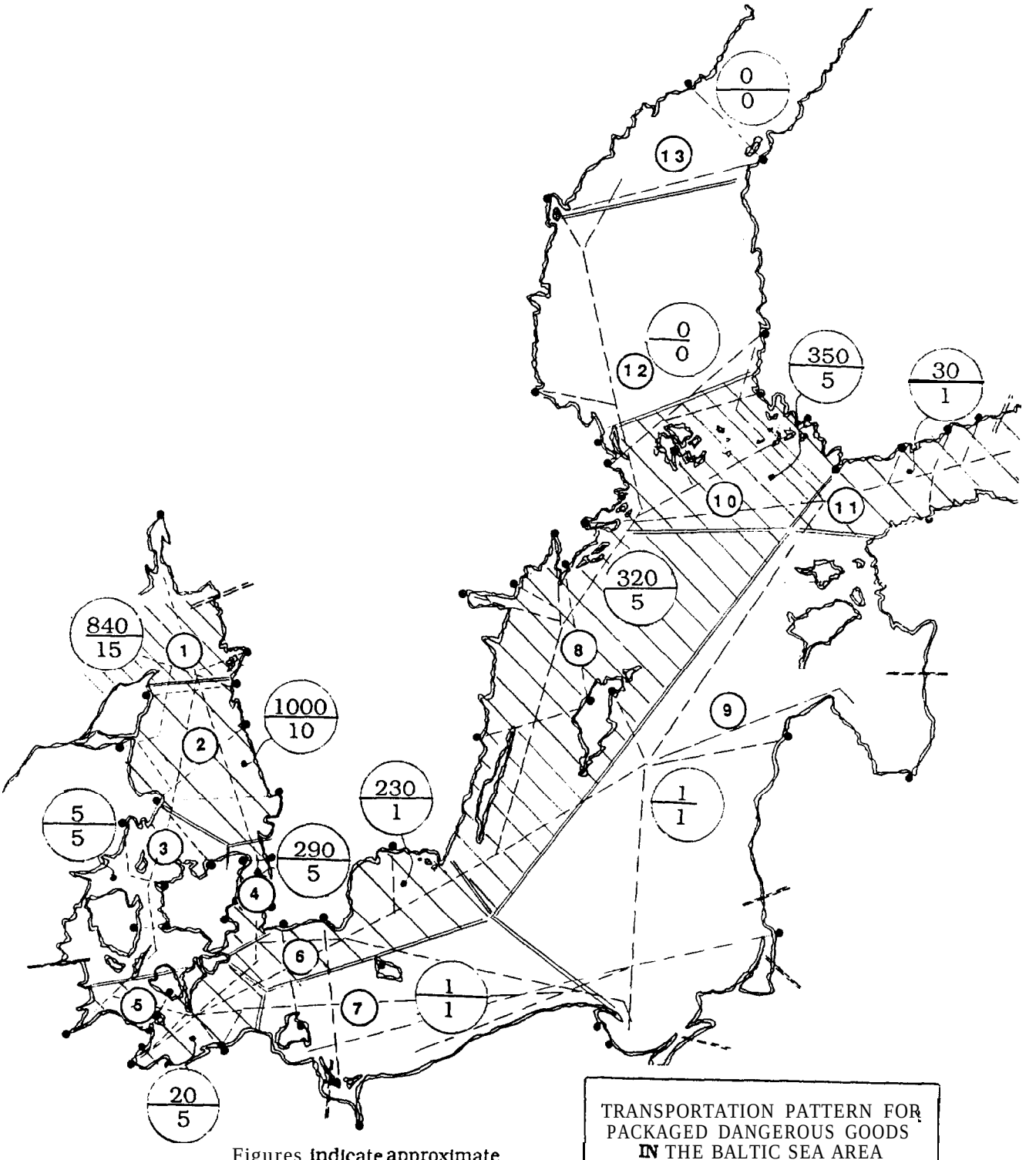


Figures indicate approximate shipments per month,
Quantity (tons)
Number (of parcels)

TRANSPORTATION PATTERN FOR PACKAGED DANGEROUS GOODS IN TBE BALTIC SEA AREA

IMDG CLASS 6
(POISONOUS SUBSTANCES)

FIGURE 3.7

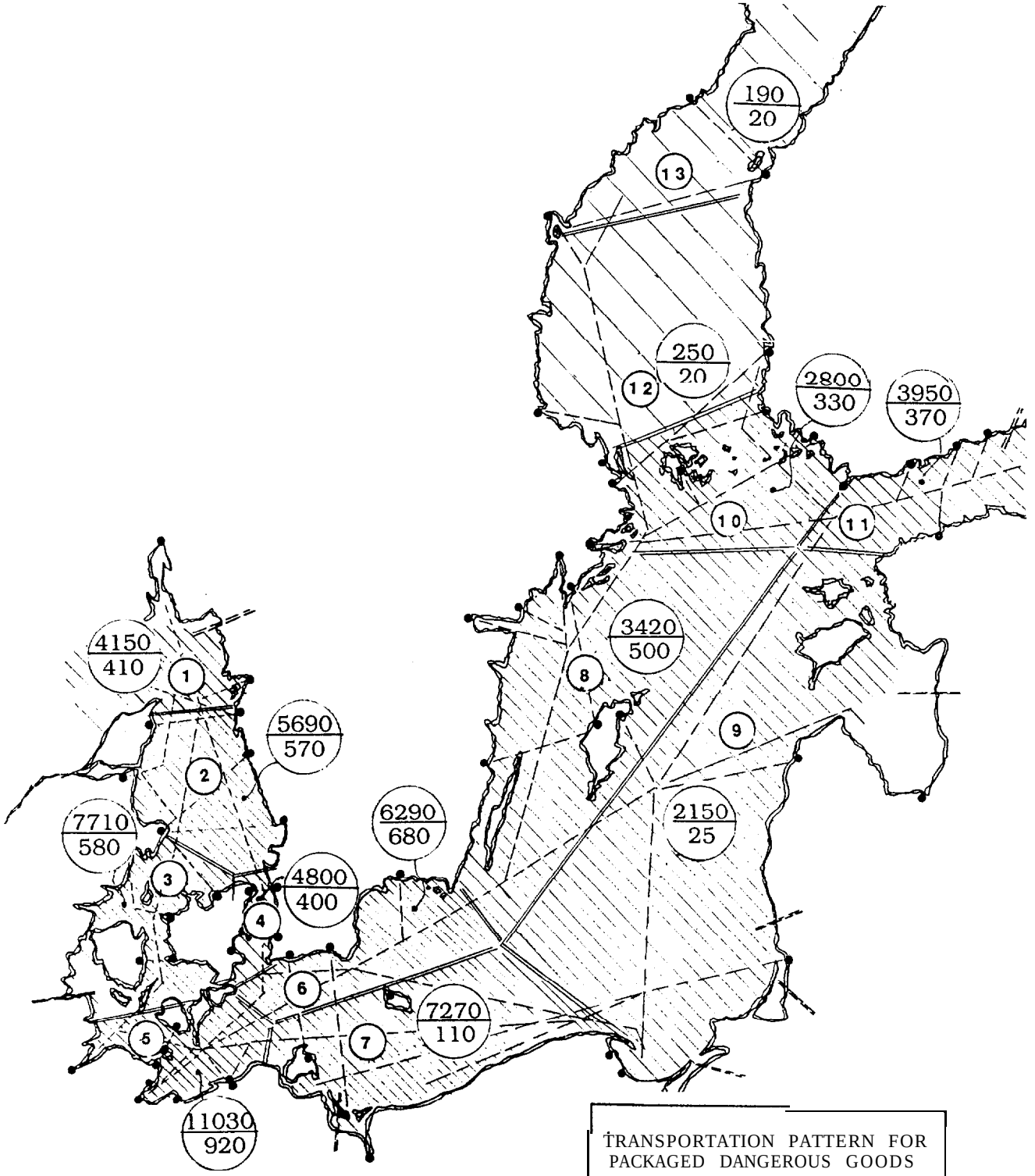


Figures indicate approximate shipments per month,
Quantity (tons)
Number (of parcels)

TRANSPORTATION PATTERN FOR PACKAGED DANGEROUS GOODS IN THE BALTIC SEA AREA

IMDGcLASs7
(RADIOACTIVE MATERIALS)

FIGURE 3.8

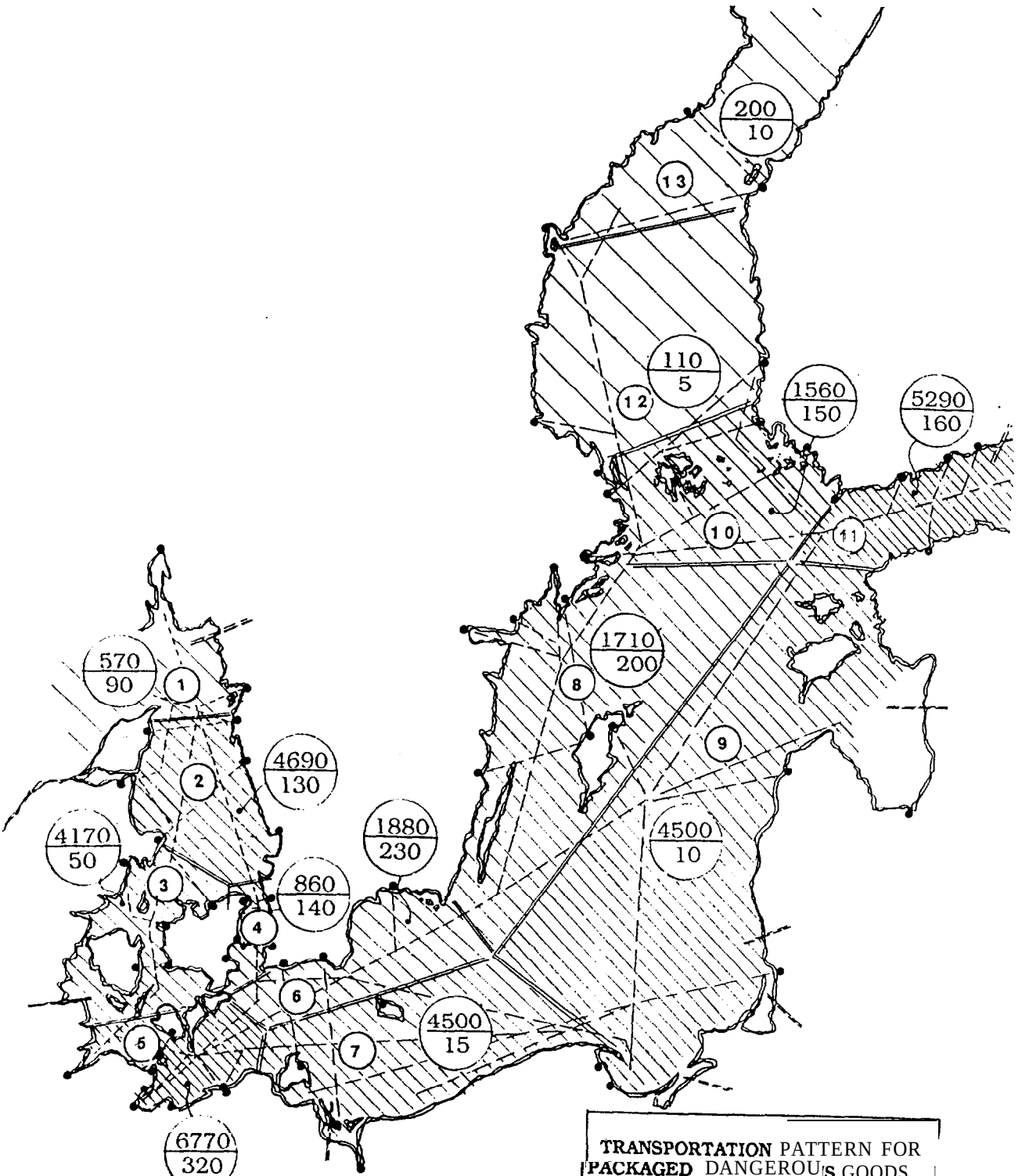


Figures indicate approximate shipments per month.
Quantity (tons)
Number [of parcels]

TRANSPORTATION PATTERN FOR PACKAGED DANGEROUS GOODS IN THE BALTIC SEA AREA

IMDG CLASS 8 (CORROSIVES)

FIGURE 3.9



Figures indicate approximate shipments per monlh.
Quantity [Ions]
Number (of parcels)

TRANSPORTATION PATTERN FOR **PACKAGED** DANGEROUS GOODS IN THE BALTIC SEA **AREA**

XMDG **CLASS** 9
(MISCELLANEOUS)

FIGURE 3.10

Table 3
OVERVIEW OF **SIGNIFICANT** SUBSTANCES SHIPPED
IN THE **BALTIC** **A AREA AS PACKAGED DANGEROUS GOODS**

Sea area	Substance				Significant shipments per month		
	Class	UN-No	Mar poll	Name	Number	Quantity tons	% of all dangerous goods
1 and 2. Skagerack and Kattegatt	8	1823		Sodium hydroxide	30	1500	4,7
	5	1495		Sodium chlorate	25	1400	4,4
	3	1263	(P)	Paint	140	1300	4,1
	6	1759	(P)	Corrosive solids, n.o s.	60	1300	4,1
	3	1993	(P)	Inflamable liquids, n.o.s.	100	1000	3,2
	7	2982		Radioactive subst, n.o.s.	10	900	2,8
	all	all		All packaged dangerous goods	2400	31600	100,0
3 Danish waters	3	misc	(P)	Waste	100	2500	8,8
	8	1830		Sulphuric acid	70	1100	3,9
	8	2031		Nitric acid	30	1000	3,5
	8	1789		Hydrochloric acid	40	1000	3,5
	2	1073		Oxygen. liquid	40	950	3,3
	4	2448		Sulphur, molten	30	800	2,8
	all	all		All packaged dangerous goods	2600	28500	100,0
4 Öresund	8	1789		Hydrochloric acid	50	1200	5,6
	3	1263	(P)	Paint	150	1100	5,1
	6	1935	P	Cyanide solution	15	600	2,8
	6	2312		Phenol, molten	15	600	2,8
	8	1830		Sulphuric acid	25	600	2,8
	3	1993	(P)	Flamable liquid	60	550	2,5
	all	all		All packaged dangerous goods	2200	21600	100,0
5 Kieler Bight	5	2067		Ammonium nitrate fertilizer	10	9000	13,2
	4	1402		Calcium carbide	5	8000	11,7
	2	1017		Chlorine	80	2400	3,5
	3	1263	(P)	Paint	500	2000	2,9
	8	1726		Aluminium chloride	1	1500	2,2
	9	2211		Polystyrene beads	50	1000	1,5
	all	all		All packaged dangerous goods	5000	68300	100,0
6 Swedish south coast	5	1942		Ammonium nitrate	10	1500	4,2
	3	1263	(P)	Paint	200	1200	3,4
	8	2067		Ammonium nitrate fertilizer	1	900	2,5
	8	1760	(P)	Corrosive liquid, n.o s.	10	800	2,2
	5	1466		Potassium nitrate	8	700	2,0
	5	1495		Sodium chlorate	10	500	1,4
	all	all		All packaged dangerous goods	3700	35700	100,0
7 Baltic Sea south coast	5	2067		Ammonium nitrate fertilizer	12	12000	27,0
	4	1402		Calcium carbide	5	8000	18,0
	8	1726		Aluminum chloride	1	1500	3,4
	5	1942		Ammonium nitrate	20	1500	3,4
	8	1823		Sodium hydroxide. solid	5	1000	2,3
	3	1263	(P)	Paint	20	600	1,4
	all	all		All packaged dangerous goods	650	44400	100,0
6 Baltic Sea, western part	5	1942		Ammonium nitrate	6	2000	8,7
	3	1866	(P)	Resin solution	160	1400	6,1
	5	2067		Ammonium nitrate fertilizer	5	1000	4,3
	3	1993	(P)	Flamable liquid, n.o.s.	150	700	3,0
	5	1495		Sodium chlorate	7	500	2,2
	7	2982		Nuclear waste	3	330	1,4
	all	all		All packaged dangerous goods	2700	23000	100,0
9 Baltic Sea, eastern part	9			Unknown	1	4000	26,5
	8	1726		Aluminium chloride	1	1500	9,9
	5	1942		Ammonium nitrate	10	700	4,6
	8	1759	(P)	Corrosive solids, n.o.s.	50	700	4,6
	6	1689	(P)	Sodium cyanide	2	600	4,0
	all	all		All packaged dangerous goods	150	15100	100,0
10 The Åland Sea	9	2211		Polystyrene beads	40	4800	37,5
	3	1866	(P)	Resin solution	100	1100	8,6
	3	1263	(P)	Paint	120	800	6,3
	8	1759	(P)	Corrosive solids, n.o.s.	50	600	4,7
	5	1942		Ammonium nitrate	10	500	3,9
	7	2982		Nuclear waste	3	330	2,6
	all	all		All packaged dangerous goods	1200	12800	100,0
11 Gulf of Finland	9	2211		Polystyrene beads	80	1600	7,4
	3	1866	(P)	Resin solution	160	1400	6,5
	5	2014		Hydrogen peroxide sol	90	900	4,2
	3	1993	(P)	Inflamable liquids. n.o.s.	120	600	2,8
	6	2489		MDI	80	600	2,8
	5	1942		Ammonium nitrate	10	500	2,3
	all	all		All packaged dangerous goods	2200	21500	100,0
12 and 13 Gulf of Bothnia	9	2211		Polystyrene beads	30	700	26,9
	4	1486		Potassium nitrate	10	200	7,7
	8	1838		Titanium tetrachloride	15	200	7,7
	3	1131	P	Carbon disulphide	10	160	6,2
	8	2789		Acetic acid	5	150	5,8
	6	2811	P	Poisonous solids, n.o.s.	10	150	5,8
	all	all		All packaged dangerous goods	150	2600	100,0

Table 4

LIST OF SUBSTANCES CARRIED AS PACKAGED OANGEROUS GOODS

Substances shipped in 3 parcels or more per month.

A = UN Number

B = IMDG Class

C = shipments per month

D = Marine pollutant "P", conditional marine pollutant "(P)" or severe marine pollutant "PP"

A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
12	1	87		1120	3	7		1364	4	13		1806	8	19		2055	3	31	P	2734	8	5	P
14	1	3		1123	3	16		1378	4	3		1810	8	3		2056	3	6		2735	8	64	P
27	1	4		1131	3	32	P	1384	4	12		1813	8	41		2059	3	23		2757	6	4	P
44	1	9		1133	3	212	(P)	1396	4	17		1814	8	101		2060	3	4		2788	6	4	PP
55	1	6		1139	3	80	(P)	1402	4	18		1819	8	3		2067	5	12		2709	a	19	
65	1	4		1142	3	38	(P)	1405	4	7		1821	8	6		2074	6	12		2790	8	18	
81	1	20		1145	3	4		1408	4	57		1823	8	98		2076	6	3	P	2794	a	133	
82	I	4		1148	3	3		1418	4	3		1824	8	153		2078	6	19		2795	8	19	
137	1	3		1154	3	3		1428	4	6		1830	8	101		2079	8	11		2796	8	30	
160	1	3		1155	3	7		1436	4	7		1836	8	3		2080	5	3		2798	8	6	
161	1	9		1165	3	3		1444	5	10		1838	a	19		2087	5	9		2800	8	12	
168	1	3		1168	3	12		1463	5	13		1a40	a	6	P	2093	5	4		2801	8	9	P
195	1	11		1169	3	15	P	1474	5	3		1845	9	4		2110	5	4		2809	8	3	
197	1	3		1170	3	135		1477	5	3		1846	6	5		2118	2	3		2810	6	95	(P
209	1	4		1171	3	5		1479	5	10		1849	8	8		2187	2	13		2811	6	71	(P
241	1	4		1172	3	7		1485	5	10		1866	3	503	(P	2206	6	16	P	2813	3	1s	
323	1	12		1173	3	55		1486	5	22		1873		3		2207	6	9	P	2819	8	3	
334	1	9		1188	3	3		1489	5	6		1884	3	3		2209	6	46		2831	6	54	
335	1	23		1193	3	14		1492	5	5		1888	6	7	P	2211	9	218		2846	4	6	
336	1	22		1197	3	35	(P)	1493	5	7		1897	6	14	P	2213	4	11		2874	6	24	
337	1	7		1198	3	3		1495	5	53		1903	8	3		2214	8	11		2876	6	6	
360	1	4		1199	3	4		1498	5	15		1908	5	7		2215	8	I6		2895	5	3	
409	1	3		1202	3	27		1500	5	13		1915	3	4		2218	8	17		2902	6	21	(P
431	1	28		1203	3	34	P	1505	5	5		1935	6	23	P	2265	3	7		2910	7	4	
432	1	9		1206	3	24		1547	6	4		1940	5	4		2282		3		2911	7	5	
484	1	3		1208	3	9		1561	6	8	P	1942	5	55		2286	3	3		2912	7	5	
1001	2	47		1210	3	120		1564	6	12	P	1944	4	45		2269	8	12		2918	7	5	
1002	2	8		1212	3	3		1586	6	4	P	1950	9	493		2291	6	9	P	2920	8	17	P
1005	2	41		1219	3	78		1588	6	5	P	1951	2	18		2303'		a		2922	8	6	P
1006	2	25		1220	3	8		1593	6	9		1953	2	5		2312	6	22		2924	3	17	
1009	2	7		1223	3	53		1593	6	2s		1954	2	10		2315		5		2927	6	11	
1010	2	20		1226	3	18		1602	6	5		1955	2	44		2327		3		2929	6	15	P
1011	2	28		1230	3	28		1604	6	28		1956	2	32		2331	8	5	P	2949		3	
1012	2	17		1245	3	13		I648	3	6		1959	2	3		2348	3	13		2966	6	4	
1013	2	44		1247	3	45		1649	6	3	P	1962	2	4		2357	3	3		2967	8	16	
1016	2	7		1262	3	4		1662	6	4		1965	2	22		2368	3	la		2974	8	3	
1017	2	59		1263	3	1208	(P)	1664	6	a		1966	2	3		2369	6	19		2977	7	7	
1018	2	22		1265	3	3		1671	6	12		1969	2	11		2439	6	5		2978		9	
1028	2	16		1266	3	198	(P)	1680	6	5	P	1971	2	5		2448	4	9		2982	7	4	
1037	2	9		1268	3	26	(P)	1689	6	9	P	1973	2	6		2449	6	8		2984	5	5	
1040	2	9		1270	3	9		1690	6	6		1977	2	17		2465	5	3		2990	9	3	
1044	2	27		1271	3	24		1710	6	11	P	I978	2	14		2484	3	4		3017	6	8	P
1046	2	17		1274	3	11		1715	a	10		1980	2	4		2489	6	184		3019	6	a	PP
1049	2	18		1280	3	3		1719	8	69	P	1985	3	5		2491	8	25		3045	5	3	
1050	2	13		1282	3	3		1726	8	4		1987	3	22	(P	2517	2	6		3051	4	5	
1053	2	4		1287	3	9	P	I727	8	3		1992	3	24	(P	2531	8	6		3070		5	
1057	2	47		1289	3	3		1748	5	5		1993	3	452	(P	2550	5	10		3090	9	6	
1060	2	7		1292	3	3		1750	8	13		1999	3	38	P	2556	4	28		3149	3	3	
1063	2	3		1294	3	41		I755	a	9		2000	4	3		2557	4	28		3153		4	
1066	2	48		1296	3	14		1759	a	175	(P	2006	4	4		2579	8	12		vaste	3	82	(P
1070	2	64		1299	3	17	P	1760	a	291	(P	2011	4	24		2581	8	7		vaste	6	21	(P
1072	2	38		1300	3	77		1775	a	9		2014	5	76		2582	8	14					
1073	2	26		1306	3	9	P	1778	8	10		2015	S	3		2585	8	4					
1078	2	3		1307	3	31		1779	8	24		2023	6	a		2586	8	55					
1079	2	17		1309	3	16		1780	8	3		2030	8	7		2651	6	3					
1080	2	6		1325	4	34	(P)	1789	a	99		2031	a	39		2657	6	3					
1083		7		1327	4	5		1790	8	33		2038	2	3		2659	6	7					
1089	3	4		1345	4	4		1791	8	45		2045	3	7		2672	8	24					
1090	3	74		1350	4	30		1794	8	4		2051	3	6		2680	a	3					
i093	3	24		1361	4	7		1805	a	86		2052	3	12		2686	3	4					

Table 5
LIST OF **SUBSTANCES CARRIED AS PACKAGED DANGEROUS GOODS**
Substances shipped in 20 parcels or more mer month

a = more than 500 parcels per month
b = 100 - 500 parcels per month
c = 50 100 parcels per month
d = 20 - 50 parcels per month

Class	UN-No	Name	Mar poll	Parcels /month
3	1263	Paint	(P)	a
3	1866	Resin solution	(P)	a
9	1950	Aerosols		a
3	1993	Flammable liq, n.o.s.	(P)	b
3	1133	Adhesives	(P)	b
3	1170	Ethanol		b
3	1210	Printing ink		b
3	1266	Cosmetics, inllamable	(P)	b
6	2489	Diphenylmethane		b
8	1759	Corrosive solid, n.o.s.	(P)	b
8	1760	Corrosive liquid, n.o.s.	(P)	b
8	18 14	Potassium hydrox. sol.		b
8	1823	Sodium hydrox. solid		b
8	1824	Sodium hydrox. sol.		b
8	1830	Sulphuric acid		b
8	2794	Acid filled batteries		b
9	22 11	Polystyrene beads		b
1	12	Cartridges		c
2	1001	Acetylene		c
2	1017	Chlorine	P	c
2	1070	Nitrous oxide		c
3	1090	Acetone		c
3	1139	Coating solution	(P)	c
3	11 73	Ethyl acetate		c
3	1219	Isopropanol		c
3	1223	Kerosene		c
3	1247	Methyl metachrylate		c
3	1294	Toluene		c
3	1300	White spirit		c
3	waste	Misc	(P)	c
4	1408	Ferrosilicone		c
5	1495	Sodium chlorate		c
5	1942	Ammonium nitrate		c
5	20 14	Hydrogen peroxide aqu		c
6	28 10	Toxic liquid, n.o.s.	(P)	c
6	281 1	Toxic solids, n.o.s.	(P)	c
6	2831	Methyl chloroform		c
8	17 19	Caustic alkali liq		c
8	1789	Hydrochloric acid sol.		c
8	1805	Phosphoric acid sol.		c
8	2586	Alkyl sulphonic acid		c
8	2735	Alkylamines	P	c
1	8 1	Explosives		d
1	335	Fireworks		d
1	336	Fireworks		d
1	431	Pyrotechnicals		d
2	1955	Toxic gas, n.o.s.		d
2	1956	Compr or liq gas, n.o.s.		d
2	1965	Hydrocarbon gas, n.o.s		d
2	1005	Ammonia liq		d
2	1006	Argon		d
2	1010	Butadiene		d
2	10 11	Butane		d
2	10 13	Carbon dioxide		d
2	1018	Chlorodifluormethane		d
2	1044	Fire ext w compr gas		d
2	1057	Lighters/refills		d
2	1066	Nitrogen		d
2	1072	Oxygen, compr		d
2	1073	Oxygen, liq		d
3	1987	Alcohols, n.o.s.	(P)	d
3	1992	Toxic flam liq, n.o.s.	(P)	d
3	1999	Tar liq, asphalt	P	d
3	2055	Styrene monomer	P	d
3	2059	Nitrocellulose sol.		d
3	1093	Acrylonitrile		d
3	113 1	Carbon disulphide	P	d
3	11 42	Inflamable liquid	(P)	d
3	11 97	Flavouring liq	(P)	d
3	1202	Gas oil		d
3	1203	Gasoline	P	d
3	1206	Heptanes		d
3	1230	Methanol		d
3	1268	Petroleum destillate	(P)	d
3	1271	Petroleum spirit		d
3	1307	Xylene		d
4	1944	Safety matches		d
4	20 11	Magnesium phosphite		d
4	2556	Nitrocellulose		d
4	2557	Nitrocellulose		d
4	1325	Flammable solid, n.o.s.	(P)	d
4	1350	Sulphur		d
5	1486	Potassium nitrate		d
6	1935	Cyanide solution	P	d
6	2209	Formaldehyde sol.		d
6	23 12	Phenol, molten		d
6	2874	Furfuryl alcohol		d
6	2902	Pesticides. liq, n.o.s.	(P)	d
6	waste	Misc	(P)	d
6	1593	Dichloromethane		d
6	1604	Ethylenediamine		d
8	1779	Formic acid		d
8	1790	Hydrofluoric acid sol.		d
8	1791	Hypochlorite sol.		d
8	1813	Potassium hydrox. solid		d
8	2031	Nitric acid		d
8	2491	Ethanolamine		d
8	2672	Ammonia sol.		d
8	2796	Battery acid		d

Table 6
TRANSPORTATION OF PACKAGED DANGEROUS GOODS, SUMMARY
Approximate values for one month, routes with more than 100 tons

Between ports	Per month Tons	Number	Major classes	Between ports	Per month Tons	Number	Major classes
North Sea and Aalborg	150	120	3.1	Travemiinde and Malmö	3300	600	3,8,6
North Sea and Copenhagen	150	20	8	Travemünde and Rauma	160	40	8
North Sea and Gothenburg	13300	1100	8.5.3	Travemünde and Trelleborg	3200	560	3,8,5
North Sea and Hanko	350	10	5,1	Travemirnde and Turku	100	50	3
North Sea and Helsingborg	600	50	0.3	Kiellcanal and Aalborg	100	5	4.8
North Sea and Helsinki	60	10	8	Kiel/canal and Gdansk/Gdy	16200	60	4,5,8
North Sea and Kiel	1000	120	3,8	Kiellcanal and Gävle	160	5	5
North Sea and Kotka	400	30	5.8	Kiellcanal and Halmstad	130	5	3
North Sea and Leningrad	3900	1	9	Kiellcanal and Hamina	450	2.5	3
North Sea and Rostock	750	50	6.3	Kiellcanal and Helsingborg	950	75	3,8
North Sea and Uddevalla	240	25	1,4	Kiellcanal and Helsinki	6000	950	3,6,8,9
North Sea and Varberg	600	15	1	Kiellcanal and Kotka	140	5	5
North Sea and Wallhamn	700	40	8,3	Kiel/canal and Leningrad	2900	5	8,6
Gothenburg and Copenhagen	100	15	3	Kiellcanal and Mälaren	500	20	5
Gothenburg and Fredrikshavn	1200	150	3,2	Kiel/canal and Pori	1100	80	6,8
Gothenburg and Hanko	600	15	5.1	Kiel/canal and Aauma	130	20	8
Gothenburg and Helsinki	750	40	5,8	Kiellcanal and Riga	720	5	4,5
Gothenburg and Kiel	500	120	3,8	Kiel/canal and Stockholm	600	20	5,3
Gothenburg and Kotka	200	5	5	Kiellcanal and Sundsvall	750	1	5
Gothenburg and Travemünde	4200	420	3,2,5,8	Kiel/canal and Szczecin	5000	30	5,8
Copenhagen and Helsingborg	6300	320	3,6,8,4	Kiel/canal and Turku	700	120	8,6
Copenhagen and Helsinki	170	220	3	Kiellcanal and Ventspifs	710	1	6
Copenhagen and Malmö	370	90	8.9	Rostock and Riga	220	5	6
Aarhus and Gdansk/Gdy	300	1	5	Sassnitz and Trelleborg	9400	470	2,3,4,8
Aarhus and Kalundborg	350	20	8	Swinoujscie and Ystad	1500	30	2,3
Aarhus and Uddevalla	200	1	4	Klaipeda and Mukran	2000	35	4.8
Aalborg and Oskarshamn	120	5	4,8	Nynäshamn and Visby	100	5	3.8
Ebeltoft and Zealand	230	30	8	Oskarshamn and Visby	400	170	3,4
Grenaa and Hundestedt	700	50	3,4	Forsmark and Ringhals	200	1	7
Halsskov and Knudshoved	3800	250	8,3,4	Gdansk/Gdy and Helsinki	1000	15	5,6
Korsör and Nyborg	12000	1500	3,8,2,4	Gdansk and Mälaren	900	1	5
Helsingborg and Helsingör	5100	790	3,8,9	Gdansk/Gdy and Norrkdping	1000	5	5
Helsingborg and Helsinki	280	20	3,8	Gdansk/Gdy and Stockholm	350	1	5
Helsingborg and Kotka	290	5	5	Gdansk and Uddevalla	500	1	8
Hefsingborg and Turku	120	10	3	Hargshamn and Uusikaupunki	1600	200	9,3,5
Gedser and Warnemünde	800	60	3.8	Stockholm and Helsinki	1800	230	3,9,8
Puttgarden and Rödby	5500	400	3,6,2,8	Stockholm and Turku	3000	330	8,3
Travemirnde and Gedser	250	70	3	Kapellskär and Turku	120	25	3
Travemgnde and Hanko	1500	75	2,3	Holmsund and Vaasa	240	15	8
Travemünde and Helsinki	4600	1000	3,5,8	Sundsvall and Vaasa	200	15	9

'able 7
.ARGE QUANTITY SUBSTANCES
pproximate values for one month

Class	UN-No	Marine pollut	Name	Quantity tons	Number	Sea areas
2	10171		Chlorine	3200	120	3,5,6
3	1263	(P)	Paint	5000	800	all
3	1866	(P)	Resin solution	3100	350	1,2,4,5,6,8,10,11
3		(P)	Waste	2500	100	3;
3	1993	(P)	Inflamable liq. n.o.s.	1600	300	1,2,4,5,6,8,10,11
4	1402		Calcium carbide	7500	10	5,7,8
5	2067		Ammonium nitrate fertilizers	12000	10	5,7,8
5	1942		Ammonium nitrate	3000	40	6,7,8,9,10,11
5	1495		Sodium chlorate	1700	60	1,1
5	2014		Hydrogen peroxide sol	1230	120	5,6,8,10,11
6	1935	P	Cyanide solutions	1300	30	4.5
8	1759	(P)	Corrosive solids nos	2200	150	1,2,7,9,10
8	1726		Aluminium chloride	1600	1	5.7
8	1789		Hydrochloric acid	1200	50	3,4
8	1023		Sodium hydroxide, solid	1000	10	5.7
8	1760	(P)	Corrosive liquids nos	1000	120	5,6,8,10,11
6	1830		Sulphuric acid	1000	40	3,4
9	2211		Polystyrene beads	3000	150	10,11,12

'able 8
.ARGE INDIVIDUAL SHIPMENTS, examples

Class	UN-No	Marine pollut	Name	Quantity, tons	Sea areas
1	82		Explosives	400	1.2
2	to79		Sulphur dioxide, liquid	1100	6,7
3	1219		Isopropanol	500	5,7,9
4	1402		Calcium carbide	7000	5,7
4	1402		Calcium carbide	1400	5,7
4	1381		Phosphorous compound	600	7.9
4	1334	P	Naphtalene	400	5,7,9
5	1942		Ammonium nitrate	1900	8,9
5	1942		Ammonium nitrate	1500	5,6,8
5	2067		Ammonium nitrate lertilizer	2100	5.7
5	2067		Ammonium nitrate fertilizer	700	7,8
6	1689	P	Sodium cyanide	400	5,7,9
6	2078		Toluene diisocyanate	400	5,7,9
7	2902	P	Nuclear waste	400	2,4,6,8
8	1726		Aluminium chloride	1900	5.7.9
8	1023		Sodium hydroxide, solid	1000	2,4,6,7
9			unknown	7700	2,3,5,7,9

Table 9
OVERVIEW OF TRANSPORTATION OF PACKAGED DANGEROUS GOODS ON FERRY LINES

Sea areas	Between ports			luantity er month ons	Number of parcels per month	Quantity per trip, average tons	Number of parcels per ferry voyage
2	Fredrikshavn	and	Gothenburg	1200	160	4	0,8
2	Grenaa	and	Halmstad	50	15	0	0,2
2	Grenaa	and	Varberg	30	15	0	0,3
2,3,5	Gothenburg	and	Travemunde	4500	500	75	8,3
2,3,5	Gothenburg	and	Kiel	500	100	8	1,7
3	Aarhus	and	Kalundborg	350	20	2	0,0
3	Ebeltoft	and	Zealand	500	30	1	0,1
3	Grenaa	and	Hundestedt	750	50	3	0,3
3	Halsskov	and	Knudshoved	3900	250	6	0,1
3	Korsör	and	Nyborg	12000	1500	13	0,5
4	Copenhagen	and	Malmö	400	100	1	0,1
4	Copenhagen	and	Helsingborg	6300	330	10	1,1
4	Helsingör	and	Helsingborg	5100	800	1	0,1
4,5	Malmö	and	Travemiinde	3300	600	28	10,0
4,6	Copenhagen	and	Rönne	80	40	5	1,6
5	Gedser	and	Travemünde	300	70	2	0,2
5	Gedser	and	Warnemünde	800	70	7	0,1
5	Puttgarden	and	Rödby	5500	400	9	0,2
5,6	Trelleborg	and	Travemunde	3200	600	21	4,0
5,6	Rostock	and	Trelleborg	30	1	0	0,0
5,6,8,1C	Hanko	and	Travemiinde	1500	80	25	1,3
5,6,8,11	Helsinki	and	Travemunde	4600	1000	77	8,3
6,7	Sassnitz	and	Trelleborg	9400	480	31	1,6
6,7	Swinoujscie	and	Ystad	1500	30	5	0,3
7,9	Klaipeda	and	Mukran	2000	40	67	0,7
8	Nynäshamn	and	Visby	200	10	2	0,2
8	Oskarshamn	and	Visby	400	160	7	1,6
10	Hargshamn	and	Uusikaupunki	1700	200	14	1,0
10	Helsinki	and	Stockholm	1800	230	15	1,9
10	Kapellskär	and	Turku	100	30	1	0,3
10	Stockholm	and	Turku	3000	350	12	1,2
10.11	Stockholm	and	Tallin	90	3	10	0,2
13	Holmsund	and	Vaasa	240	20	1	0,2
13	Sundsvall	and	Vaasa	200	20	3	0,3
all		total		75520	8304	6	0,4

6. Packaging and Shin Types.

Requirements on packaging and labelling of dangerous goods and specific stowage requirements, where applicable, are detailed in the IMDG Code for each substance. Additionally those substances being identified as "marine pollutants" or "severe marine pollutants" come under the requirements of Annex III of MARPOL 73/78, detailing additional requirements on packaging, labelling, marking and documentation.

Available information about types of packaging is summarised in Table 10. Detailed information regarding the prime containment, e.g. sacks, drums etc, is only available for a relatively small portion of the total number of shipments and the information may therefore not be regarded as fully representative. Generally, individual parcels are carried stowed in containers or on trailers/trucks. Large quantities of base material substances are shipped in sacks or drums and may be loaded in the holds of conventional cargo ships. The latter mode of shipment represents a small number of shipments but accounts for large quantities as most of the biggest individual shipments are carried in this way.

Table 11 shows the quantity and number of parcels carried on different types of vessels. The table shows that the major part of the shipments are made on ferries, both by quantity and number. Roro vessels (other than passenger ferries) and conventional vessels are the second biggest carriers by quantity. The number of shipments by conventional vessels is relatively low, although the quantities may be large.

Insufficient information has been available from the questionnaires regarding the actual stowage of the parcels of packaged dangerous goods onboard the vessel. The large portion of the parcels being carried on ferries is generally contained in trailers, trucks, containers or railcars. stowed on the vehicle decks in the vessels and to some extent on open deck on ferries of pronounced cargo type. A large portion of the substances are in liquid or liquified form, carried in tank trucks, tank trailers or railroad tanks.

Shipments of more irregular type are most often loaded as consolidated cargo in containers and these containers may be stowed in cargo holds or on deck of container vessels, ro-ro vessels or conventional cargo vessels. A small number of shipments representing large quantities are however, as indicated above, loaded in conventional cargo vessels, packed in sacks or drums.

7. Environmental and Human Hazards.

The environmental hazard has been evaluated in the international codes all chemicals being shipped as packaged dangerous goods. The IMDG Code identifies such substances as being "marine pollutants" or, for a relatively small number of substances, "severe marine pollutants".

25 of the 100 substances carried most frequently in the Baltic Sea area are classified as marine pollutants or potential marine pollutants. Several of these are, however, shipped frequently and about 50% of all parcels being shipped are marine pollutants or potential marine pollutants. Potential marine pollutants here refers to substances coming under a group UN number which identifies substances which may or may not be pollutants, e.g. paints and laquers.

Substances are listed in the IMDG code because they pose a hazard to human activities and to personnel engaged in the transportation, also when the substance causes no harm to the marine environment. Table 12 lists significant substances being shipped in the Baltic Sea area and which have highly hazardous characteristics.

The hazardous nature of these substances is in most cases related to the risk for a fire onboard. For some of the substances also the release of the material without a fire, e.g. due to damage to the ship or the cargo containment, may cause hazardous conditions for the crew and the rescue personnel.

Explosives, propane, carbon disulphide, propylene oxide, cellulose nitrate, hydrogen peroxide and sodium chlorate all contribute to a hazard of explosion in conjunction with a fire, alone or in combination with flamable materials. Carbon disulphide gases ignite already at about 100° C, phosphorous auto-ignites if exposed to air. Also nitric acid and perchloric acid may contribute to fire in combination with organic materials.

Some of the inflamable substances develop highly toxic gases when burning. This applies for instance to carbon disulphide and potassium cyanide. Some substances in Table 12 are non-flamable but develop highly toxic gases when exposed to a fire, this applies for instance to chlorine, chloroform, nitric acid and perchloric acid.

The shipping pattern for some of these substances, being shipped most frequently, has been analysed separately. Figures 4.1 to 4.10 illustrate the shipment pattern for these substances, including the transportation activity per sea area and identification of major shipping routes. This information is related to the period of investigation and should be regarded as an illustration, shipment of highly hazardous substances may during other time periods take place also outside the patterns illustrated in these figures.

Table 10
OVERVIEW OF CONTAINMENT OF PACKAGES
Based on available information from a two month period

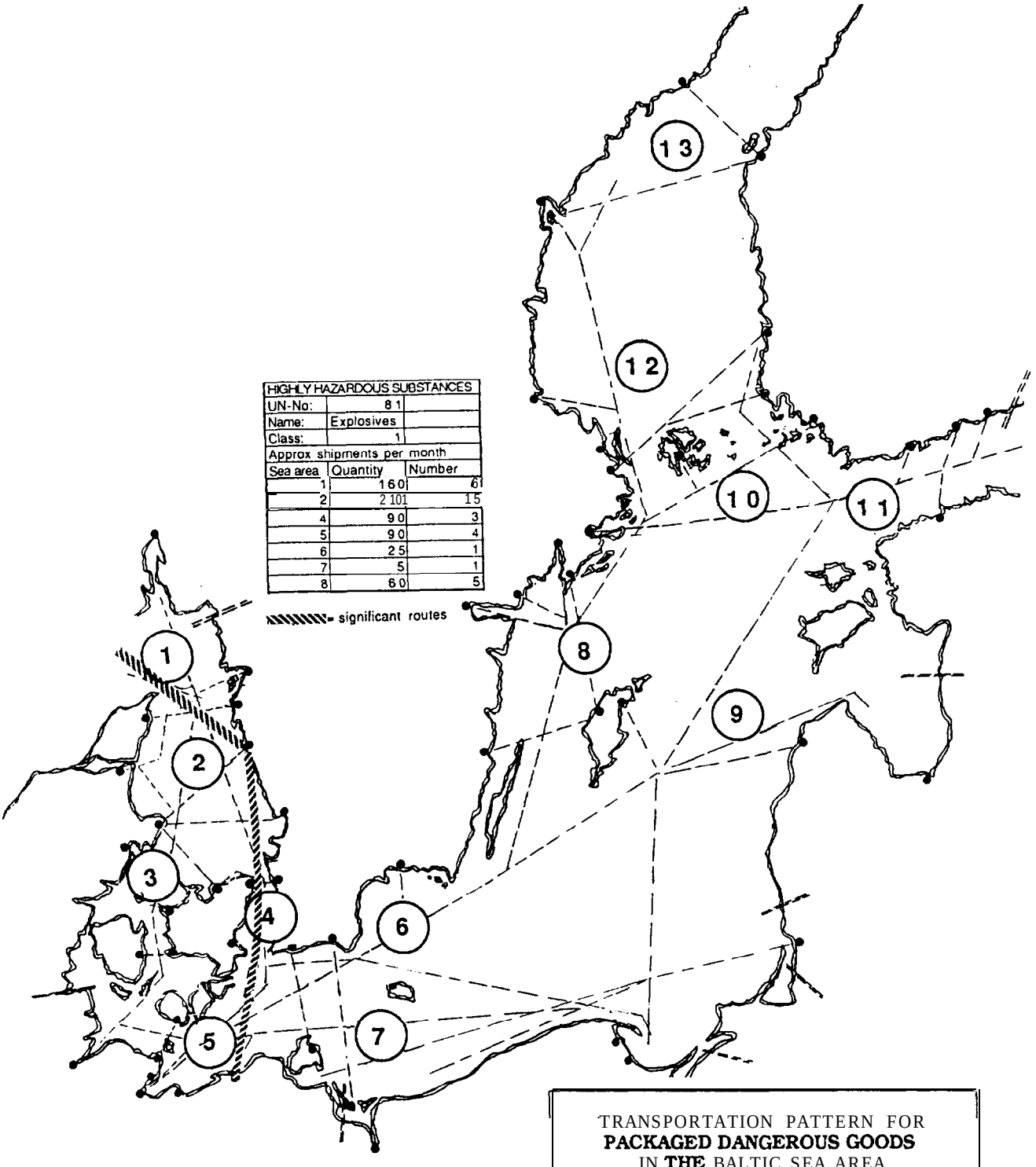
Type of containment	Quantity tons	Number of parcels	Average parcel size, tons	Percentage (by quantity)
Prime containment				
Barrels, drums, cans	39000	500	78	59
Tanks (incl railr.)	14000	600	23	21
Bags, sacks	11000	60	183	17
Cases, boxes, package	2000	400	5	3
Cylinders	500	80	6	1
Carrier				
Trailer	29000	6100	5	35
Container	24000	2400	10	29
Loose, other	15000	400	38	19
Railroad car	8000	250	32	10
Tank	6000	400	15	7

Table 11
OVERVIEW OF SHIP TYPES
Based on available information from a two month period

Ship type	Quantity tons	Number of parcels	Average parcel size, tons
Ferry	144000	134001	11
Conventional	53300	600	89
Roro	41200	6000	7
Container	15000	1200	13
Other	6700	400	17
Special	3001	3	100
Total	2605001	216001	12

Table 12
EXAMPLES OF HIGHLY HAZARDOUS SUBSTANCES
ARRIED AS PACKAGED DANGEROUS GOOD!

Class	UN-No	Name	Parcels per month	Quantity per month	Main sea areas
1	0027128	Black powder	5	151	2.3.5
1	72	Cyclonite	2	10	4.5
1	81182	Blasting explosives	25	300	1,2,4,5
2	1017	Chlorine	70	3700	2,3,4,6,7
2	1978	Propane	10	40	4,5,7,9,11
3	1131	Carbon disulphide	40	800	5,6,7,9,11
3	1280	Propylene oxide	5	80	4,5
4	1381	Phosphorous	1	25	7,9
4	2556	Cellulose nitrate	20	130	5,6
5	2014	Hydrogen peroxide	75	2000	2,5,7,9
5	1495	Sodium chlorate	110	4 100	1,2,5,6,7
6	1680	Potassium cyanide	5	5	5,11
6	1888	Chloroform	10	15	5,7,9,11
7	2974182	Radioactive materials	5	1000	1,2
7	2977	Uranium hexafluoride	10	350	2,4,6,8,10
8	1802	Perchloric acid	1	15	7.9
8	2031132	Nitric acid	50	1000	3



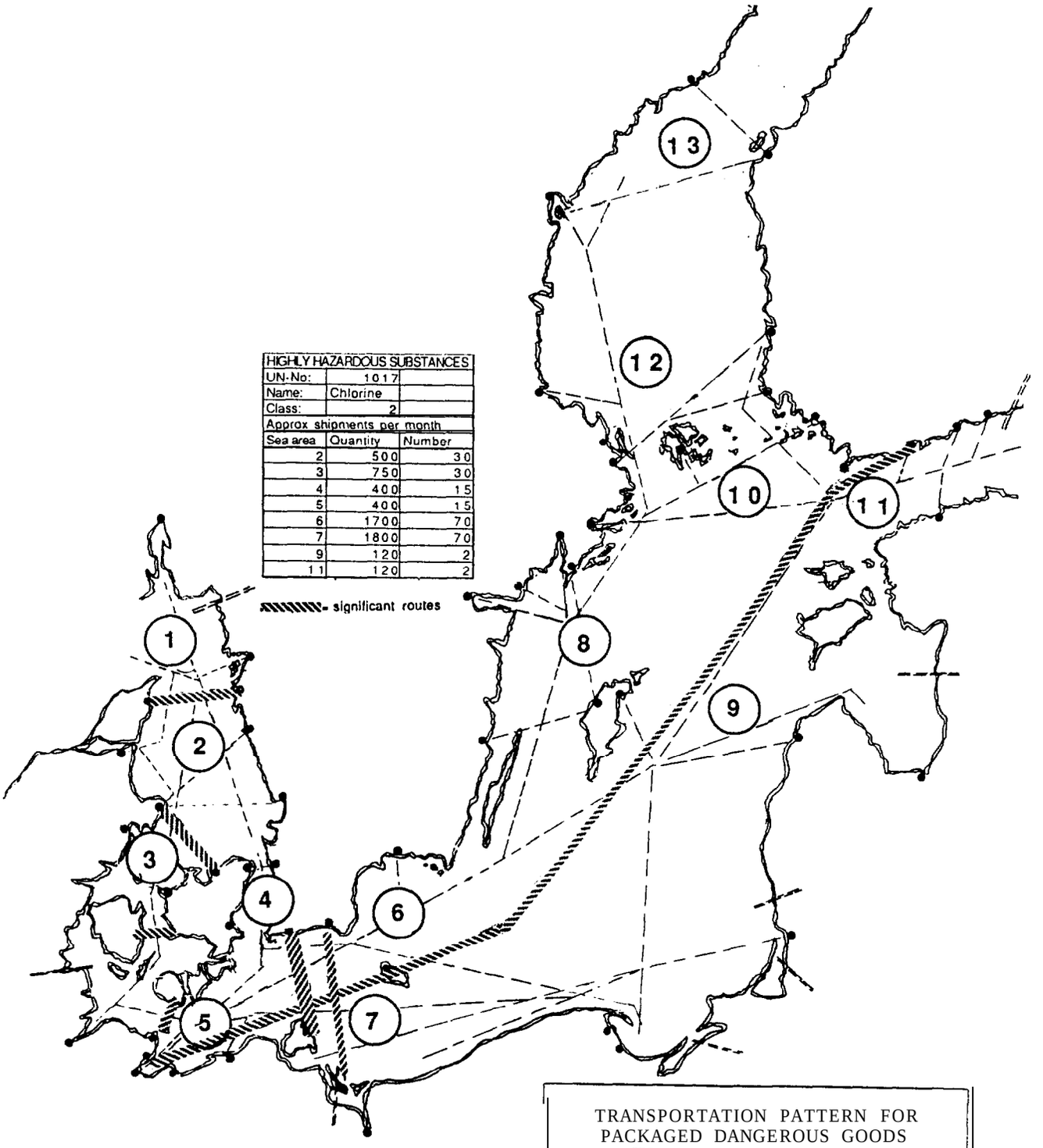
HIGHLY HAZARDOUS SUBSTANCES		
UN-No:	81	
Name:	Explosives	
Class:	1	
Approx shipments per month		
Sea area	Quantity	Number
1	160	6
2	2 101	15
4	90	3
5	90	4
6	25	1
7	5	1
8	60	5

▨ significant routes

TRANSPORTATION PATTERN FOR
PACKAGED DANGEROUS GOODS
IN **THE** BALTIC SEA AREA

Shipment of highly hazardous substances
UN-No: 0081
class: 1

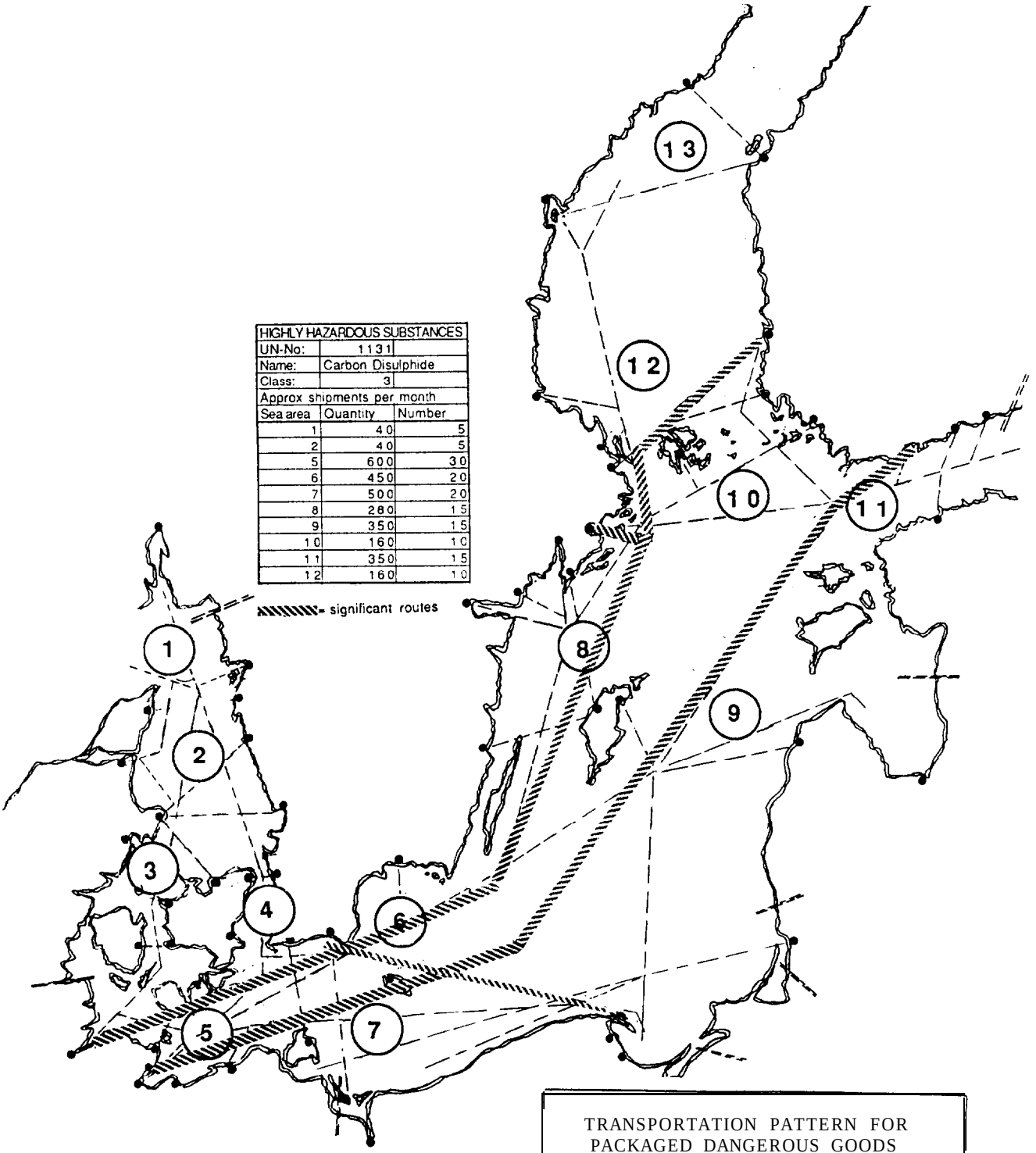
FIGURE 4.1



TRANSPORTATION PATTERN FOR
PACKAGED DANGEROUS GOODS
IN THE BALTIC SEA AREA

Shipment of highly hazardous substances
UN-No: 1017
class: 2

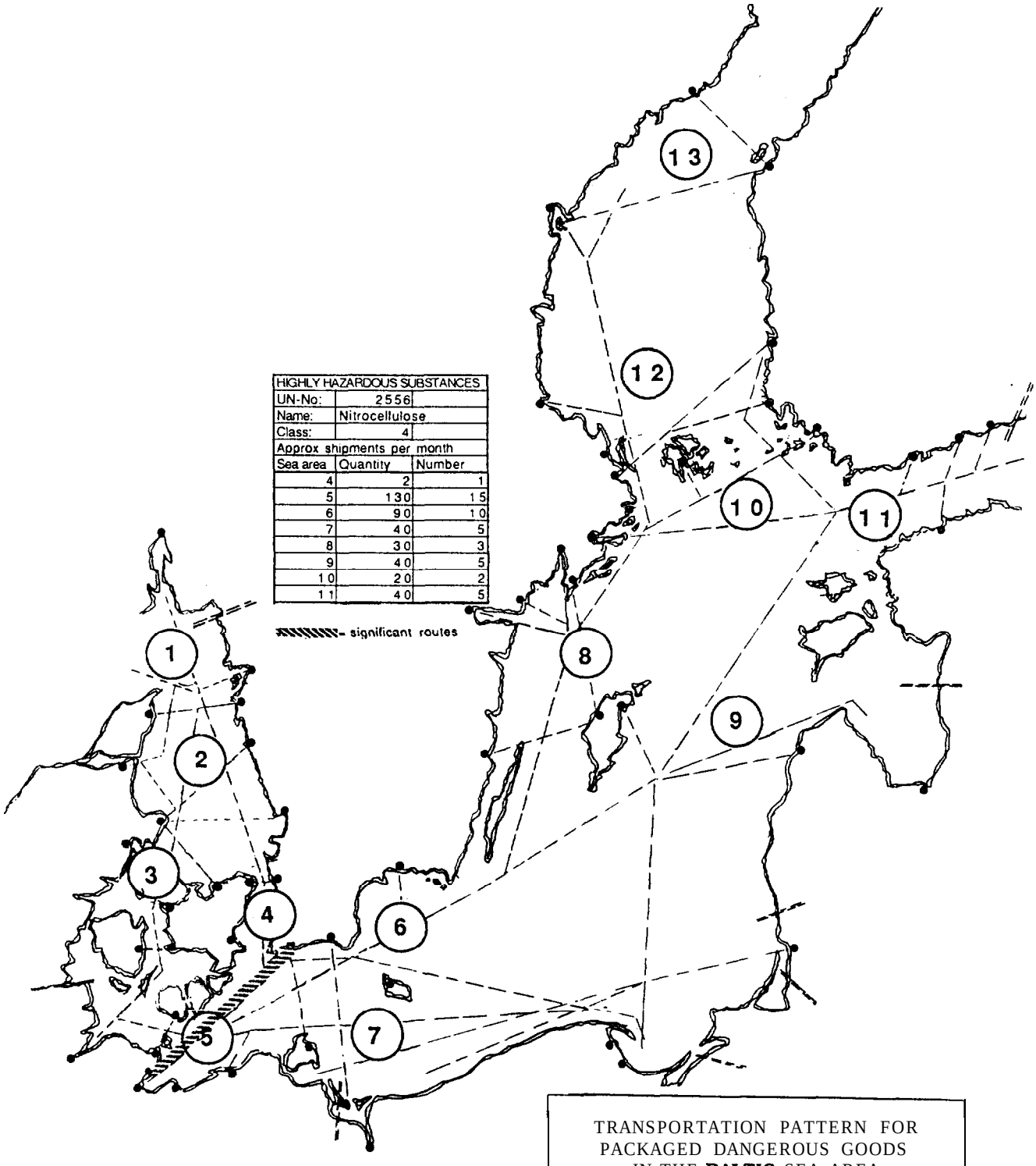
FIGURE 4.2



TRANSPORTATION PATTERN FOR
PACKAGED DANGEROUS GOODS
IN THE BALTIC SEA AREA

Shipment of highly hazardous substances
UN-No: 113 1
class: 3

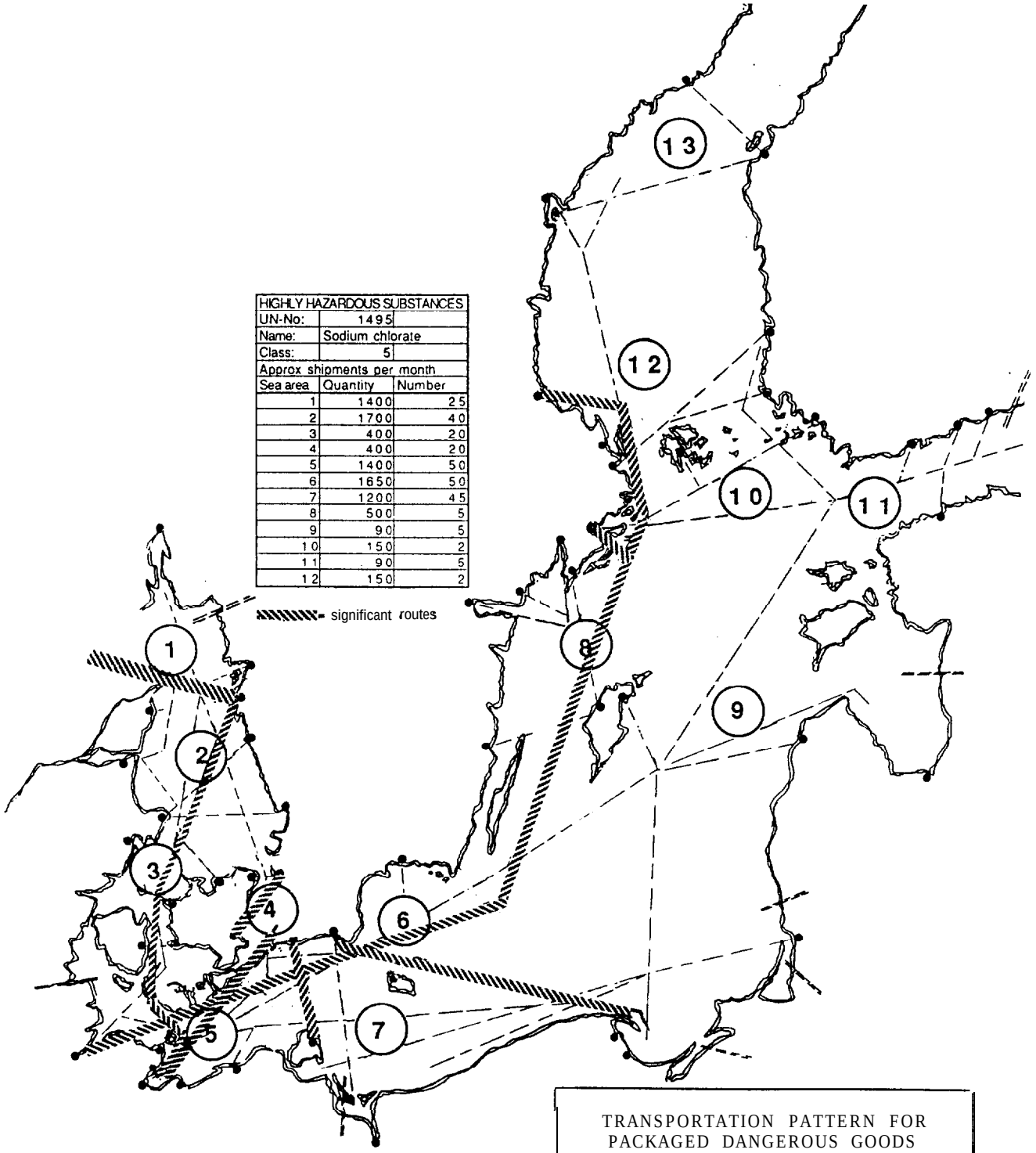
FIGURE 4.3



TRANSPORTATION PATTERN FOR
PACKAGED DANGEROUS GOODS
IN THE **BALTIC** SEA AREA

Shipment of highly hazardous substances
UN-No: 2556
class: 4

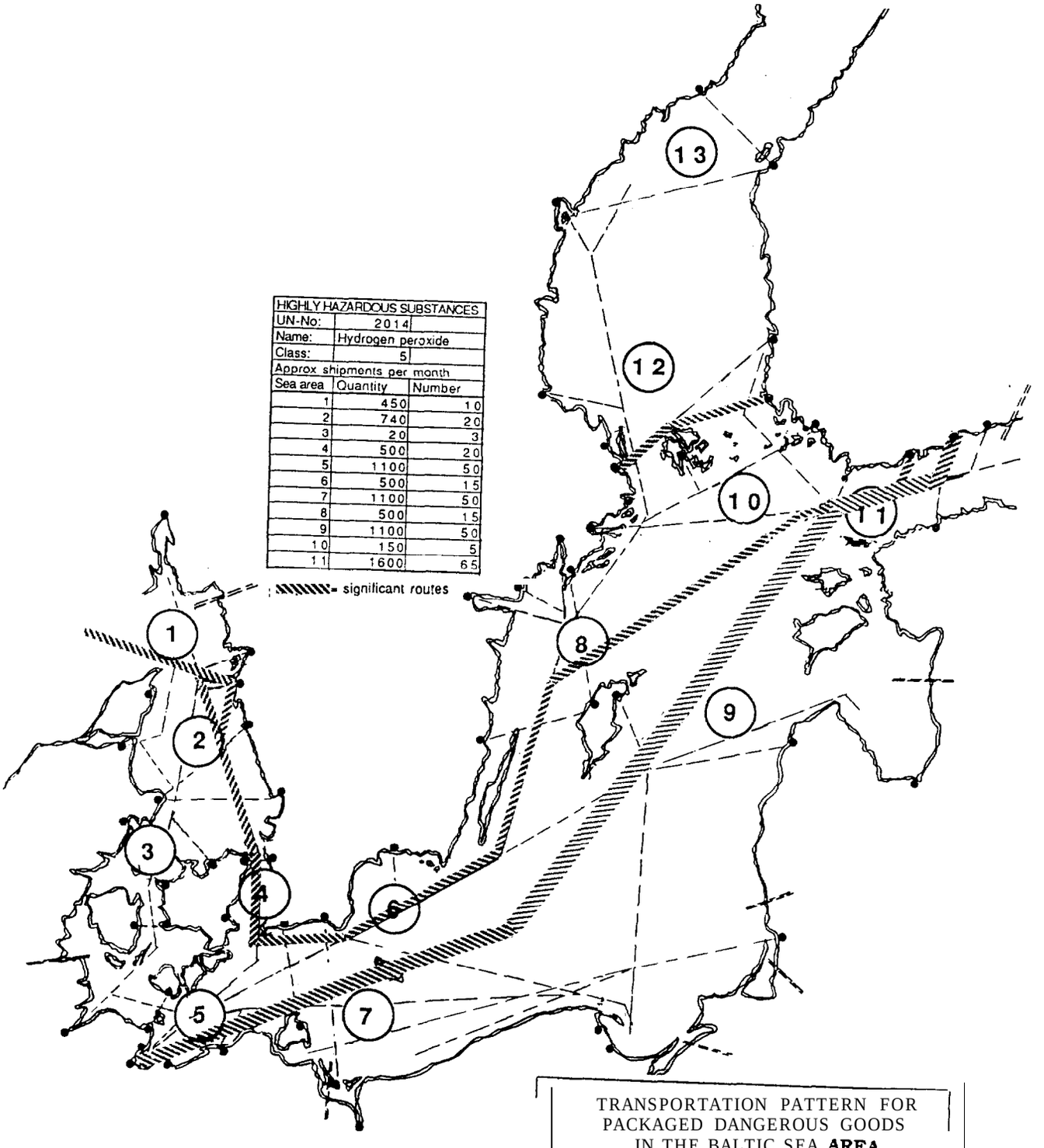
FIGURE 4.4



TRANSPORTATION PATTERN FOR
PACKAGED DANGEROUS GOODS
IN TBE BALTIC SEA AREA

Shipment of highly hazardous substances
UN-No: 1495
class: 5

FIGURE 4.5



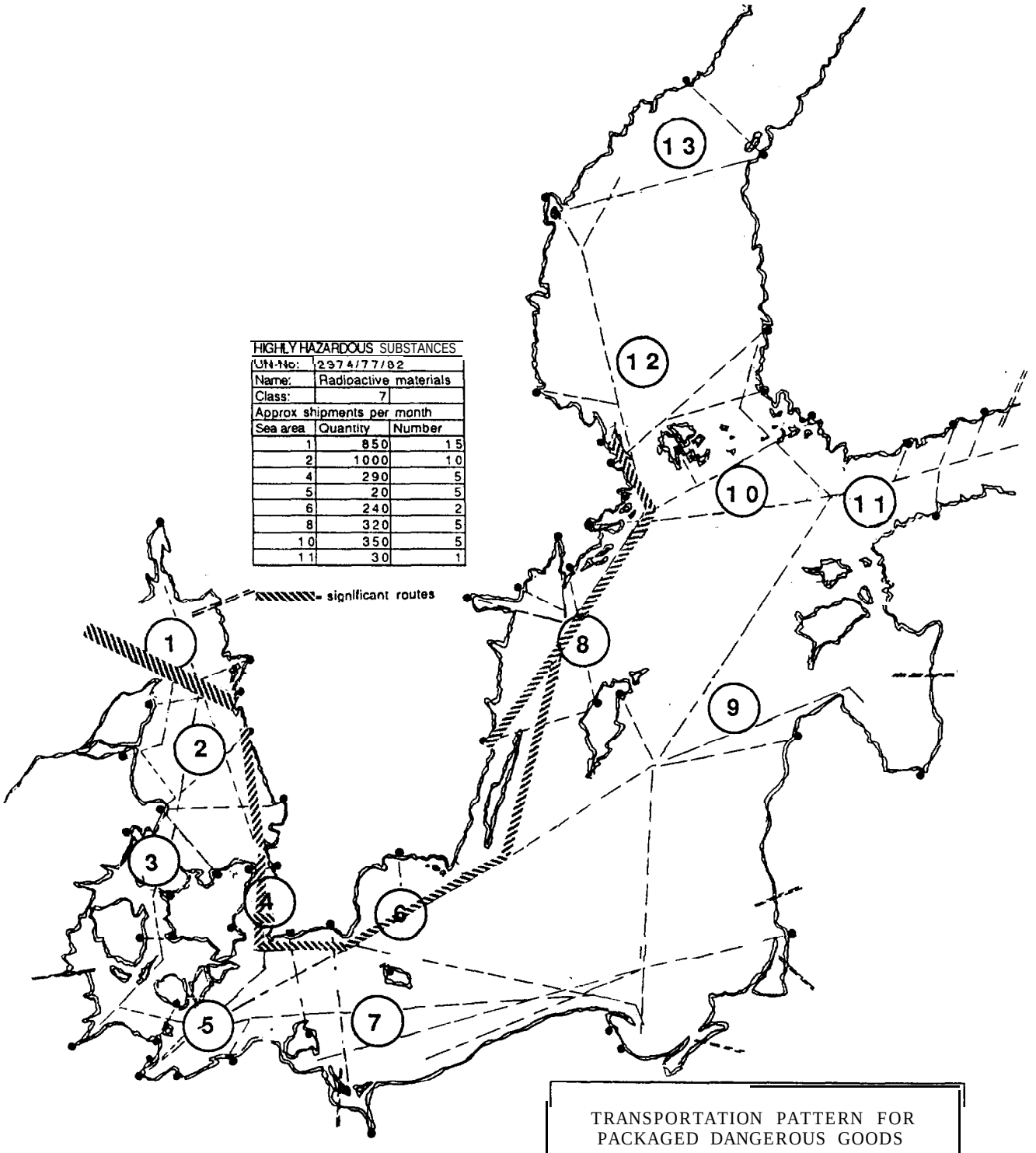
HIGHLY HAZARDOUS SUBSTANCES		
UN-No:	2014	
Name:	Hydrogen peroxide	
Class:	5	
Approx shipments per month		
Sea area	Quantity	Number
1	450	10
2	740	20
3	20	3
4	500	20
5	1100	50
6	500	15
7	1100	50
8	500	15
9	1100	50
10	150	5
11	1600	65

= significant routes

TRANSPORTATION PATTERN FOR
PACKAGED DANGEROUS GOODS
IN THE BALTIC SEA **AREA**

Shipment of highly hazardous substances
UN-No: 2014
class: 5

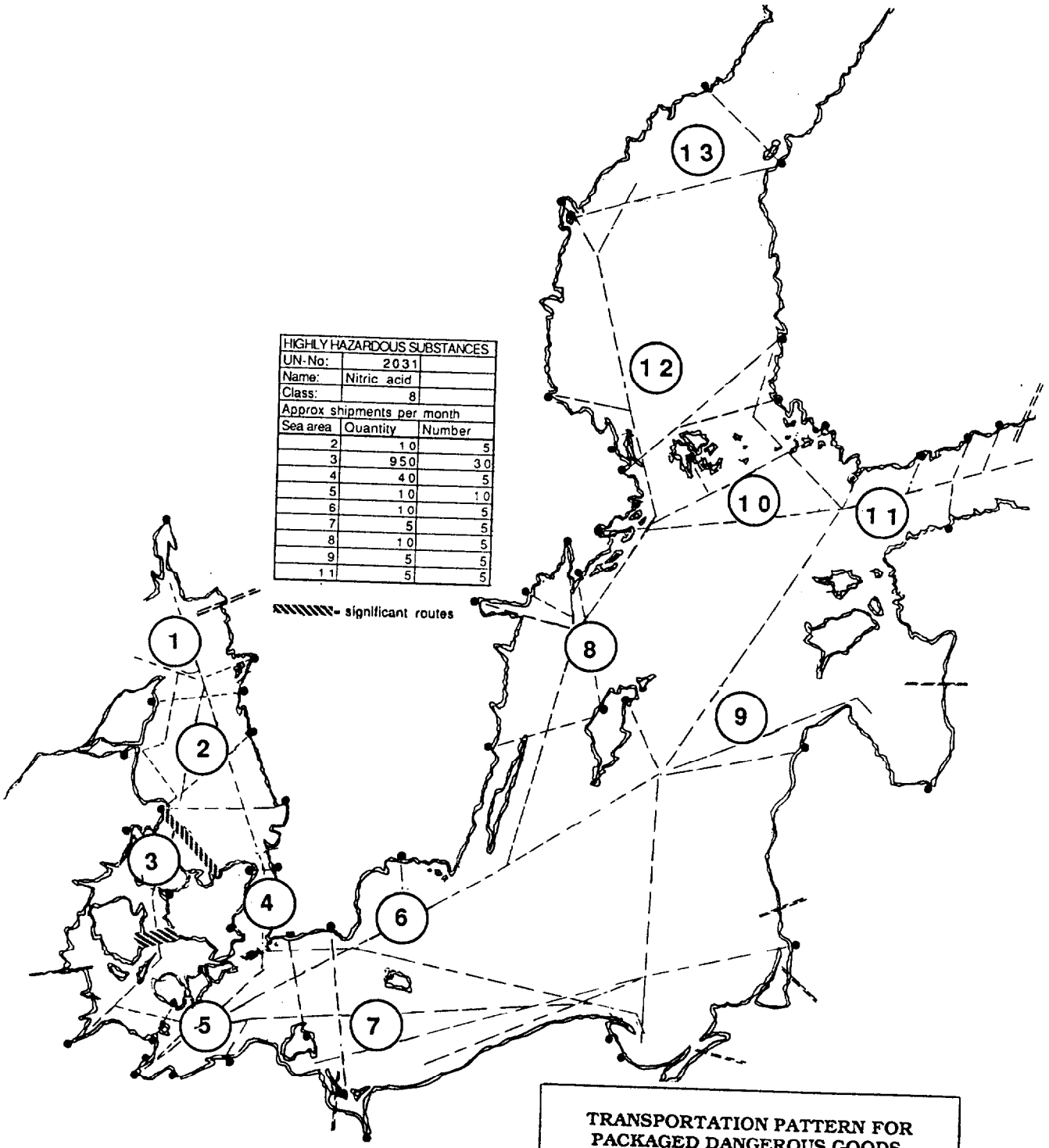
FIGURE 4.6



TRANSPORTATION PATTERN FOR
PACKAGED DANGEROUS GOODS
IN THE BALTIC SEA AREA

Shipment of highly hazardous substances
UN-No: **2974/77/82**
class: 7

FIGURE 4.7



TRANSPORTATION PATTERN FOR PACKAGED DANGEROUS GOODS IN THE BALTIC SEA AREA

Shipment of highly hazardous substances
UN-No: 2031
Class: 8

FIGURE 4.8

8. Risk for Accidents.

The risk for a serious accident to a vessel carrying packaged dangerous goods on board can be estimated to be about once per year. The risk for damage to packages, resulting in outflow of the substance is higher. The frequency of such incidents with substantial outflow is estimated to be about six times per year.

The reported transportation activity involves about 4000 voyages per month. The majority of these are ferry voyages of relatively short duration. The number of passages through port inlets is on the other side high. The number of hours at sea has been estimated to be 25000 per month, corresponding to 35 ships in continuous operation at sea or about 60 ships continuously engaged in loaded condition with a normal time at sea factor. If a general, statistically based, risk factor for a serious accident of 1.5 in 100 ship years is applied, one such accident should then, hypothetically, be expected about once per year. This frequency refers to an accident to the vessel, including grounding, collision, engine break-down, fire and other serious accidents.

The hypothetical accident rate for the vessels can be calculated for the main causes, based on the predominant parameters, i.e. the traffic density in the area, the frequency of the port entries and the length of the voyages. Such calculations indicate for the various incident scenarios and various parts of the Baltic Sea area the following rates per year.

Area	Collision	Grounding	Fire/other	Total
the Baltic Sea proper	0.08	0.15	0.20	0.4
the Öresund	0.09	0.10	0.02	0.2
the Belt/Danish waters	0.07	0.10	0.02	0.2
the Kattegatt	0.04	0.05	0.06	0.2

The total risk for an accident with a vessel carrying dangerous packaged goods may thus be in the magnitude of 0.4 per year in the Baltic Sea proper and about 0.2 per year in each of the areas of Öresund, the Belt and related waters and the Kattegatt.

Only a fraction of these accidents may directly effect the parcel of dangerous cargo carried onboard. These figures do, however, only indicate serious accident to the ship. A further risk from the transportation of packaged dangerous good arises if the cargo containment gets damaged or lost due to ship movement in bad weather or due to poor stowage or handling. Statistics indicating the frequency of such damages, which may pose a hazard to personnel or the marine environment, is not generally available. From limited statistics it may be concluded, however, that bad stowage is the major cause for cargo damage, both for containerized cargoes and for bulk and general cargoes. Crew and shore staff error is attributed as the main cause for the bad stowage and mechanical failure is a relatively less common cause for the damage. According to one international insurance source reporting about major claims, the number of cargo damage claims is about six times higher than the number of collision damage claims. This would indicate about two to three significant cases of cargo damage per year in the Baltic Sea area. A number of cases of smaller damage should be added to this figure.

The actual number of incidents involving carriage of packaged dangerous goods in the Baltic Sea area was for the ten year period 1980 - 1989, as reported by Administrations of the Baltic Sea states:

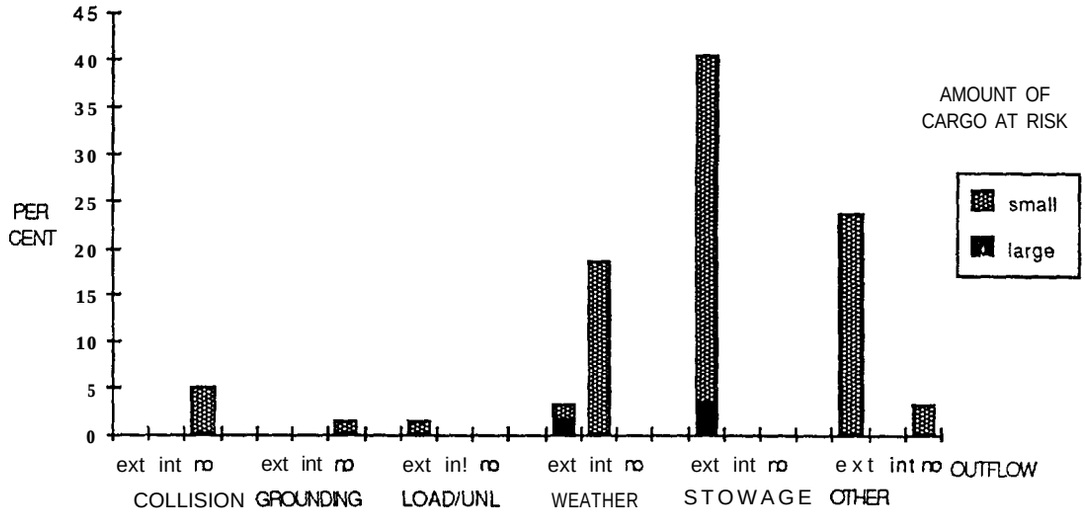
3 collisions,
I grounding.
14 heavy weather incidents and
24 cases of damage due to inadequate stowage,
17 miscellaneous (incl fire).

This makes in total 59 cases in ten years or about six per year. A total of 52 of these cases are reported as having resulted in loss overboard of packages with dangerous goods. 30 of the cases have resulted in direct discharge of chemicals into the sea and a further 10 have

resulted in release of cargo inside the ship. The frequency of release of dangerous cargo has thus been about 5 per year. The relative frequency of occurrance of these incidents is illustrated in Figure 5. These cases of damage are of the magnitude that the administration has become involved or notified. A number of cases with lesser damage may occur, outside of the official reporting systems.

From these estimations and available statistics it may be correct to assume that the frequency of serious accidents to vessels carrying packaged dangerous goods will be in the order of one per year and the number of cases of significant release of packaged dangerous goods into the sea may be about five per year.

FIGURE 5. CAUSES OF ACCIDENTAL OUTFLOW



ext = release of cargo outside of the ship
int = release of cargo inside of the ship
no = no release of cargo